Geraldine Camilli
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01/02/2011 12:26 AM

To Christopher Hunter
cc Thomas Noble, Amy Ball, Mark Nelson
bcc
Subject Surface Coal Mining Application Review Guidance - Remaining draft summaries

9 attachments

101231_3_Science (draft)_10058.pdf 101231_4_Conductivity-summary (draft)_10058.pdf
101231_5_NPDES (draft)_10058.pdf 101231_6_CWA Section 404 (draft)_10058.pdf
101231_7_CWA Section 401 (draft)_10058.pdf 101231_8_NEPA (draft)_10058.pdf
101231_10_EconomicConsiderations-summary (draft)_10058.pdf
101231_11_Overall_Comments-summary (draft)_10058.pdf 101231_2_Fed_Auth-summary (draft)_10058.pdf

Hi Chris:

Attached are the draft summaries for the remaining nine issues. As Amy mentioned to you on December 21st, some issues received very few comments as of the December 1st docket postings, particularly issues VII and VIII. In addition, as of December 1st, the docket had not yet posted comments from certain commenter categories (e.g., Federal agencies). We left placeholders in the attached drafts, but will remove them altogether if no comments are received under these categories.

Please note that we added the following sub-issues to issue areas III, X, and XI because these could not easily be summarized into the existing sub-issues. Any of these can be removed if you feel they are not relevant to you.

- III. e. Insufficient Scientific Evidence (some commenters felt that the Guidance referenced insufficient scientific evidence, or that additional peer review or research was needed);
- X. e. General Economy (some comments did not specify the geographic impact to the economy but raised valid points)
- XI. c. General Opposition to Mountaintop Mining (some comments were very generic and barely addressed the Guidance, if at all, so they would not have been categorized)
- XI. d. General Support of Mountaintop Mining (same as above)

While we were developing these summaries, we re-characterized the issue areas addressed by certain commenters (i.e., X or no X in the database). We are updating the database to reflect those and will submit it to you when it is complete.

Finally, here is a quick update on the overall comment volume. The docket is still posting comments, and the total was 792 comments as of December 31st. We have downloaded and sorted comments posted

between December 1st and 31st, and have identified only approximately 25 additional comments submitted by commenters other than modified mass mailers and private citizen general.

Happy New Year,
Geraldine

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XI. Overall Comments

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The Overall Comments issue includes those comments, recommendations, and opinions submitted by stakeholders in general support or opposition to the Guidance, and/or to mountaintop mining in general.

There were a total of 104 unique tallied comments posted by the docket as of December 1, 2010. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 11-1 on the next page presents the total comment letters that made an overall comment by commenter category.

Most comments from private citizens and the mass mailing campaigns are in general agreement with the Guidance and commend EPA for issuing it; and are generally opposed to mountaintop mining in general. They argue that mountaintop mining activities are destructive of wildlife, forests, and streams, and have negative health impacts; and that the Guidance is based on sound science. The few private citizens in opposition to the Guidance express economic concerns. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. Industry commenters contend that the Guidance is legally flawed, will have negative economic impacts, and relies on insufficient scientific data and peer review. Congressional delegates argue that the Guidance was issued prematurely, will cost many jobs, and undermines the authority, role, and responsibility of State agencies in reviewing and issuing permits. The Sierra Club argues that the Guidance is based on sound scientific evidence and commends EPA for issuing it. The Kentucky Energy and Environment Cabinet highlights EPA's challenge of implementing existing requirements while protecting other interests, including the economy and energy supply.

Below are summaries of the overall comments, presented by commenter category. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline)

and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

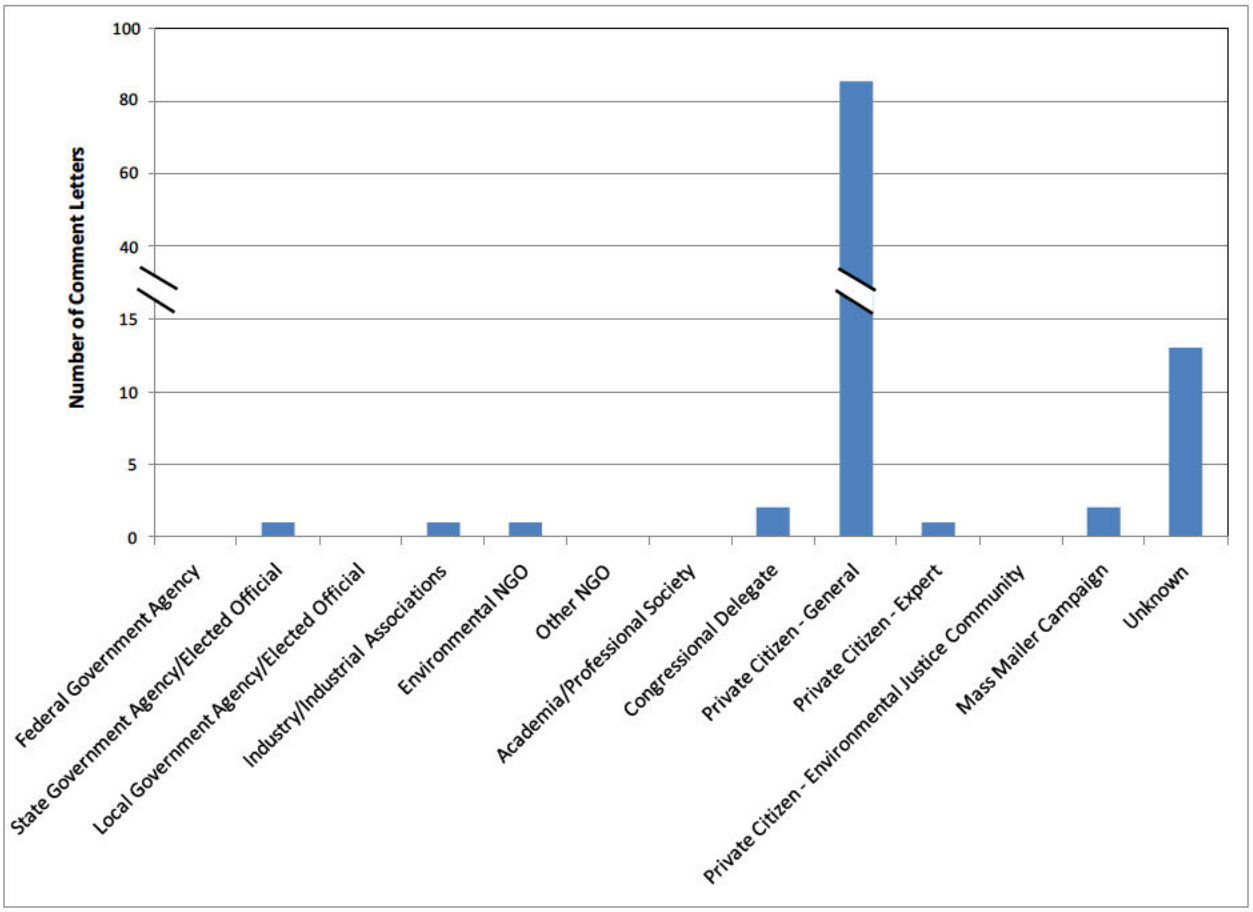

Figure 11-1. Overall Comments, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations.

a. General Support for the Guidance

The Kentucky Energy and Environment Cabinet agrees with EPA's commitment to developing environmentally effective, scientifically sound, and economically responsible approaches for

meeting existing requirements while not compromising the Appalachian region and depriving the entire nation of the benefits coal provides, both for the economy and energy supply.

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance.

b. General Opposition for the Guidance

Frost Brown Todd argue that the Guidelines "impose insurmountable technical and economic burdens on the coal mining industry, effectively shutting down surface coal mining (and possibly significant underground coal mining) throughout much of Central Appalachia" (p. 2)and request the Guidelines be immediately withdrawn. The following several arguments are provided to support their request:

- "The Guidance Memorandum is legally flawed and imposes inappropriate requirements on the regulated community without following proper procedures" (p. 3);
- "EPA's implementation of the Guidance threatens to effect unconstitutional taking of the property of mineral owners" (p. 6);
- "The April 1 Guidance Memorandum will create unnecessary confusion and uncertainty and treats the states, regions, and industries inequitably" (p. 7); and
- "The April 1 Guidance Memorandum relies on limited, questionable, and unproven scientific 'data' and analyses" (p. 8).

They further request EPA to "instruct the states, EPA regions, and other federal agencies not to implement or enforce any of the requirements contained therein" (p. 9).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, one letter was submitted from an Environmental NGO commenting on

EPA's Guidance. The Sierra Club (Doc. #0225.1) strongly supports the Guidance and commends EPA for issuing it.

a. General Support for the Guidance

The Sierra Club is of the opinion that the EPA was justified in implementing the Guidance immediately. They agree that the most recent, peer-reviewed scientific evidence was used as the basis for the Guidance and further state the Guidance is "necessary to protect water quality from the effects of mountaintop removal mining" (p. 2).

6. Other NGOs

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

8. Congressional Delegates

Two comment letters posted by the docket as of December 1, 2010 were submitted by congressional delegates. Both letters are signed by several members of Congress and disagree with the Guidance. The first letter (Doc. #0011) is signed by three congressional delegates representing the States of Virginia and West Virginia. The second letter (Doc. #0015) is signed by 23 congressional delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming.

b. General Opposition for the Guidance

Both letters argue the Guidance was issued prematurely and urge EPA to withdraw it. Some congressional delegates (Doc. #0011) agree that regulations are necessary but suggest EPA "continue to work with the affected States, the involved federal agencies, and all stakeholders to develop guidelines that truly provide a balanced process for energy development and environmental protection" (p. 2).

9. Private Citizen - General

Eighty two comment letters, typically one page in length, were received from members of the general public. Two letters from private citizens (Doc. #0019, and Doc. #0249) disagree with EPA's Guidance. The remaining private citizen commenters either support the Guidance or are opposed to mountaintop mining in general.

a. General Support for the Guidance

The majority of the general public is in support of the Guidance and commends EPA for issuing it. Several commenters point out that mountaintop mining destroys wildlife, forests, and streams and are of the belief that the Guidance will help protect people and the environment from negative impacts of mountaintop mining. Many agree the Guidance has been based on the best available science and thank EPA for enforcing the CWA.

One commenter (Doc. #0009) sums up the feelings of the overall general public by saying, "I applaud the Environmental Protection Agency for setting a tough new policy that should protect waterways and communities from the destruction caused by mountaintop removal. The new policy represents the most significant administrative action ever taken to address mountaintop removal coal mining and reaffirms the administration's commitment to science and environmental justice for the communities and natural areas of Appalachia."

b. General Opposition for the Guidance

Both commenters in general opposition to the Guidance are concerned that mines will be closed, small towns will be devastated, additional poverty will be created, and residents will be forced to relocate. One comment letter states, "My family and many others like us will have to leave our state to find work (Doc. #0019)."

c. Opposed to Mining in General

Many in the general public are opposed to mining in general. Commenters argue it destroys natural resources and causes health problems. One commenter (Doc. #0020) states: "Please help bring an end to Mountaintop Removal. I just can't believe this ever happened in the first place" (p. 2). Another commenter (Doc. #0025) points out that the profits earned by coal companies do not justify the negative impacts to people's health and the environment and writes: "several billion dollars of income are earned by the coal companies but the costs to West Virginia alone amount to tens of billions of dollars in health costs and perhaps even larger amounts to the degradation of WV's environment."

10. Private Citizen – Expert

As of December 1, 2010, one letter (Doc. #0112) was submitted from a private citizen - expert commenting on the issue of federal authority to regulate these activities in EPA's Guidance. The commenter is a biologist, with a Masters degree in biology, and is currently a teacher teaching Wildlife Management and Environmental Earth Science, with more than three decades of experience in the public school system.

a. General Support for the Guidance

The commenter is in general agreement with the Guidance, concurring that there is unequivocal scientific evidence to supports the Guidance. The commenter is of the opinion that: "it is our duty as the most powerful species to exist on this planet to use our might to protect the integrity

of our life support systems for the benefit of all living things" (p. 1).

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

a. General Support for the Guidance

Both campaigns are in support of EPA's Guidance and suggest that the Guidance should be strengthened and finalized. They agree the most recent, peer-reviewed scientific information documents that mountaintop mining negatively impacts water quality.

13. Unknown

Thirteen comment letters, typically one page in length, were received from unknown or unidentified commenters. One commenter is in general disagreement with EPA's Guidance; the others are in general agreement.

a. General Support for the Guidance

The majority of the commenters in general agreement with the Guidance feel it will help protect public health and water quality from the impacts of mountaintop mining. Many commenters also urge EPA to strengthen and finalize the Guidance.

b. General Opposition for the Guidance

The commenter in general disagreement with the Guidance argues it is based on "scientific studies that are limited in scope and analysis (Doc. #0010)." The commenter feels the individual states should be able to administer their own water quality programs and define what constitutes stream degradation. The commenter claims the Guidance is a violation of states' rights.

X. Economic Considerations

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The issue area of Economic Considerations includes those comments, recommendations, and opinions submitted by stakeholders regarding lost jobs or income, impacts to the national, state, or local/county economy, and general economic considerations.

There were a total of 12 tallied comments submitted to the docket as of December 1, 2010, discussing the economy. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, congressional delegates, and the general public. Most comments were received from private citizens or anonymous commenters. Figure 10-1 on the next page presents the total comment letters that address the economy by commenter category.

Private citizen (including anonymous stakeholders) comments are both in support with and in opposition to the Guidance. Those in support of the Guidance express the view that natural resources and the public health should outweigh economic considerations, including jobs. Those in opposition to the Guidance associate it with negative economic impacts both locally (i.e., at the individual level) and at a larger scale.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) is in general support of the Guidance but seeks clarification on Guidance implementation through a series of questions. Both groups contend that the Guidance may render mountaintop mining activities economically unfeasible, negatively impacting local economies and the industry and resulting in potential closures of mountaintop mining activities. They also make note of the Guidance's limited applicability to six states, which they contend will result in economic disparities. Questions from the Kentucky Energy and Environment Cabinet relate to economic concerns associated with lost job opportunities, geographic inequity of the Guidance applicability, and environmental justice for low-income, high-unemployment areas.

Below are summaries, presented by commenter category, on economic considerations. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

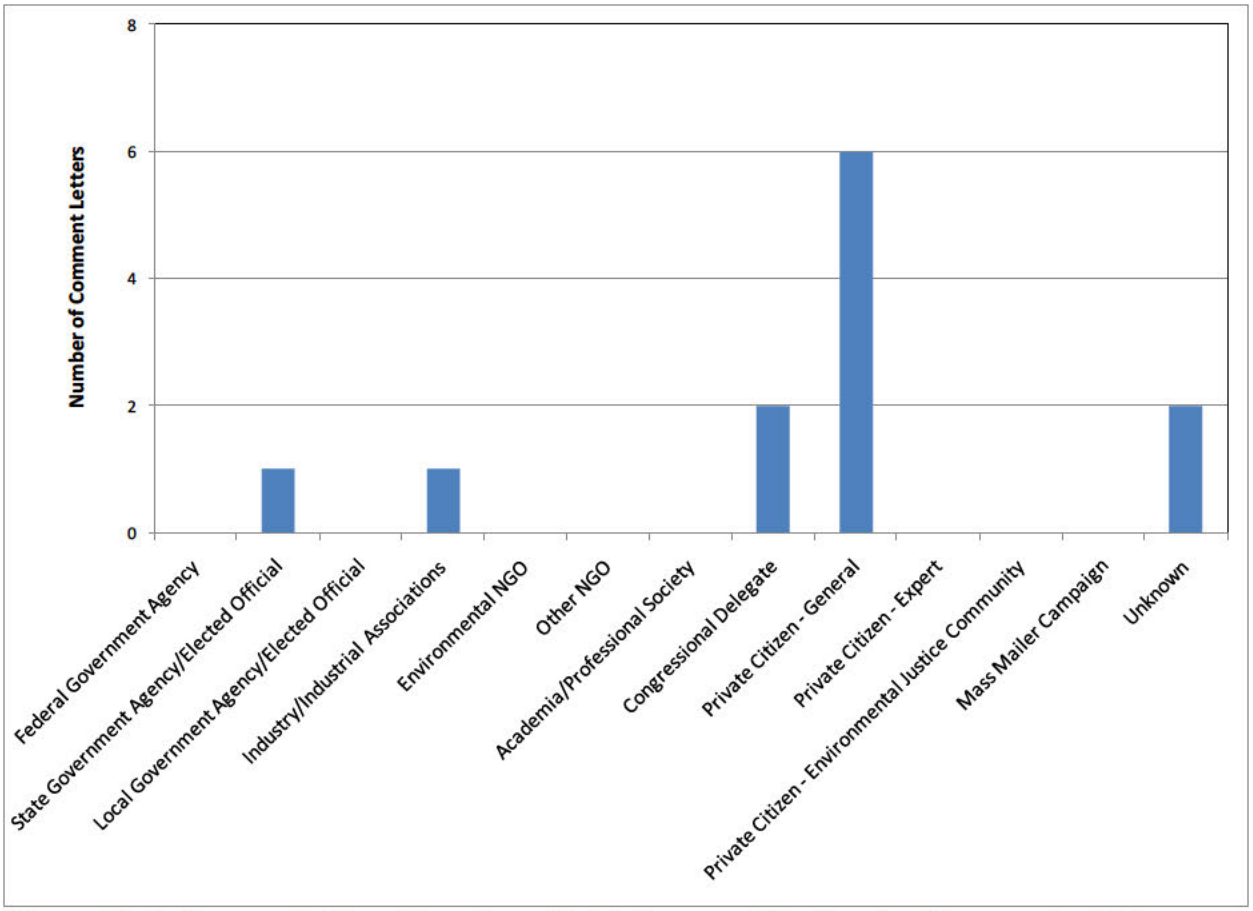

Figure 10-1. Economic Considerations, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

The Kentucky Energy and Environment Cabinet (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations. They express concern that the Guidance is premature and may unnecessarily impact the economy.

a. Jobs Lost/Lost Income

The Kentucky Energy and Environment Cabinet is concerned that the Guidance may be premature and has the potential to cause more economic harm than good. They ask: "is there not

a potential for permit requirements to be imposed by U.S. EPA in the interim that are more restrictive or potentially more cost prohibitive than in the final guidance, resulting in job loss and economic hardship that could be avoided by waiting until the guidance is finalized. (p. 3)?"

c. Impacts to State Economy

The Kentucky Energy and Environment Cabinet points out that only six states (Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia) are subject to the Guidance and speculate that the Guidance may be creating "economic inequity and a competitive disadvantage between the six targeted states and other coal producing states (p. 3)?"

e. General Economic Considerations

The Kentucky Energy and Environment Cabinet raises the issue of economic impacts to low-income areas of Appalachia. They acknowledge that "each Federal agency shall make achieving environmental justice (EJ) part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (p. 4), and ask: "How does the potential elimination of high wage jobs for citizens living in low-income, high unemployment areas of Appalachia, factor into the EJ decision-making process?" (p. 4).

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the economy. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance and argue that it will have negative economic impacts on the industry, resulting in potential closures of mountaintop mining activities.

a. Jobs Lost/Lost Income

Frost Brown Todd claim that the strict standards in the Guidance "will make most mining activities practically and economically infeasible" (p. 6). They further argue the Guidance focuses too much attention on community water supplies while ignoring "the potential severe harmful socio-economic effects that would be inflicted on low-income communities throughout Appalachia through the loss of employment" (p. 5).

b. Impacts to National Economy

Frost Brown Todd foresee impacts to the national economy, including loss of profits and resulting lawsuits against the federal government by the coal industry and property owners. They view the coal mining industry as "an essential part of our nation's economic vitality and a key to our short- and long-term economic and energy security" (p. 9). They suggest the Guidance will cause significant loss of profits and lead to lawsuits filed by companies in the coal business and property owners to recover hundreds of billions of dollars of lost profits. They claim the Federal Government will be required to provide compensation for these lawsuits and "at such a tenuous financial time, this would have disastrous, wide-spread effects on our nation" (p. 7).

c. Impacts to State Economy

Frost Brown Todd point out that the Guidance focuses on eliminating a specific type of mining in only six states (Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia) and argue: "This disparity creates dramatic economic inequities and puts these states and this industry at a crippling competitive disadvantage with industries in other states and regions. The result will be nothing less than catastrophic" (p. 8).

e. General Economic Considerations

Frost Brown Todd argue that the Guidelines "impose insurmountable technical and economic burdens on the coal mining industry, effectively shutting down surface coal mining (and possibly significant underground coal mining) throughout much of Central Appalachia" (p. 2).
They further contend that EPA's adaptive remedial action provision will "impose economically impracticable and technically unachievable mitigation requirements on them in perpetuity" (p. 8).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

6. Other NGOs

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. Congressional Delegates

Two comment letters posted by the docket as of December 1, 2010 were submitted by congressional delegates. Both letters are signed by several members of Congress, are in general opposition to the Guidance, and discuss economic considerations. The first letter (Doc. #0011) is signed by three congressional delegates representing the States of Virginia and West Virginia. The second letter (Doc. #0015) is signed by 23 congressional delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming.

a. Jobs Lost/Lost Income

Both letters express concern that the Guidance will jeopardize a significant number of jobs. For example, on letter states: "Permits issues under the Clean Water Act affect nearly 80,000 direct coal mining jobs in Appalachia" (Doc. #0015, p. 1).

b. Impacts to National Economy

The Guidance is specific to surface coal mining in Appalachia, and congressional delegates feel it "sorely fails to address the equally noble goal of economic fairness. The Appalachian states know all too well the challenges of economic inequity and any actions that would serve to further undermine the fragile economy of this region ought to be met with a robust federal effort to shore up and improve the economy" (Doc. #0011, p. 1).

d. Impacts to Local / County Economy

One letter argues that the Guidance will have a negative impact to the local economy and that "EPA has jeopardized the future of mining operations [and] the sustenance of local communities" (Doc. 0015, p. 1).

e. General Economic Considerations

Commenters express concern that the Guidance will have economic impacts to communities that have not had opportunity to provide input, as stated "with the country's economy still

floundering and unemployment hovering near 10%, the potential economic impact of these policies validate our request that affected communities be given the opportunity to voice their concerns in the decision-making process" (Doc. #0015, p. 1).

9. PRIVATE CITIZEN - GENERAL

Seven comment letters, typically one page in length, submitted by members of the general public discuss economics. Two letters (Doc. #0019, and Doc. #0249) disagree with EPA's Guidance, while the remaining general private citizen letters either support the Guidance or are opposed to mountaintop mining in general.

a. Jobs Lost/Lost Income

Commenters, both in support of and in disagreement with EPA's Guidance, recognize it could impact the workforce. One commenter in disagreement with EPA's Guidance is concerned "my daughter will not be able to attend college if my husband loses his job in mining" (Doc. #0019). Another commenter in general agreement with the Guidance states "I'm all for creating more jobs, and allowing people to use their land as they see fit. But I'm not going to let them trash what isn't theirs –the water and air—in the process" (Doc. #0006, p. 1).

d. Impacts to Local / County Economy

One commenter in general opposition to the Guidance, is concerned that mines will be closed, small towns will be devastated, and residents will be forced to relocate: "my family and many others like us will have to leave our state to find work" (Doc, #0019).

e. General Economic Considerations

Many in the general public support the Guidance and hope it will be a "change to business as usual that places private profit above public resources" (Doc. #0088). Several commenters feel the protection of public health and waterways should outweigh economic concerns.

10. PRIVATE CITIZEN – EXPERT

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

11. ENVIRONMENTAL JUSTICE AND/OR TRADITIONALLY DISADVANTAGED COMMUNITY

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

13. Unknown

Two comment letters, both one page in length, received from unknown or unidentified commenters discuss the economy. One commenter is in general agreement with EPA's Guidance; the other is in general disagreement.

a. Jobs Lost/Lost Income

The commenter in general disagreement with the Guidance feels it has had a negative impact on the economy stating "our families were forced to leave to find work" (Doc. #0010). The same commenter further suggests the "true endangered species … is the American worker."

d. Impacts to Local / County Economy

The commenter in support of the Guidance suggests people are being pushed from their homes by mining and argues that "property rapidly devalues due to mining activities nearby leaving poor people with few options" (Doc. #0183).

e. General Economic Considerations

The commenter opposed to EPA's Guidance feels it is a violation of states' rights and suggests "this administration does not care about the people of Appalachia and the industry that so many of us depend on to provide for our families" (Doc. 0010). This commenter feels individual states should be allowed to regulate water quality programs.

VIII. National Environmental Policy Act

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The NEPA issue includes comments and opinions submitted by stakeholders regarding cumulative impact analyses under NEPA, the need to prepare Environmental Impact Statements (EISs), and any recommended changes to the Guidance specifically relating to NEPA.

Three tallied comments submitted to and posted by the docket as of December 1, 2010, discussed NEPA. These comments were submitted by the following commenter categories: industry representatives, the general public, and an anonymous commenter. The general private citizen and the anonymous commenter are generally supportive of the issuance of the Guidance and encourage EPA to further its environmental protections when reviewing mountaintop mining projects. Industry commenters focus their comments on the need for preparing an EIS, citing a lack of sufficient information to support EPA's conclusion that an EIS should be required categorically for certain mountaintop mining projects affecting more than one mile of jurisdictional streams. They recommend that the Guidance be immediately withdrawn.

Below are summaries, presented by commenter category, on the NEPA issue. Under each commenter category all sub-issues commented on are listed by letter (based on the issue outline) and discussed.

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. INDUSTRY OR INDUSTRIAL ASSOCIATIONS

Five comment letters were received from industry representatives regarding NEPA. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance, and disagree on the requirement to prepare an EIS under NEPA for specific types of mining activities.

b. Need to Prepare Environmental Impact Statements

Frost Brown Todd contend that "EPA has prematurely, and without sufficient specific information, concluded that an environmental impact statement ('EIS') will be required under the National Environmental Policy Act ('NEPA') for any proposed mining activity that will affect more than one mile of jurisdictional 'streams' (…) Again, EPA has provided no information to support a general conclusion that all such actions will have a 'significant effect' on the human environment" (p. 6).

The commenters further argue that "Moreover, EPA has not subjected that conclusion to notice and comment, as would be required for any general determination to require an EIS for a whole category of activities (as is the case here)" (p. 6).

While not specifically providing recommendations for changes in the guidance relating to NEPA, the commenters conclude with a request that EPA "immediately withdraw the April 1 Guidance in its entirety" (p. 9).

5. ENVIRONMENTAL NON-GOVERNMENTAL ORGANIZATIONS (NGOS)

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

6. OTHER NON-GOVERNMENTAL ORGANIZATIONS (NGOS)

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. ACADEMIA/ PROFESSIONAL SOCIETIES

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. CONGRESSIONAL DELEGATES

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

9. PRIVATE CITIZEN – GENERAL

Only one comment letter from a private citizen had been posted by the docket as of December 1, 2010. This individual, while not specifically referencing the NEPA process, encourages the EPA to "write specific steps in the permitting process which address the collection and analysis of data about the public health impacts (Doc. # 0186, p. 1)" of mountaintop removal coal mining.

10. PRIVATE CITIZEN – EXPERT

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

11. ENVIRONMENTAL JUSTICE AND/OR TRADITIONALLY DISADVANTAGED COMMUNITY

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. FORM LETTERS AND MASS MAILER CAMPAIGNS

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

13. UNKNOWN

One letter (Doc. #0183) posted to the docket as of December 1, 2010, from unknown sources commented on NEPA. The commenter appears to be generally supportive of the Guidance, and encourages the EPA to "Enforce water quality requirements of CWA" and "incorporate WQBELs into permit requirements" again presumably referring to the information necessary for submittal within an EIS.

VII. Clean Water Act Section 401

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The Clean Water Act Section 401 issue includes comments and opinions submitted by stakeholders regarding recommended changes to the Guidance specifically relating to Section 401 of the CWA.

There were a total of three tallied comments submitted to and posted by the docket as of December 1, 2010, discussing Section 401 of the CWA. These comments were all submitted by private citizens, one of whom is a citizen of Appalachia. Commenters express gratitude for the issuance of the Guidance and urge further protection under the CWA, citing the destructive nature of mountaintop mining practices to date.

Below are summaries, presented by commenter category, of the comments received on Section 401 of the CWA.

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

2. State Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

4. Industry or Industrial Associations

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will

be addressed in the final summary.

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

6. Other Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

7. Academia/ Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

8. Congressional Delegates

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

9. Private Citizen – General

Three comment letters posted by the docket as of December 1, 2010, and submitted by members of the general public commented on Section 401 of the CWA either directly or by reference to water quality issues. Additional comments received subsequently will be addressed in the final summary. The comments generally support the issuance of the Guidance, and recommend further measures. For example, one commenter recommends that EPA "further increase protections for our streams and our communities. Stream protections must be more permanent via rule-making. I urge the EPA to assure that state and federal agencies do not issue permits that are contrary to the clear science and legal requirements discussed in the guidance (Doc. #0247)."

10. Private Citizen – Expert

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

13. Unknown

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

VI. Clean Water Act Section 404

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The CWA Section 404 issue area includes those comments, recommendations, and opinions submitted by stakeholders regarding the following sub-issues:

a. Federal Roles of EPA, the Unites States Army Corps of Engineers (Corps), and the Office of Surface Mining Reclamation and Enforcement (OSM) in Evaluating CWA 404 Applications;
b. Independent Evaluation of Water Quality under CWA 404;
c. Mine Design;
d. Relationship of Water Quality to Significant Degradation under 230.10(c);
e. Compensatory Mitigation under CWA 404;
f. Monitoring and Reporting Requirements;
g. Cumulative Impact Analysis under CWA 404; and
h. Recommended Changes in Guidance Relating to CWA 404.

A total of 69 comments posted by the docket as of December 1, 2010 discussed the CWA Section 404. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 6-1 on the next page presents the total comment letters that address the CWA Section 404 issue, by commenter category.

Most comments from private citizens and the mass mailing campaigns are in general agreement with the Guidance and support EPA's implementation of the CWA requirements and identify EPA and the Corps as responsible for the prevention of water quality degradation. These comments are not supportive of valley fills, viewed as destructive, or of stream creation, qualified as insufficient mitigation for stream loss. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. Industry

commenters contend that the Guidance oversteps established authorities and regulatory structures, is incorrectly reflective of the so-called Hobet 45 mine case outcomes which they view as not necessarily applicable to all surface coal mining operations, and imposes unrealistic and unpredictable monitoring requirements. Congressional delegates urge EPA to withdraw the Guidance because it represents substantial changes that exceed the intent of the CWA, and undermines the authority, role, and responsibility of State agencies in reviewing and issuing permits. The Sierra Club disagrees with the sequencing of valley fills and compensatory mitigation, particularly for headwater streams, and urges EPA to further strengthen the Guidance requirements and ensure its prompt implementation in Appalachia. The Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions, some of which relate to mitigation.

Below are summaries, presented by commenter category, on the issue of the CWA Section 404. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

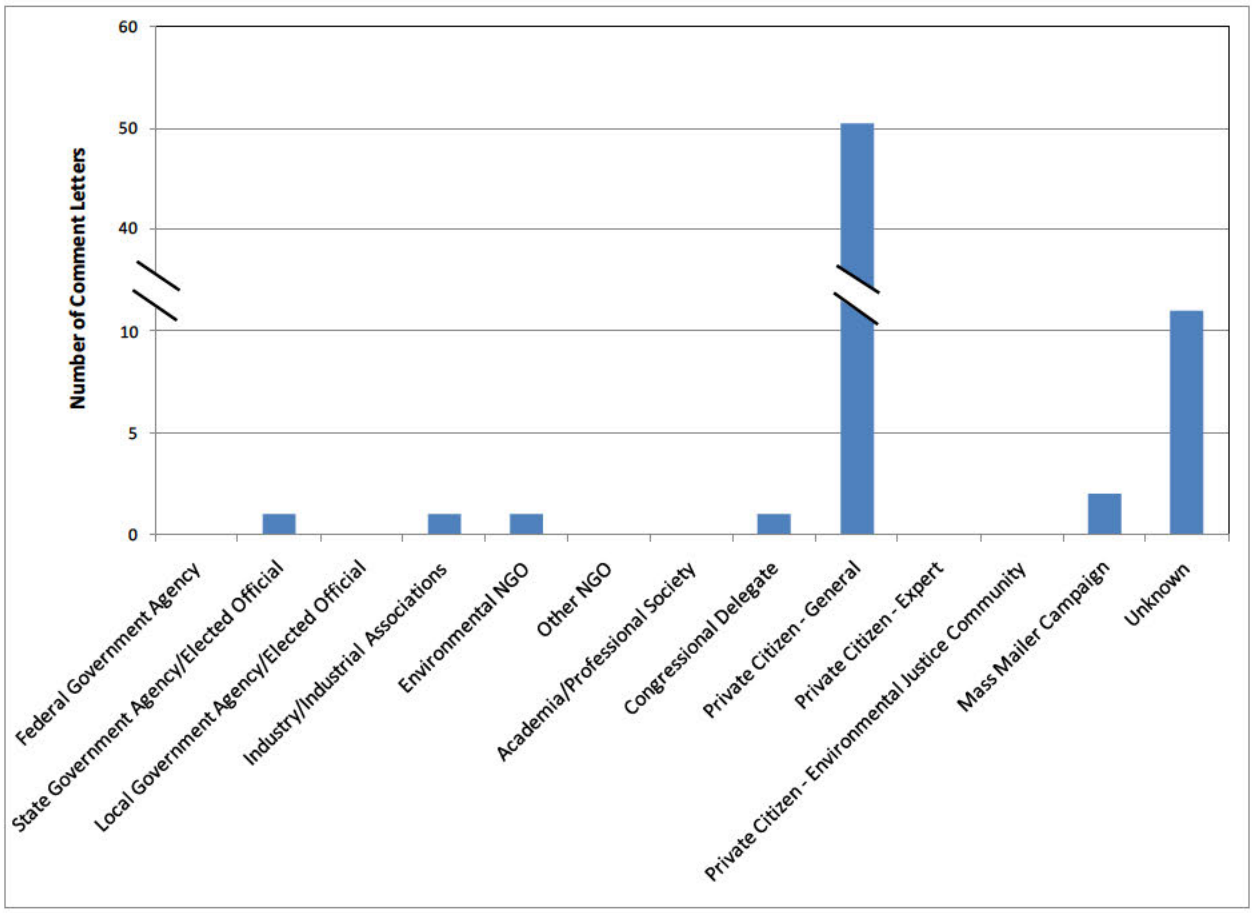

Figure 6-1. Clean Water Act Section 404, Total Comment Letters by Commenter Category

1. FEDERAL GOVERNMENT AGENCIES

As of December 1, 2010, comments from this category group discussing the issue area of the CWA Section 404 had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. STATE GOVERNMENT AGENCIES AND ELECTED OFFICIALS

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations, specifically on the roles of federal agencies in evaluating Section 404 applications.

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

The Kentucky Energy and Environment Cabinet seeks confirmation of whether a Section 404 permit may be issued if a surface coal mining operation "complies with the suggested alternative mining practices in this guidance," and whether "such alternative mining practices will sufficiently mitigate for a reasonable potential to violate for the parameters identified at the bottom of page 22 for a CWA § 402 permit" (p. 5). Seeking further clarification on the roles of federal agencies, Kentucky inquires as to whether the Corps may issue a CWA § 404 permit "in advance of issuance of a CWA § 402 permit" (p. 5).

3. LOCAL GOVERNMENT AGENCIES AND ELECTED OFFICIALS

As of December 1, 2010, no comments from this category group discussing the issue area of Section 404 of the CWA had been posted by the docket. Any comments received subsequently will be addressed in the final summary.

4. INDUSTRY OR INDUSTRIAL ASSOCIATIONS

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. In general, the comments do not support the Guidance. Their CWA Section 404 comments focus

on the roles of government agencies, independent evaluations of water quality under CWA Section 404, sequencing of valley fills, and monitoring and reporting requirements.

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

Frost Brown Todd imply that EPA is overstepping its legal and regulatory boundaries under the 404(b)(1) program: "EPA has clearly directed its regional offices to enforce these requirements, which are set forth in detail in the Guidance, through various means, including objecting to proposed NPDES permits; ignoring state water quality certifications under Section 401 of the CWA; and forcing state and federal agencies to 'correct' NPDES permit deficiencies through other permitting programs, such as the U.S. Army Corps of Engineers' ("Corps") program under CWA Section 404" (p. 3).

They further contend that the Guidance "ignores the careful federal-state balance established by Congress, and imposes numerous requirements on coal mining permitting that are not authorized under the Clean Water Act and related statutes" (p. 4). Frost Brown Todd finally conclude on this subject with the following statement. "These heavy-handed requirements not only contradict the long-established regulatory standards, authorities, and programs under the CWA, SMCRA, and related statutes – they threaten to establish precedents that would undermine the consistent and fair application of those statutes to activities and industries throughout the United States."

b. Independent Evaluation of Water Quality under CWA 404

Frost Brown Todd also assert that the Guidance "effectively precludes the use of whole effluent testing ("WET") and/or best management practices, as allowed under 40 CFR § 122.44, to implement narrative water quality standards," and that the EPA has effectively done so "without notice and comment or appropriate regulatory action" (p. 5).

c. Mine Design with Respect to Sequencing Valley Fills

Referencing the so-called Hobet 45 mine case, Frost Brown Todd argue that the Guidance is reflective of the outcome of that specific case, qualified as "one of the first permits to be addressed through the so-called Enhanced Coordination Procedures adopted by EPA and the Corps in mid-2009" (p. 3). They further imply that the outcome of the negotiations between the EPA, the Corps, and Hobet Mining, LLC, is not necessarily applicable to all surface coal mining operations.

> "This includes the imposition of strict conductivity limits that may not be attainable, dramatic reductions in the percentage of coal to be recovered, requirements for mitigation monitoring and 'adaptive management plans,' and significant revisions to valley fill design. These measures were clearly the 'price to be paid' in order to eliminate EPA's objections to the permits required for the Hobet 45 mine, and EPA has made it patently clear in the April 1 Guidance Memorandum and all of its recent actions that it intends to make these measures mandatory for all future mine permits in Central Appalachia" (p. 3).

f. Monitoring and Reporting Requirements

Echoing the opinion expressed above, Frost Brown Todd further assert that the Guidance imposes unnecessary and costly monitoring requirements for permittees.

> "to include provisions for 'adaptive remedial action" [that] threatens to require every permittee to write an open-ended blank check for further, unlimited mitigation demands by EPA and other resource agencies – without any clear standards or expectations in advance. This threatens to force permittees to attempt to hit constantly moving targets for mitigation and to impose economically impracticable and technically unachievable mitigation requirements on them in perpetuity" (p. 8)

They argue that these monitoring requirements are "arbitrary and capricious and well beyond EPA's statutory authority," and contend that "EPA and other permitting agencies must provide clear, predictable, and attainable standards in advance" (p. 8).

5. ENVIRONMENTAL NON-GOVERNMENTAL ORGANIZATIONS (NGOS)

As of December 1, 2010, one letter was submitted from an Environmental NGO commenting on the issue of the CWA Section 404. Overall, the Sierra Club (Doc. #0225) is supportive of the Guidance, yet encourages the implementation of additional measures to protect the environment from the "environmentally destructive activities taking place" in Appalachia (p. 1). Sierra Club comments upon the sequencing of valley fills and the ability of mitigation measures imposed under Section 404 to mitigate for water quality impacts, and provides recommendations for changes to the Guidance relating to Section 404 of the CWA.

c. Mine Design with Respect to Sequencing Valley Fills

While generally supportive of the Guidance, Sierra Club disagrees "with the policy of sequencing approval of valley fills" (p. 2). Citing that valley fills "cause irreparable damage to streams," the commenter notes that "high conductivity levels cause the loss of streams' ecological services" (p. 2) as demonstrated by the scientific information on which EPA's Guidance is based. The commenter goes on to remind the EPA and the Corps of their "responsibility to prevent water pollution, not simply monitor it after it occurs" (p. 2).

e. Compensatory Mitigation under CWA 404 and the Ability of Mitigation to Compensate for Water Quality Impacts

The Sierra Club disagrees with compensatory mitigation by asserting that "Mitigating for the loss of headwater streams should not be permitted because it is not possible to re-create the ecological functions of these streams." The Sierra Club also wishes for EPA to "recognize that mitigation for these streams is not a viable option" (p. 2).

h. Recommended Changes in Guidance Relating to CWA 404

Sierra Club commends EPA for issuing the Guidance, but urges EPA to further strengthen its requirements with respect to Guidance implementation under the CWA Section 404. "While Sierra Club supports the guidance as an important initial step, we believe that EPA must strengthen it in several aspects" (p. 2). Sierra Club concludes with the statements, "We urge EPA to ensure that the guidance is faithfully carried out in its regional offices and in the Appalachian states. In addition, we ask EPA to strengthen the guidance by recognizing the failure of stream mitigation effort and to abandon its policy of sequencing valley fills" (p. 2).

6. OTHER NON-GOVERNMENTAL ORGANIZATIONS (NGOS)

As of December 1, 2010, no comments from this category group discussing the issue area of Section 404 of the CWA had been posted by the docket. Any comments received subsequently will be addressed in the final summary.

7. ACADEMIA/ PROFESSIONAL SOCIETIES

As of December 1, 2010, comments from this category group discussing the issue area of the CWA Section 404 had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. CONGRESSIONAL DELEGATES

One comment letter (Doc. #0011) submitted by congressional delegates discusses Section 404 of the CWA. The letter is signed by three members of Congress representing the States of Virginia and West Virginia, is in general disagreement with the Guidance, and expresses concerns on many of its aspects.

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

The congressional delegates focus their comments on the Guidance around the "far-reaching implications of the policies it espouses" (p. 1). Specific to the roles of federal agencies in evaluating CWA 404 applications, they assert that "Essentially, EPA is seeking to bootstrap conductivity as a section 402 effluent limitation standard through the section 404 process … [and] only in Appalachia, and only with respect to surface coal mining operations" (p. 1). The commenters contend that "not only is there no precedent for such an action, but [that] it is also patently a wrong approach to implementing the Clean Water Act."

The congressional delegates conclude by urging EPA to withdraw the Guidance and to "continue to work with the affected States, the involved federal agencies, and all stakeholders to develop guidelines that truly provide a balanced process for energy development and environmental protection" (p. 2).

9. PRIVATE CITIZEN – GENERAL

Fifty-one comment letters posted by the docket as of December 1, 2010, from members of the general public commented on the issue area of the CWA Section 404. Several identical comments are expressed by many of the commenters, and many of these comment letters appear to be modified versions of the mass mailing campaigns (e.g., Doc. #0022 from Earthjustice, and Doc. # 0103 from Sierra Club).

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

Many of the private citizen letters comment upon the roles of federal agencies in evaluating CWA 404 applications, with most expressing gratitude that the Guidance will strengthen this process and "ensure that regional staff will finally following Clean Water Act Requirements calling for an end to one of the devastating impacts of mountaintop removal coal mining" (e.g., Doc. # 0179). Others are thankful that "EPA has recognized the role of the Clean Water Act to support this scientific research and protect the people of Appalachia" (e.g., Doc. # 0180), and that "both EPA and the Army Corps have the duty up front to prevent significant degradation of waters from happening before any permit is issued" (e.g., Doc. # 0222.1)

One commenter (Doc. #0053) summarizes the general sentiment by writing: "I urge the EPA to apply the Clean Water Act to permit applications for mountain top removal mines. I understand that this type of mining has continued despite its violation of law due to carious waivers and loopholes based on false information. I urge the EPA to base their decisions in fact and enforce laws passed to protect air and water quality".

c. Mine Design and Sequencing of Valley Fills

More than half of the private citizen commenters express concern over the practice of sequencing valley fills, imploring that "EPA must also not establish a policy of sequencing its approval of valley fills, because there is no scientific evidence that sequential construction of valley fills avoids the devastating long-term and downstream pollution caused by valley fills" (e.g., Doc. # 0032).

One Tennessee resident (Doc. #0074, p. 1) expresses the strong opinion that: "there is no mitigation value or other benefit to any policy of 'sequencing' valley fills. Such a policy would only lengthen the period of time over which the same absolute ecological genocide occurs. There is, to date, no actual restoration of Appalachian forest following the removal of its topsoil yet demonstrated, let alone practiced by mining companies. Without such restoration, 'sequencing' would only delay the inevitable destruction. Environmental laws are meant to prevent ecological destruction, not merely delay it."

c. Mine Design and Material Handling and Upland Disposal

Among the commenters who discuss the material handling and upland disposal of sediments, most focus upon valley fills, and express skepticism of the practice. For instance, one commenter writes: "Scientific research suggests that one valley fill is too many, because the

unique headwater streams filled are lost forever, along with all of the ecological services they provide to the ecosystem. On top of that, every valley fill becomes a source of pollution that contaminates the watershed downstream" (Doc. #0222.1, p. 3).

Another commenter states that "Scientific research suggests that one valley fill is too many, because the unique headwater streams filled are lost forever, along with all of the ecological services they provide. On top of that, every valley fill becomes a source of pollution that contaminates the watershed downstream" (Doc. #0245).

d. Relationship of Water Quality to Significant Degradation under 230.10(c)

Several comments (sometimes with identical sections) express that "both EPA and the Army Corps have the duty up front to prevent significant degradation of waters from happening before any permit is issued" and that "After-the-fact monitoring is not a legal or effective substitute for preventing significant harm and loss of waters in the first place" (e.g., Doc. #0222.1, p. 3).

A Tennessee resident expresses a slightly different, and more strongly worded opinion (Doc. #0074): "This outrage will stop when EPA enforces the Clean Water Act and other environmental laws as they were intended. 'Undue degradation' of waterways necessarily includes their complete obliteration, and the latter is therefore illegal. The Corps of Engineers' determination in 2002 that the complete burial of streams could constitute 'fill,' permissible under the CWA, was driven by political directives from the former administration, not science or a plain reading of the law. The EPA must not further indulge this violence to environmental law and the resulting violence to the Appalachians."

e. Compensatory Mitigation under CWA 404 and Suitability of Stream Creation

More than half of the private citizen letters discuss the suitability of stream creation as compensatory mitigation under Section 404, with many expressing the identical comment that "there is no scientific evidence to support claims of 'stream creation,' and it is never a viable option to mitigate for stream loss, especially for headwater streams" (e.g., Doc. #0032).

Several commenters also make the identical statement that: "EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams. Similarly, EPA must not allow sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation of downstream waters" (e.g., Doc. #0088).

One commenter furthers the general opinion expressed by many by stating: "The proposed guidance policy is only a first step toward compliance with the Clean Water Act. In particular, there is no scientific evidence that 'stream creation' is a sufficient means of mitigation, as no replication of an intact, functioning Appalachian forest stream has ever been attained" (Doc. #0074, p. 1).

e. Compensatory Mitigation under CWA 404 and the Ability of Mitigation to Compensate for Water Quality Impacts

Only a small handful of commenters from the private citizen – general category reference the ability of proposed mitigation under CWA 404 to compensate for water quality impacts, primarily referring indirectly to this sub-issue by referencing the ecological functions of streams. They state that "EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams" (Doc. #s 0217, 0218, and 0219). Another commenter (Doc. #0254) points out that "stream creation does not mitigate for stream loss, especially for headwater streams."

f. Monitoring and Reporting Requirements

The docket contains several letters from private citizens commenting on the monitoring and reporting requirements, although only in passing. These commenters make the identical statement that "After-the-fact monitoring is not a legal or effective substitute for preventing significant harm and loss of waters in the first place" (e.g., Doc. #0222.1, p. 3).

g. Cumulative Impact Analysis under CWA 404

Several letters from private citizens address the concept of cumulative impacts under Section 404 of the CWA, commenting that "EPA also deserves credit for finally recognizing in the policy that the Clean Water Act does not permit the massive, cumulative impacts that result from mountaintop removal mining. Appalachia cannot afford to continue to bury its streams and pollute entire watersheds" (Doc. #s 0088, 0089, 0090, 0091, and 0222.1, p. 2).

h. Recommended Changes in Guidance Relating to CWA 404

Most private citizen comments provide recommendations to EPA that they feel will strengthen the environmental protections of the Guidance. A quote found repeatedly among this commenter category is as follows: "Finally, EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams. Similarly, EPA must not allow sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation of downstream waters" (e.g., Doc. 0213.1).

The opinion expressed by many of the general private citizen letters is that "the proposed guidance policy is only a first step toward compliance with the Clean Water Act," (Doc. # 0074), recommending that EPA strengthen its Guidance document by reconsidering several aspects of the Guidance. These aspects include the practice of sequencing valley fills and relying upon stream creation as suitable mitigation for impacts under CWA 404. One commenter (Doc. #0230) is particularly adamant regarding valley fills stating that "Valley fills should be completely banned anywhere in the USA forever!"

Several commenters (Doc. #s 0244, 0245, and 0253) cite that "More than 2,000 miles of streams have already been destroyed, and we cannot afford to lose more, especially unique and vital headwater streams. Because of this, I strongly urge the EPA to strengthen this guidance."

One letter recommends the use of rule-making: "The EPA now must further increase protections for streams and communities. Please use rule-making to make stream protections permanent" (Doc. #0264), a recommendation echoed by other commenters.

Doc. #0088 calls for "a change to business as usual that places private profit above public resources by upholding the Clean Water Act in the mining practice in Appalachia and live up to the name The Environmental Protection Agency." Another comment (Doc. #0075) simply states: "NO MORE MOUNTAIN REMOVAL MINING".

A West Virginia commenter (Doc. #0251) implores: "Please don't back down on the rules you have started to create; move forward with confidence and courage knowing that the vast majority of Americans are rooting for you to curb the out-of-control greed and rapacious practices of what we call BIG COAL."

10. PRIVATE CITIZEN – EXPERT

As of December 1, 2010, one letter was submitted by a private citizen - expert commenting the CWA Section 404. The commenter is a biologist with a Masters degree in biology and more than 30 years in the Appalachian region public school system, and is currently teaching wildlife management and environmental earth science (Doc. #0112). The comment echoes most of the Earthjustice mass mailing campaign (Doc. #0022), with some personal insight to his experience living in this region. He comments upon the sequencing of valley fills and the suitability of stream creation to provide compensatory mitigation under Section 404 of the CWA, and provides recommended changes in the Guidance relating to CWA Section 404.

c. Mine Design and Sequencing of Valley Fills

As with others who are against the practice of sequencing valley fills, the commenter expresses that "EPA must also not establish a policy of sequencing its approval of valley fills, because there is no scientific evidence that sequential construction of valley fills avoids the devastating long-term and downstream pollution caused by valley fills."

e. Compensatory Mitigation under CWA 404 and Suitability of Stream Creation

The comment letter, inclusive of content from the Earthjustice mass mailing campaign repeats the statement that "There is no scientific evidence to support claims of 'stream creation,' and it is never a viable option to mitigate for stream loss, especially for headwater streams."

h. Recommended Changes in Guidance Relating to CWA 404

As with many other supporters of the Guidance, the commenter supports EPA in its efforts to finalize the Guidance with even further environmental protections. "After years of neglect by

EPA, Appalachia deserves better than another failed experiment that allows for the damage to start before the impact of the permit is appropriately assessed, in permits that put a local community in limbo while decisions about the future of their waters get made behind closed doors" (p. 2).

11. ENVIRONMENTAL JUSTICE AND/OR TRADITIONALLY DISADVANTAGED COMMUNITY

As of December 1, 2010, no comments from this category group discussing the issue area of the CWA Section 404 had been posted by the docket. Any subsequent comments received from this commenter category will be addressed in the final summary.

12. FORM LETTERS AND MASS MAILER CAMPAIGNS

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns are in support of EPA's Guidance and focus on the sequencing of valley fills, the suitability of stream creation, and the ability of mitigation to compensate for impacts to water quality. Both mass mailing letters advocate for strengthening the Guidance.

c. Mine Design and Sequencing Valley Fills

Despite overall agreement with the issuance of the Guidance, neither mass mailing campaign supports the practice of sequencing valley fills. "Additionally, EPA must also not establish a policy of sequencing its approval of valley fills, because there is no scientific evidence that sequential construction of valley fills avoids the devastating long-term and downstream pollution caused by valley fills." This sentiment is echoed by the Sierra Club mass mailing campaign.

e. Compensatory Mitigation under CWA 404 and Suitability of Stream Creation

The Earthjustice campaign comments generally on the ability of stream creation to provide suitable mitigation under the CWA by stating, "There is no scientific evidence to support claims of 'stream creation,' and it is never a viable option to mitigate for stream loss, especially for headwater streams." The Sierra Club campaign furthers this reaction by stating that "…EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams."

e. Compensatory Mitigation under CWA 404 and the Ability of Mitigation to Compensate for Water Quality Impacts

While not commenting directly on the ability of the mitigation practices to compensate for water quality impacts, the Earthjustice supporters urge EPA to carefully assess the impact of a permit before it is issued, stating "both EPA and the Army Corps have the duty up front to prevent significant degradation of waters from happening before any permit is issued."

h. Recommended Changes in Guidance Relating to CWA 404

The Earthjustice campaign concludes with a plea for EPA to further the environmental protections within the Guidance: "Finally, I strongly urge you, Administrator Jackson, to strengthen this guidance." Sierra Club supporters echo this sentiment.

13. UNKNOWN

Eleven letters from unknown or anonymous sources comment on the CWA Section 404. All comments support the Guidance. These letters comment upon aspects of Section 404 of the CWA, the roles of federal agencies, sequencing of valley fills, the relationship of water quality to significant degradation, the suitability of stream creation as mitigation, the ability of mitigation to compensate for water quality impacts, and cumulative impacts. About half of these comment letters also provide recommended changes, mostly related to strengthening the Guidance.

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

One commenter (Doc. #0216) expressed gratitude that "EPA has recognized the role of the Clean Water Act to support this scientific research and protect the people of Appalachia. The streams in coal country must not be destroyed by mining impacts."

c. Mine Design and Sequencing Valley Fills

Most letters from unknown sources disapprove of the practice of sequencing valley fills, "as there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation of downstream waters" (e.g., Doc. #0187) and that "scientific research suggests that one valley fill is one too many, because the unique headwater streams filled are lost forever, along with all of the ecological services they provide to the ecosystem" (e.g., Doc. # 0209).

d. Relationship of Water Quality to Significant Degradation under 230.10(c)

Two of the unidentified commenters (Doc. #s 0185 and 0214.1) reference the relationship of water quality to significant degradation, noting that "the EPA and the Army Corps have the duty up front to prevent significant degradation of waters from happening before any permit is issued."

e. Compensatory Mitigation under CWA 404 and Suitability of Stream Creation

The majority of the commenters from this category remark on the suitability of stream creation, by stating that "Science shows that current mitigation strategies are ineffective and that we can not replace buried streams. This needs to be recognized as part of permitting process" (Doc. #0183). Many expressed the identical sentiment that "EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams" (e.g., Doc. #0210).

e. Compensatory Mitigation under CWA 404 and the Ability of Mitigation to Compensate for Water Quality Impacts

A few commenters from this category make a passing reference to the ability of mitigation to compensate for water quality impacts, most of them expressing skepticism. One commenter advises EPA to "recognize that current mitigation strategies do not work" (Doc. #0183), while another "oppose[s] the use of permit mitigation for damage created by surface mining. Once the damage occurs it is irreparable. No amount of mitigation can off-set this type of injury to our land, water, and citizens" (Doc. #0226).

h. Recommended Changes in Guidance Relating to CWA 404

About half of the comment letters provide recommendations for changes to the Guidance relating to Section 404 of the CWA, with many encouraging EPA to strengthen the guidance "by refusing to permit mitigation as an option for the loss of streams" (Doc. #s 0187, 0209, and 0211). "EPA must further increase protections for our streams and our communities; too many streams have been lost, and no more valley fills should be permitted. While these initial steps are important, stream protections must be made more permanent via rule-making" (Doc. #s 0184 and 0214.1).

Multiple commenters also express appreciation for "EPA's commitment to finally enforce the Clean Water Act to protect Appalachia," and encourage EPA to "Finalize your guidance to improve review of Appalachian surface coal mining (Doc. #s 0209 and 0216).

V. NPDES Oversight and Review

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The issue area of NPDES oversight and review includes those comments, recommendations, and opinions submitted by stakeholders regarding the following sub-issues:

a. Federal authority to regulate these activities under 402;
b. Application of reasonable potential analysis;
c. Incorporation of numeric standards in NPDES permit;
d. Monitoring and reporting requirements;
e. Compliance schedules;
f. Narrative standards;
g. Antidegradation; and
h. Recommended changes in guidance relating to CWA 402.

There were a total of 34 tallied comments submitted to the docket as of December 1, 2010, discussing NPDES oversight and review. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 5-1 on the next page presents the total comment letters that address the issue of NPDES oversight and review, by commenter category.

All comments received from private citizens and the mass mailing campaigns either support the Guidance or are opposed to mountaintop mining activities in general, and recommend that water quality criteria for conductivity be set and adopted throughout Appalachia. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. Industry commenters view the Guidance as flawed in imposing new requirements on NPDES permits solely for mountaintop mining activities, and request that the Guidance be withdrawn. Congressional delegates disagree that EPA's emphasis on conductivity for NPDES permits

related to mountaintop activities. The Sierra Club urges EPA to set water quality criteria for conductivity throughout Appalachia and to encourage states to implement them. The Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions, including data collection, water quality standards, baseline monitoring, and compliance schedules.

Below are summaries, presented by commenter category, on the issue of NPDES oversight and review. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

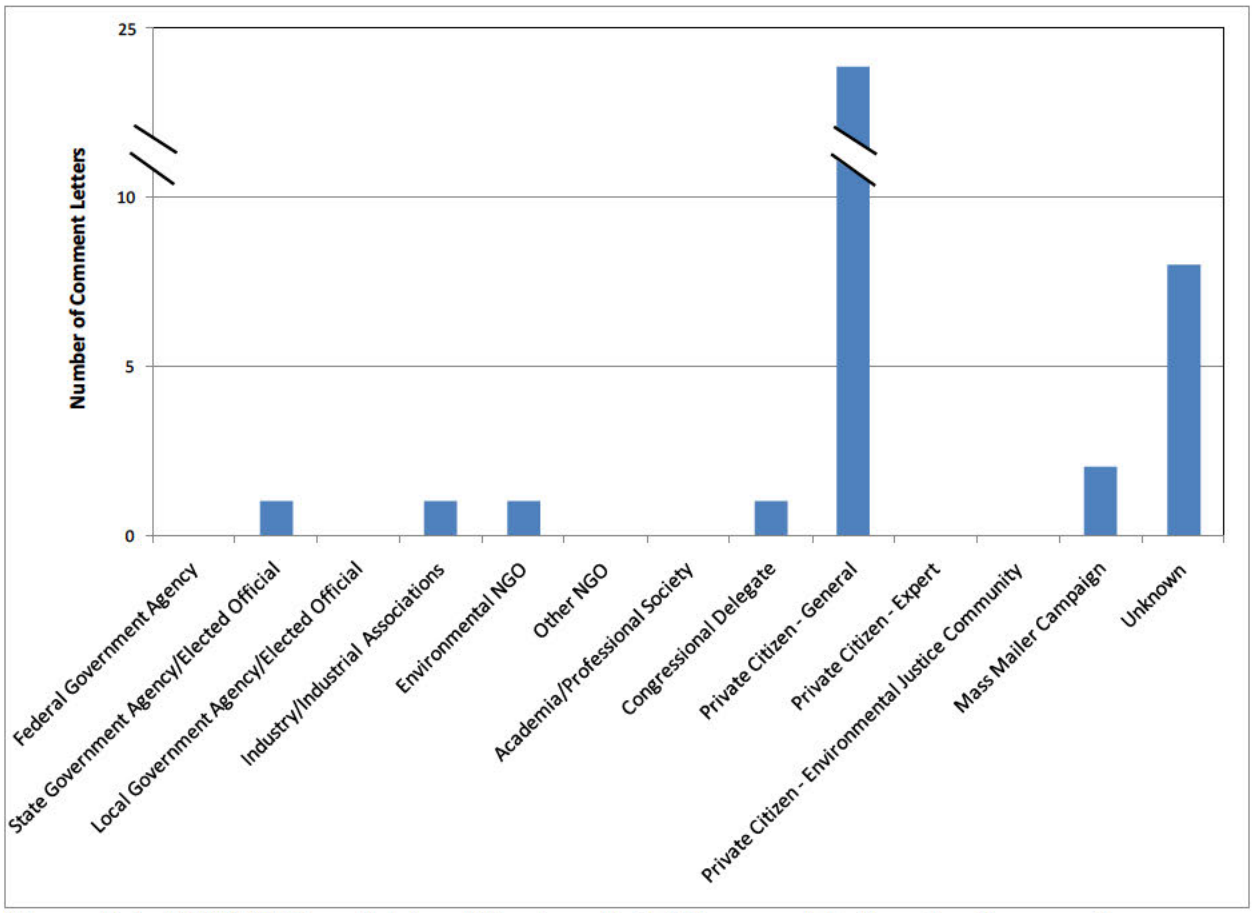

Figure 5-1. NPDES Oversight and Review, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. STATE GOVERNMENT AGENCIES AND ELECTED OFFICIALS

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations.

b. Application of Reasonable Potential Analysis

The Kentucky Energy and Environment Cabinet requests clarification regarding the issue of a permit conditional on the collection of data during the permit term, and the status of States not listed in the Guidance. Their questions are as follows:

- "Is it U.S. EPA's determination that the issuance of a CWA § 402 permit may not be conditioned on collection of data during the permit term appropriate for performance of a reasonable potential analysis, with the requirement in the permit that it be re-opened or conditioned to include appropriate requirements once reasonable potential is determined?" (p. 4); and
- "Will States other than those specified in the Guidance also be "subject to reasonable potential analysis of non-coal mining activities?" (p. 5).

c. Incorporation of Numeric Standards in NPDES Permit

The Kentucky Energy and Environment Cabinet questions the relevance of numeric standards, and asks if other water quality standards (including narrative standards) could be used. Question 15 (p. 2) asks: "Is it U.S. EPA's determination that a delegated state cannot in some or all cases use the available approaches outlined in 40 CFR 122.44 for implementing a narrative water quality standard, including whole effluent testing (WET) or best management practices (BMPs) in lieu of a numeric limit for a narrative water quality standard?"

d. Monitoring and Reporting Requirements

The Guidance requires baseline monitoring data for biological condition, conductivity, total dissolved solids, sulfates, bicarbonate, chloride, magnesium, potassium, calcium, sodium, pH, and selenium. The commenter wonders if EPA is concerned with other parameters or if the concern is limited specifically to this list. The comment letter also asks (question 25, p.5): "What is U.S. EPA's position as it relates to the use of water quality variances with respect to this new final interim guidance?"

e. Compliance Standards

The Kentucky Energy and Environment Cabinet questions EPA's position on compliance schedules in the new Guidance.

f. Narrative Standards

The Guidance states that a top priority of the Administration is to reduce and minimize impacts of surface coal mining. The Kentucky Energy and Environment Cabinet requests an explanation of EPA's "perspective of reducing and minimizing impacts of surface coal mining as it relates to the goals and objectives of the CWA § 402 program (p. 4)." As stated above (under c. Incorporation of Numeric Standards in NPDES Permit), the Kentucky Energy and Environment Cabinet references 40 CFR 122.44 to recommend the use of narrative standards (question 15 p. 2).

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance.

a. Federal Authority to Regulate These Activities Under 402

Frost Brown Todd claim the Guidance is a legally binding rule that has been adopted without public notice and comment, making it legally flawed, and request it be withdrawn immediately. They state "EPA has made clear its intent to impose specific new requirements on NPDES permits (and other related environmental permits) associated with surface mining activities in Appalachia, and to use its full authority and influence to compel the states and other federal agencies to enforce these requirements" (p. 3).

Frost Brown Todd is of the opinion that the permit requirements and environmental standards have not been subject to a full scientific review and feel the Guidance was issued prematurely. For example, the Guidance does not allow coal mining activities to be authorized under the NPDES general permit. Frost Brown Todd argues that EPA has not provided enough information to justify this requirement. They further claim EPA "improperly seeks to 'correct'

NPDES permits that have already been issued by states by seeking to force the Corps to address those alleged deficiencies through the Section 404 permitting program" (p. 5).

c. Incorporation of Numeric Standards in NPDES Permit

The Guidance sets a specific, numeric standard for states to enforce through the NPDES permitting process and requires specific documentation to support NPDES permitting decisions. Frost Brown Todd again make the argument that the Guidance is legally flawed and request it be withdrawn.

f. Narrative Standards

Frost Brown Todd disagrees with the Guidance's position on narrative standards and contend that "the Guidance effectively precludes the use of whole effluent testing ("WET") and/or best management practices, as allowed under 40 CFR § 122.44, to implement narrative water quality standards. Through this approach, EPA has effectively written these methods out of the regulation without notice and comment or appropriate regulatory action" (p. 5).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, one letter was submitted from an Environmental NGO commenting on the issue of NPDES oversight and review. The Sierra Club (Doc. #0225) strongly supports the Guidance and commends EPA for issuing it.

c. Incorporation of Numeric Standards in NPDES Permit

The Sierra Club feels the Guidance is necessary to protect water quality from negative impacts of mountaintop removal mining. They further urge EPA to "set water quality criteria for conductivity for central Appalachia and require states to adopt these criteria as soon as possible (p. 1)." Given the number of pending mining permits, they agree with EPA's immediate implementation of the Guidance.

6. Other NGOs

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. Congressional Delegates

One comment letter (Doc. #0011) posted by the docket as of December 1, 2010 was submitted by congressional delegates. It is signed by three members of Congress representing the States of Virginia and West Virginia, and is in general disagreement with the Guidance and federal authority to regulate mountaintop mining activities under 402.

a. Federal Authority to Regulate These Activities Under 402

The members of Congress are in general disagreement with the Guidance and are of the opinion that "EPA is seeking to bootstrap conductivity as a section 402 effluent limitation standard through the section 404 process" (p. 1) for surface coal mining in Appalachia. They argue there is no precedent to justify this action and it is a "wrong approach to implementing the Clean Water Act. This is a national law and should be applied evenly and equally throughout the country as has been done in the past, and there is simply no justification for departing from that practice" (p. 1).

9. Private Citizen - General

Twenty three comment letters, typically one page in length, submitted by members of the general public comment on the issue of NPDES oversight and review. All of the private citizen commenters either support the Guidance or are opposed to mountaintop mining in general.

a. Federal Authority to Regulate These Activities Under 402

Commenters support EPA's decision to implement the Guidance immediately. One commenter (Doc. # 0222.1) states: "I also strongly encourage the EPA to promptly follow the science discussed in this guidance by setting a National Recommended Water Quality Criterion for conductivity for Central Appalachia and requiring states to adopt the criterion" (p. 2).

c. Incorporation of Numeric Standards in NPDES Permit

Most commenters express concern with the impacts of mining to water quality. Many feel EPA should set water quality criteria for conductivity for Central Appalachia and require these standards be adopted by states as soon as possible.

h. Recommended Changes in Guidance Relating to CWA 402

As stated above, the majority of commenters are concerned with the impacts of mining to water quality. Many feel EPA should set water quality criteria for conductivity for Central Appalachia and require these standards be adopted by states as soon as possible. Several commenters further suggest that EPA "prohibit issuance of permits that are contrary to the guidance (Doc. #0215)."

10. Private Citizen – Expert

As of December 1, 2010, one letter was submitted from a private citizen - expert commenting on the issue of NPDES oversight and review. The commenter is a biologist, with a Masters degree in biology, and is currently a teacher teaching Wildlife Management and Environmental Earth Science (Doc. #0112).

c. Incorporation of Numeric Standards in NPDES Permit

The commenter shares concern for water quality with commenters from several other commenter categories and reiterates the request for EPA to "follow the science discussed in this guidance by setting a National Recommended Water Quality Criterion for conductivity for Central Appalachia" (p. 2).

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns are in support of EPA's Guidance and suggest that the Guidance should be strengthened and finalized.

c. Incorporation of Numeric Standards in NPDES Permit

Both campaigns share concern for water quality with commenters from several other commenter categories and reiterate the request for EPA to "follow up the policy by setting water quality criteria for conductivity for central Appalachia and require states to adopt these criteria as soon as possible (Doc. #0103)."

13. Unknown

Eight comment letters received from unknown or unidentified commenters discuss NPDES oversight and review. All commenters are in general agreement with EPA's Guidance.

c. Incorporation of Numeric Standards in NPDES Permit

The majority of commenters "strongly encourage EPA to promptly follow the science discussed in this guidance by setting a National Recommended Water Quality Criterion for conductivity for Central Appalachia and requiring states to adopt the criterion (Doc. #0214.1, p. 1)."

h. Recommended Changes in Guidance Relating to CWA 402

Many commenters appreciate EPA's commitment to protect Appalachia by enforcing the CWA and urge EPA to "strengthen and finalize your guidance to improve review of Appalachian surface coal mining (Doc. #0192)."

IV. Conductivity

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The issue area of conductivity includes those comments, recommendations, and opinions submitted by stakeholders regarding the suitability of specific conductance as a benchmark, the use of constituent ions instead of conductivity, and the use of pollutants other than conductivity or constituent ions as a benchmark for water quality.

There were a total of 35 tallied comments submitted to the docket as of December 1, 2010, discussing conductivity. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 4-1 on the next page presents the total comment letters that address conductivity issue by commenter category.

Most comments from private citizens and mass mailing campaigns are in general agreement with the Guidance and support the use of conductivity as a benchmark. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, arguing that specific conductance is not an adequate benchmark for water quality downstream of mountaintop mining activities, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. The Sierra Club argues that scientific research has demonstrated that mountaintop mining activities are responsible for downstream high levels of conductivity because these cannot be attributed to residential development or agriculture, and recommends a stricter conductivity benchmark. The Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions, some of which are related to water quality measures and benchmarks.

Below are summaries, presented by commenter category, on the issue of conductivity as it relates to the Guidance. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

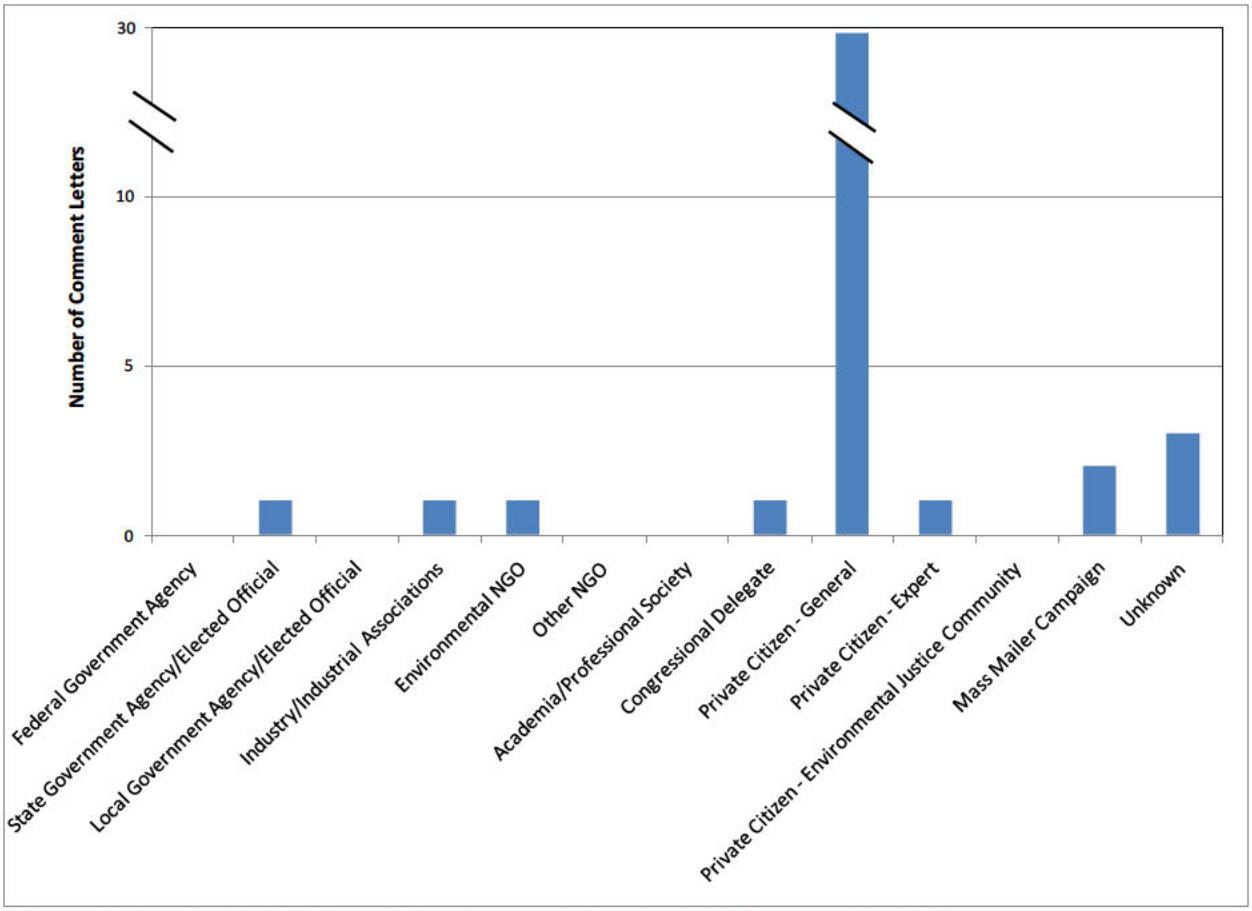

Figure 4-1. Conductivity, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations. Some of their questions relate to the Guidance's proposed water quality benchmarks.

b. Use of Constituent Ions Instead of Conductivity

The Kentucky Energy and Environment Cabinet refers to footnote 21 in the Guidance and a study "that narrows the applicability of this guidance to waters dominated by salts of SO_4^{2-} and

HCO_3^- at circum-neutral pH and low levels of chloride (q. A.16)" to request that EPA describe how this determination will be made when processing CWA Section 402 permits. They further ask "what delegated states should do when waters are not so dominated (q. A.16)."

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance, and to conductivity measures that they feel cannot be upheld.

a. Suitability of Specific Conductance as a Benchmark

With respect to conductivity, Frost Brown Todd states that the Guidance "includes the impositions of strict conductivity limits that may not be attainable" (p. 3).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, one letter was submitted by an environmental NGO commenting on the issue of conductivity in EPA's Guidance. The Sierra Club (Doc. #0225) strongly supports the Guidance, commends EPA for issuing it, and supports the suitability of conductivity as a benchmark for water quality.

a. Suitability of Specific Conductance as a Benchmark

The Sierra Club argues that ample scientific research has demonstrated that high levels of conductance are seen downstream of mountaintop removal mines in Appalachia. They also argue that EPA's research has shown that other sources, such as soil disturbances from residential development and agriculture are not responsible for high conductance levels. They therefore make the point that the use of specific conductance is a suitable benchmark for determining water quality.

They are requesting the implementation of a higher conductivity benchmark in the Guidance "to prevent damage to headwater streams as well as the larger, downstream aquatic system" (p. 2). Furthermore, they reference the peer review conducted by the Science Advisory Board that confirms the validity of the conductivity study and the numeric benchmark and argue that the "levels that EPA identified for the benchmark may not be sufficiently protective of water quality" (p. 2).

6. Other NGOs

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. Congressional Delegates

One comment letter received from congressional delegates (Doc. #0011) addresses conductivity. The letter is signed by three Congressional Delegates representing the States of Virginia and West Virginia. It is in general disagreement with the Guidance and the use of conductivity as a benchmark.

a. Suitability of Specific Conductance as a Benchmark

The congressional delegates argue that the Guidance is "premature largely" and contend that full consideration has not been given to the "far-reaching implications of the policies it espouses, especially as it relates to conductivity" (p. 1).

9. Private Citizen - General

Twenty four comment letters, typically one page in length, received from members of the general public comment on conductivity. All letters are in agreement with the Guidance and the suitability of specific conductance as a benchmark.

a. Suitability of Specific Conductance as a Benchmark

Commenters argue that specific conductance is suitable as a benchmark, with all letters except one (Doc. #0006) stating at least one of the following three reasons:

- "Because conductivity is elevated downstream from mountaintop removal mines;"

- "Best available science has shown that stream conductivity level is a reliable indicator of stream health and function;" or
- "Based on the research showing a strong relationship between conductivity of at least 300 – 500 µs/cm and harm to aquatic life."

About half of all the commenters encouraged EPA to "promptly follow the science discussed in this guidance by setting a National Recommended Water Quality Criterion for conductivity for Central Appalachia and requiring states to adopt the criterion." It should be noted that this language is also found in the mass mailing campaign sponsored by Earthjustice (Doc. #0022)

One commenter (Doc. #0006) applauds and supports the new conductance tests for streams and "supports the limits of conductance, on dissolved solids and small particulates" (p. 1).

10. Private Citizen – Expert

As of December 1, 2010, one letter submitted by a private citizen - expert comments on conductivity. The commenter is a biologist, with a Masters degree in biology, and is currently a teacher teaching Wildlife Management and Environmental Earth Science (Doc. #0112). The commenter strongly supports the Guidance and of the use of specific conductance as a benchmark.

a. Suitability of Specific Conductance as a Benchmark

This commenter is in support of specific conductance suitability as a benchmark and further states that "available science shows that stream's conductivity level is a reliable indicator of stream health and function" and that "best available science shows a strong relationship between conductivity of at least 300 – 500 µs/cm and harm to aquatic life."

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns are in support of EPA's Guidance, and of the use of specific conductance as a benchmark.

a. Suitability of Specific Conductance as a Benchmark

Both Earthjustice and the Sierra Club support the suitability of specific conductance as a benchmark. They argue that research has shown a strong correlation between conductivity levels exceeding 300 – 500 µs/cm and "harm to aquatic life." The Sierra Club (Doc. #0103) further recommends that EPA "follow up the policy by setting water quality criteria for conductivity for central Appalachia and requires states to adopt these criteria as soon as possible."

13. UNKNOWN

Three comment letters received from unknown or unidentified commenters discuss conductivity. They are all in support of the guidance.

a. Suitability of Specific Conductance as a Benchmark

Similar to the mass mailing campaign sponsored by Earthjustice, two comment letters (Doc. #0184 and #0214) support the suitability of specific conductance as a benchmark because "conductivity is elevated downstream form mountaintop removal mines."

Similar to the other mass mailing campaign sponsored by The Sierra Club, two comment letters (Doc. #0185 and #0214) encourage EPA to set a "National Recommended Water Quality Criterion for conductivity for Central Appalachia and requiring states to adopt the criterion."

III. Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia issue includes those comments, recommendations, and opinions submitted from stakeholders regarding the scientific validity of material referenced in the Guidance, scientific materials not reviewed or referenced in the Guidance, the suitability of ecoregion use in the Guidance, scientific and technical recommendations for project review and monitoring, and the issue of insufficient scientific evidence or peer review in the Guidance.

There were a total of 45 tallied comments submitted to and posted by the docket as of December 1, 2010, discussing the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. These were submitted by different types of commenters, including a State agency, representatives of the mining industry, Congressional Delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 3-1 on the next page presents the total comment letters posted to the docket as of December 1, 2010, that addressed the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia issue by commenter category.

Most comments from private citizens and mass mailing campaigns support the validity of the scientific material referenced in the Guidance, and some argue for additional scientific research to further develop an understanding of the adverse impacts of valley fills. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) is in general support of the Guidance. Congressional delegates and industry comments focus on the aspect of scientific peer review with regard to the issuance of the Guidance, generally stating that there was not sufficient scientific peer review in the process, and thereby challenging the overall validity of the Guidance. The Commonwealth of Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions regarding the scientific validity of reports referenced in the Guidance, and whether there is sufficient scientific

evidence to support the Guidance, particularly requesting scientific evidence related to Kentucky.

Below are summaries, by commenter category, on the issue of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. Under each commenter category all sub-issues commented on are listed by letter (based on the issue outline) and discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

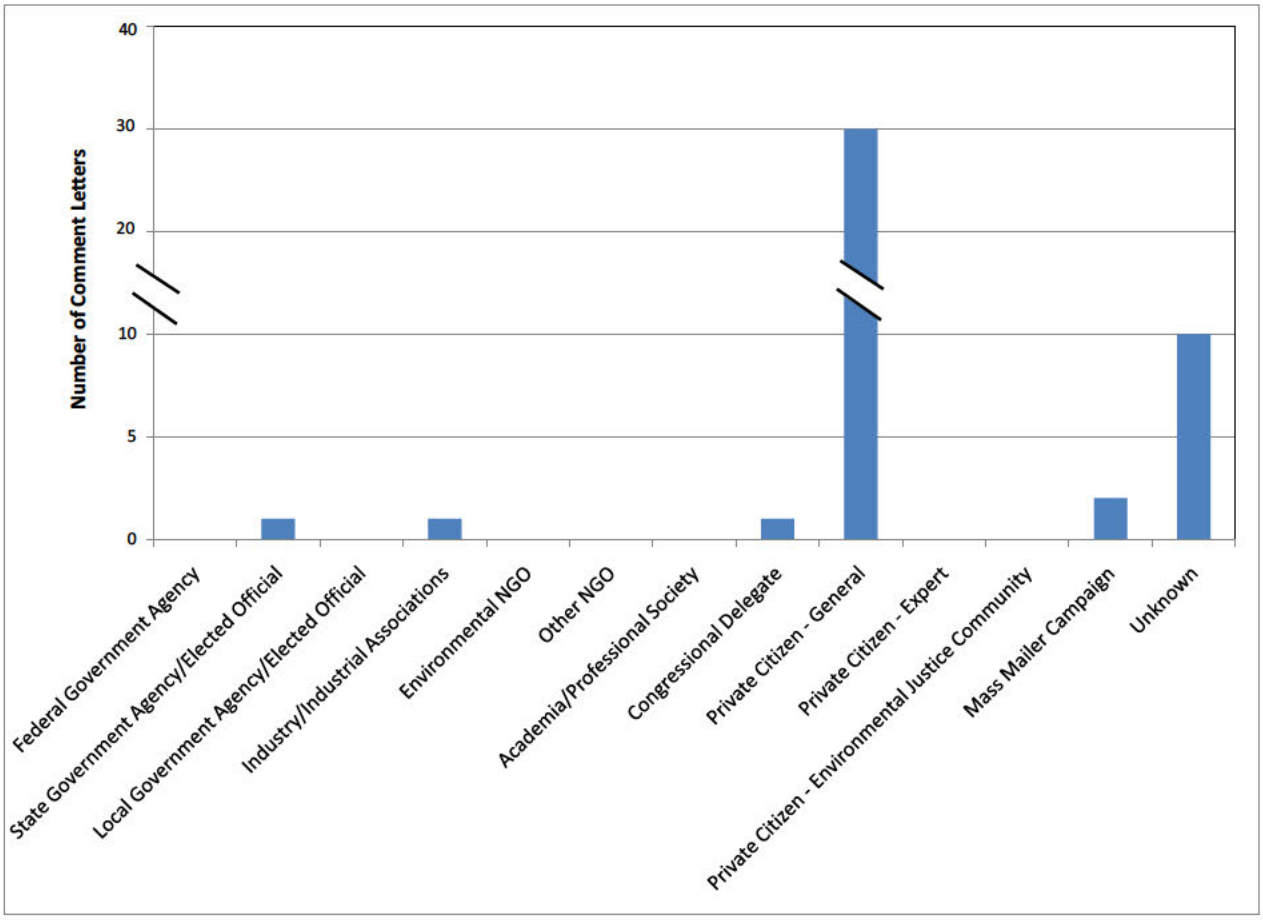

Figure 3-1. Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

2. STATE GOVERNMENT AGENCIES AND ELECTED OFFICIALS

The Commonwealth of Kentucky Energy and Environment Cabinet (Doc. #0012) was the only comment received from a state government agency or elected official commenting on the issue of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. The agency appears to be generally in support of the Guidance, but questions the scientific validity of reports referenced in the Guidance, and whether there is sufficient scientific evidence to support the Guidance. In particular the agency expresses interest in receiving documentation of scientific studies performed in Kentucky, as well as more details on its implementation: "I request that these inquiries be responded to expeditiously in writing given the CWA § 402 surface coal mining permit applications pending before the Commonwealth, and those that we continue to receive daily" (p. 1).

a. Scientific Validity of Material Referenced in Guidance

The Kentucky Energy and Environment Cabinet poses the following questions regarding the issue of Scientific Validity of Material Referenced in the Guidance:

- "10. At the top of page 3 [of the Guidance] it is stated that impairments related to surface coal mining have been 'linked to contamination of surface water supplies and resulting health concerns.' Does U.S. EPA have documentation and data specific to Kentucky that supports this statement? If so, what is that documentation and data?" (p. 3); and
- "23. In the middle of page 30, the guidance makes the statement that 'it is EPA's experience that projects that involve more than one mile of stream loss or more than one valley fill are likely to result in significant adverse impact.' What documentation with respect to Kentucky did EPA rely upon in making this statement?" (p. 5).

e. Insufficient Scientific Evidence/ Insufficient Peer Review

The Kentucky Energy and Environment Cabinet asks many questions regarding statements made in the Guidance and the sources of the supporting scientific evidence. In general, the comments and questions in this letter suggest that insufficient scientific evidence has been referenced in the Guidance to support claims of adverse environmental impacts from surface coal mining in Kentucky.

The comment letter questions the scientific data referenced in the Guidance regarding impaired stream life downstream from surface mining, citing discrepancies between the scientific data utilized in the Guidance, and that used for a different draft EPA document. The commenter writes: "EPA's assertion appears to be refuted in U.S. EPA's draft document 'The effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystem of the Central Appalachian Coalfields' on page 55 'there is little evidence in the peer-reviewed literature of cumulative impacts of mining on downstream ecology. Fulk et al. (2003) found no evidence of additive effects of multiple mines on the fish. In another MTM-VF [Mountaintop Mining-Valley Fill] study, Pond, et al. (2008) reported no evidence of a significant relationship between the number of valley fills and macro invertebrate indices" (p. 4).

The letter also requests clarification of the noted discrepancy and documentation of scientific data specific to Kentucky to support comments made in the Guidance. In addition, the commenter requests identification of scientific data and reports to support comments made in the Guidance by asking the following questions:

- "5. Please identify the recent scientific reports … and the list of other pollutants and pollutant parameters demonstrated by these recent scientific reports in Kentucky to cause or contribute to significant water quality impacts below surface mining operations other than conductivity and total dissolved solids" (p. 5); and
- "7. At the bottom of Page 11, the Q & A indicates that 'to date, there is no evidence that the streams that have been restored have returned to their normal ecological functions after the mining is completed,' what documentation with respect to Kentucky did U.S. EPA rely upon in making this statement?" (p. 6).

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

4. Industry

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below:

- Gorman Company, LLC (Doc. #0013.1);
- Kentucky Union Company (Doc. #0014.1);
- Black Gold Sales, Inc. (Doc. #0016.1);
- Hazard Coal Corporation (Doc. #0017.1); and
- Kycoga Company, LLC (Doc. #0018.1).

In general, the comments do not support the Guidance, and discuss the validity and adequacy of material referenced in the Guidance, the suitability of eco-region use, and scientific review.

a. Scientific Validity of Material Referenced in Guidance

Frost Brown Todd disagree that the Guidance is based on valid scientific evidence and express concern that the standards set by the Guidance will change once they have been subjected to peer review and "scientific scrutiny."

They recommend that EPA "engage in rigorous, scientifically valid, and peer reviewed analysis of relevant and available scientific data before attempting to impose any additional specific requirements on permits for coal mining activities" (p. 1). They contend that it is not sound science to set new standards based on scientific studies that have not been thoroughly peer reviewed and state that "It is unclear why EPA believes that it constitutes (…) sound science to

begin implementing a strict numeric limit when the science behind that limit has not even been 'truthed' out" (p. 9).

Frost Brown Todd suggest that the conductivity standard in the Guidance is based on limited scientific data, "Despite numerous statements in EPA's documents about 'extensive' data supporting its analysis, EPA's conclusions about the effects of surface coal mining on conductivity and the effects of conductivity on aquatic ecosystems in the region appear to be based largely on a single study – the so-called Pond-Passmore study – conducted in 2008" (p. 9).

Frost Brown Todd also argue that any changes may greatly impact projects permitted under the current Guidance: "… these detailed stringent requirements … are based on scientific data and conclusions that have not been subjected to peer review or scientific scrutiny. This clearly is a case of putting the policy 'cart' before the scientific 'horse" (p. 4).

c. Suitability of Ecoregion Use in Guidance

Frost Brown Todd question the applicability of the Guidance solely to Central Appalachia and argue that the suitability of ecoregion use in the Guidance is not science-based but rather a way to specifically target the coal mining industry in Appalachia through the use of policy. They question why the guidance is not applicable to other regions of the country with mining activities: "EPA has not articulated any reasonable or clear basis for the scope of these new rules – whether based on geography or industry" (p. 7). In addition they state: "It is also unclear why EPA has sought to limit the applicability of this conductivity limit to 'Central Appalachian streams containing the types of soil found in those streams.' Why is this information not relevant to other streams, regions, or industries? EPA's conductivity benchmark in fact appears to be an artificial limited and manipulated standard designed to target a specific industry in a specific region, with the sole purpose of making the continued practice of that industry a practical impossibility" (p. 9).

d. Scientific Review and Technical Recommendations for Project Review and Monitoring

Frost Brown Todd recommend that the Guidance not be implemented immediately on permits for coal mining activity. They contend that prior to implementation of the Guidance on permit and project review the scientific data referenced should be subjected to scientific peer review: "EPA also should engage in a rigorous, scientifically valid, and peer reviewed analysis of relevant and available scientific data before attempting to impose any additional specific requirements on permits for coal mining activities" (p. 2).

Frost Brown Todd convey their opinion that once the scientific data has been reviewed the Guidance may change. which will negatively impact projects that are permitted under the current Guidance, as they are subject to different requirements: "Those permits are likely to be based upon requirements in the 'interim' Guidance that may prove unnecessarily stringent, scientifically invalid, or otherwise legally unnecessary" (p. 4).

e. Insufficient Scientific Evidence and Insufficient Peer Review

Overall, the comment letter by Frost Brown Todd states their opinion that the Guidance is based on insufficient scientific evidence that has not been adequately peer reviewed or proven. They express their concern that the Guidance will have a detrimental impact on the coal mining industry in Appalachia and that insufficient scientific data and evidence have been referenced to support its requirements: "This hardly appears to be the kind of extensive data that EPA purports to rely upon, nor does it appear to be the kind of extensive data on which such a far- reaching and potential devastating limit should be based. Yet this is what EPA has done" (p. 9).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

6. Other Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

7. Academia/ Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

8. Congressional Delegates

One letter (Doc. #0015) received from congressional delegates comments on the issue of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. This letter is signed by 23 Congressional Delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming. In general the comment letter is not supportive of the Guidance, and is critical of the peer review process used by EPA for reviewing the scientific data prior to issuance of the Guidance.

a. Scientific Validity of Material Referenced in Guidance

The congressional delegates express their opinion that the scientific data referenced in the Guidance should be subject to outside peer review prior to implementation: "We believe these proposals should be subject to public comment, as well as outside peer review for any draft scientific data, prior to implementation, so as to strike a better balance between environmental protections and responsible governance" (p. 1).

9. PRIVATE CITIZEN – GENERAL

Of the 84 comment letters posted by the docket as of December 1, 2010 by members of the general public, 30 letters commented on the issue area of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. All letters but one (Doc. #0249) generally approve of the Guidance and its supporting materials.

a. Scientific Validity of Material Referenced in Guidance

A majority of the commenters support the scientific validity of materials referenced by the Guidance. Multiple comment letters state that "… there is unequivocal evidence from numerous studies both within the EPA and by independent scientists documenting that conductivity is elevated in waterways downstream from mountaintop removal mines in central Appalachia." It should be noted that this language is also found in the mass mailing campaign sponsored by Sierra Club (Doc. #0103).

Other commenters express support for the scientific material referenced in the Guidance with the following common statement: "The most recent, peer – reviewed scientific information documents the harm that mountaintop removal causes to water quality. Based on research showing a strong relationship between conductivity of at least 300 – 500 µS/cm and harm to aquatic life, the policy will help ensure clean water." It should be noted that this language is also found in the mass mailing campaign sponsored by Earthjustice (Doc. #0022).

b. Scientific Materials Not Reviewed/ Referenced by Guidance

Several commenter letters included the following common statement referencing a supplemental 2010 scientific article by Margaret Palmer that supports scientific materials referenced by the Guidance, "A recent peer-reviewed scientific article details the harm that mountaintop removal causes to water quality (Doc. #0180)." A reference to this scientific article is also mentioned by another commenter (Doc. #0222.1) quoting from the article the following statement regarding science and regulation: "The best available science clearly demonstrates that the impacts of mountaintop removal are 'pervasive and irreversible' and that 'current attempts to regulate mountaintop removal practices are inadequate" (p. 1).

e. Insufficient Scientific Evidence/ Insufficient Peer Review

Many of the commenters in support of the Guidance and the referenced scientific reports share the common opinion that the mining practice of valley fills should not be allowed. Some commenters suggest that additional research should be funded by EPA for the study of the impacts of valley fills. One commenter writes (Doc. #0186): "The EPA must fund comprehensive research aimed at increasing your understanding of the impacts of valley fills"(p. 2).

Multiple letters identify their objections to mitigation through stream creation and provide the following statement related to insufficient scientific evidence: "EPA should strengthen the policy by refusing to permit mitigation (…) it is not possible to re-create the ecological functions of

streams. Similarly, EPA must not allow for the sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation downstream (Doc. #0189)."

In general, most comment letters support the scientific reports referenced by the Guidance. However, in addition to the referenced scientific evidence they suggest that funding for additional research will further develop an understanding of the adverse impacts of valley fills.

The commenter that opposes the Guidance (Doc. #0249) is of the opinion that there is insufficient scientific evidence to prove that mountaintop mining and the practice of valley fills affect the ecological services provided by streams: "Lobbyists will tell you that scientific research suggests that one valley fill is too many, because of the unique headwater streams lost along with the ecological serviced they provide this is not supported by facts."

10. Private Citizen – Expert

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns commented on the issue area of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. These campaigns are supportive of the Guidance.

a. Scientific Validity of Material Referenced in Guidance

The comments in the letters from both the Earthjustice and Sierra Club campaigns support the scientific validity of material referenced in the Guidance. The Earth Justice campaign (Doc. #0022) states: "I support this Guidance because there is unequivocal evidence from numerous

studies both within the EPA and by Independent scientists documenting that conductivity is elevated in the waterways downstream from mountaintop removal mines in central Appalachia." The comment letter goes on to state: "The best available science shows strong relationships between conductivity of at least 300 – 500 µS/cm, and harm to aquatic life in the affected streams."

The Sierra Club campaign (Doc. #0103) argues that "The most recent, peer reviewed scientific information documents the harm that mountaintop removal causes to water quality." Comments in the letter include the support of scientific research documenting the relationship between higher levels of conductivity and water quality referenced in the Guidance.

e. Insufficient Scientific Evidence/ Insufficient Peer Review

The Sierra Club letter (Doc. #0103) expresses opposition to the Guidance allowing for the sequencing of valley fills due to insufficient scientific evidence. They convey their opinion that "EPA must not allow sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation of downstream waters."

13. UNKNOWN

Ten letters posted by the docket as of December 1, 2010 from unknown sources commented on the issue area of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. Of the ten comment letters, all but one letter (Doc. #0010) are in support of the Guidance.

a. Scientific Validity of Material Referenced in Guidance

Several of the comment letters identify scientific research referenced in the Guidance demonstrating the loss of 2,000 miles of streams and headwaters due to mountaintop removal and express their appreciation that EPA is supporting this scientific research: "I am also pleased that EPA has recognized the role of the Clean Water Act to support this scientific research and protect the people of Appalachia (Doc. #0192)."

One comment (Doc. #0010) opposes the science referenced, including the research from the Pond study by stating that the "Guidance is based on scientific studies that are limited in scope and analysis."

b. Scientific Validity of Material Referenced in Guidance

Several comment letters include the following statement referencing a supplemental 2010 Science article by Margaret Palmer that supports scientific materials referenced by the Guidance: "A recent peer-reviewed scientific article details the harm that mountaintop removal causes to water quality (Doc. #0187)."

e. Insufficient Scientific Evidence/ Insufficient Peer Review

Many of the commenters who support the Guidance and the referenced scientific reports share the common opinion that the practice of valley fills when mining should not be allowed. Some commenters suggest that additional research should be funded by EPA for the study of the impacts of valley fills. Multiple commenters state: "The EPA must fund comprehensive research aimed at increasing your understanding of the impacts of valley fills." Many of these comment letters also include the following statement of opposition to the valley fill practice citing insufficient scientific evidence: "EPA must not allow for the sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation downstream waters (Doc. #0211)."

II. Federal Authority to Regulate these Activities (Generally)

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The issue area of Federal Authority to Regulate these Activities includes those comments, recommendations, and opinions submitted by stakeholders regarding the relationship of the CWA, NEPA, and the Executive Order on Environmental Justice to the Surface Mine Coal Reclamation Act (SMCRA); as well as the authority, roles, and responsibility of federal and state agencies.

There were a total of 45 tallied comments submitted to the docket as of December 1, 2010, discussing federal authority to regulate these activities. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 2-1 on the next page presents the total comment letters that address the federal authority to regulate these activities issue by commenter category.

Most comments from private citizens and the mass mailing campaigns are in general agreement with the Guidance and support EPA's regulatory authority. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. Industry commenters contend that the Guidance contradicts established authorities and regulatory structures, could create unfair precedents, and should be withdrawn. Congressional delegates argue that the Guidance represents substantial changes that exceed the intent of the "Acts" (i.e., CWA, NEPA, and SMCRA), and undermines the authority, role, and responsibility of State agencies in reviewing and issuing permits. The Sierra Club urges EPA to ensure prompt implementation of the Guidance at the state and federal levels. The Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions, some of which are related to Federal and State authorities.

Below are summaries, presented by commenter category, on the issue of federal authority to regulate these activities as it relates to the Guidance. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

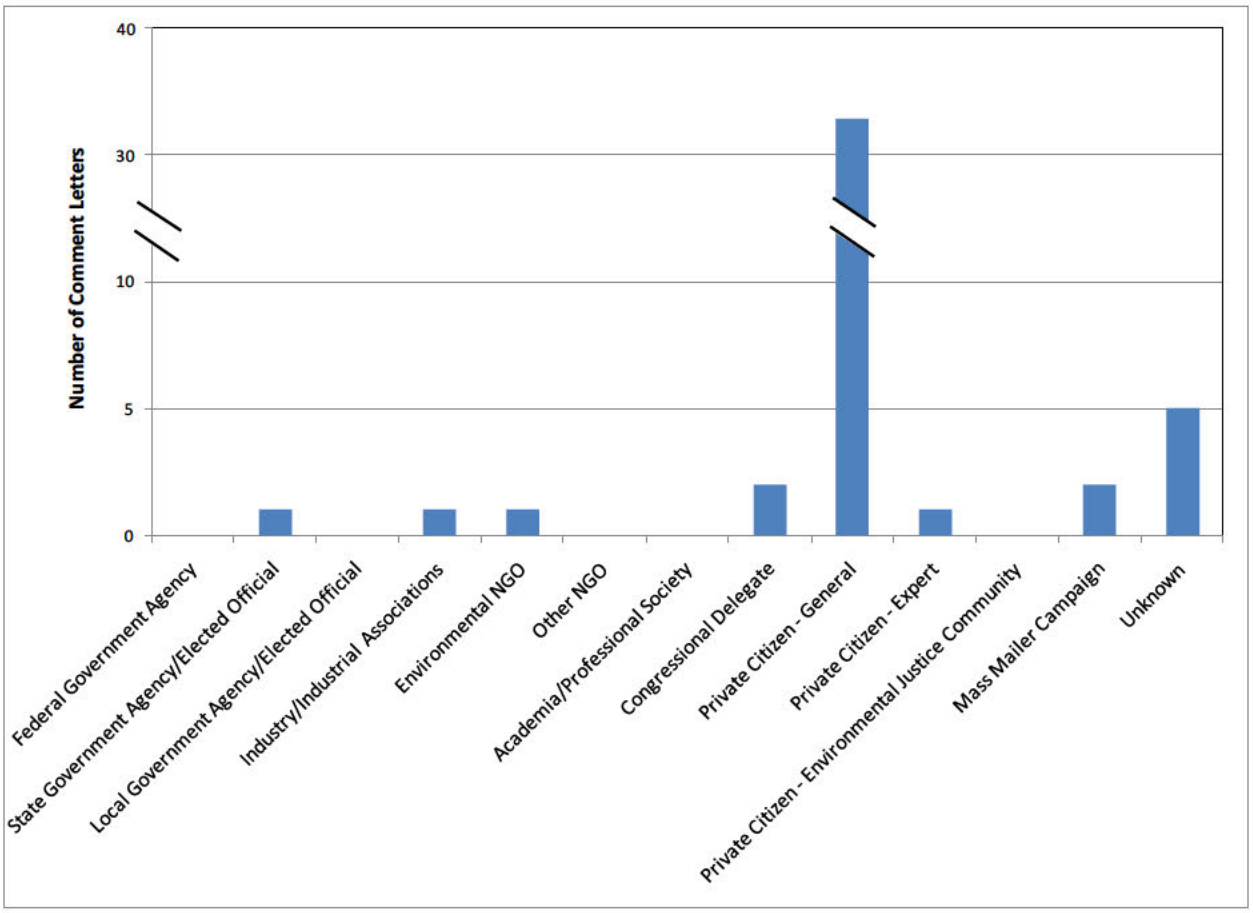

Figure 2-1. Federal Authority, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations.

a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to SMCRA

The Kentucky Energy and Environment Cabinet would like a clarification on the term "mountain top mining" in the context of the SMRCA, which they state is different from surface coal mining operations in general (q. A.1). They ask if the Guidance is for mountaintop mining or for surface mining operations as a whole (q. B.8). Furthermore, they would also like to know if it is correct to assume that the Guidance does not apply to coal mining operations (q. A.2).

b. Authority, Role, and Responsibility of Federal and State Agencies

The Kentucky Energy and Environment Cabinet referenced the detailed Guidance – footnote 3 to state that it "does not impose legally binding requirements on EPA, the U.S. Army Corps of Engineers (Corps), the States, or the regulated community, and may not apply to a particular situation depending upon the circumstances." They ask for clarification on the legal authority of the April 1, 2010 announcement and its associated references, with respect to delegated states' implementation, and EPA oversight of state delegated CWA Section 402 permitting programs (q. A.6). They would also like to know if the interim final Guidance represents the final EPA determination subject to judicial review (q. A.7).

In addition, they are also asking if EPA will proactively continue to provide technical support in the future and if EPA will commit to providing additional CWA 106 funding to the Commonwealth, to address limited staff resources for permit reviews (q. A.19 and B.6).

Finally, they ask if the Guidance is limited to certain states and Appalachian eco-regions, and if so, to clarify the basis for applying the Guidance only to certain states (q. A.8 and A.17).

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance.

a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to SMCRA

With respect to federal authority, Frost Brown Todd claim that the Guidance is in contradiction with established authorities and regulatory structures, and could create precedents that may result in unfair treatment of all applications. Specifically, they state that the "methods through which EPA has instructed to its regions to enforce those requirements, violate the carefully balanced federal-state regulatory structure established by Congress under the CWA, the SMCRA, and related environmental laws" (p. 4). Frost Brown Todd further describe the Guidance as "heavy-handed requirements [that] not only contradict the long-established regulatory standards, authorities, and programs under the CWA, SMRCA and related statutes – they threaten to establish precedents that would undermine the consistent and fair application of those statutes to activities and industries throughout the United States" (p. 5).

b. Authority, Role, and Responsibility of Federal and State Agencies

Frost Brown Todd request that EPA withdraw its Guidance which they see as unlawful and confusing, and superseding legitimate authority from other agencies to regulate these activities. They also request that EPA instruct relevant agencies not to implement or apply the Guidance as it currently stands.

Specifically, Frost Brown Todd states that the Guidance is "inconsistent with EPA's statutory authorities, and imposes an unconstitutional taking of property" (p. 2), and in violation of "the rights of the states and other federal agencies to exercise their own statutory authorities" (p. 6).

In addition, Frost Brown Todd would like EPA to "instruct all relevant state and federal agencies and EPA regions that the requirements of the Guidance are not to be implemented or applied under any circumstances until further notice; and not adopt any further requirements without the benefit of a full and fair public process, based upon input from all interested stakeholders, and in compliance with the requirements of notice-and-comment rulemaking" (p. 2).

Frost Brown Todd further claims that "EPA also seeks to supersede the Corps' authority in administering the Section 404 permitting program and working with the states under Section 401" (p. 5). They also state that the Guidance "improperly presumes that NPDES general permits may not be used to authorize activities associated with coal mining" (p. 5) and that the Guidance itself will "create unnecessary confusion and uncertainty, and treats the states, regions, and industries inequitably" (p. 7).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, one letter was submitted from an Environmental NGO commenting on the issue of federal authority to regulate these activities in EPA's Guidance. The Sierra Club (Doc. #0225) strongly supports the Guidance and commends EPA for issuing it.

b. Authority, Role, and Responsibility of Federal and State Agencies

Although not stating it directly, the Sierra Club supports the EPA's authority to regulate these activities in urging "EPA to make sure that its regional offices and other federal and state agencies adhere to the guidance and do not issue permits that are contrary to the Guidance" (p. 1).

6. Other NGOs

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. Congressional Delegates

Two comment letters posted by the docket as of December 1, 2010 were submitted by congressional delegates. Both letters are signed by several members of Congress, are in general opposition to the Guidance, and address the issue of federal authority. The first letter (Doc. #0011) is signed by three congressional delegates representing the States of Virginia and West Virginia. The second letter (Doc. #0015) is signed by 23 congressional delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming.

a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to Surface Mining Control and Reclamation Act (SMCRA)

The letter signed by 23 congressional delegates (Doc. #0015) argues that guidance is usually issued to clarify or further explain an agency's interpretation of a statute or regulation, but that the April 1, 2010 Guidance appears to make substantive changes and exceeds the original intent of the Acts. Specifically, they identify changes to "three sections of the CWA, along with various provisions of the NEPA and the SMCRA" (p. 1). They further argue that with its "sweeping regulatory action far exceeds the intent of Congress under these Acts" (p. 1) and that they are "troubled by federal efforts to undermine Congressional intent on primary state regulatory authority under SMCRA and the CWA" (p. 2).

b. Authority, Role, and Responsibility of Federal and State Agencies

Both comment letters are opposed to EPA's Guidance, and argue that it usurps certain authorities. The letter signed by congressional delegates from Virginia and West Virginia (Doc.

#0011) criticizes the Guidance's restricted applicability to Appalachia and to surface coal mining operations. They state that "Not only is there no precedent for such an action, but it is also patently a wrong approach to implementing the CWA" (p. 1). The letter signed by 23 congressional delegates representing 14 States (Doc. #0015) criticizes the Guidance because it undermines the authority, roles, and responsibility from state agencies when reviewing and issuing mining permits: "Such a determination threatens the cooperative federalism system Congress created in both SMRCA and CWA" (p. 2). They further argue that under the CWA, States have "the power to design state-specific conditions to federal permits" (p. 2) and this approach "recognizes that state regulators at the local level are better equipped to interpret water quality standards and apply them to site-specific permits because they have in-depth knowledge of local watersheds, their conditions and their long-term plans for improvement" (p. 2).

9. Private Citizen - General

Thirty two comment letters, typically one page in length, submitted by members of the general public comment on the issue of federal authority to regulate these activities. All of the letters are in support of the Guidance and most of them applaud or thank the EPA for recognizing the need to address this issue.

a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to Surface Mining Control and Reclamation Act (SMCRA)

Six of the commenters state that this Guidance is valuable "to ensure that regional staff will finally follow CWA requirements." It should be noted that this language is also found in the mass mailing campaign sponsored by Earthjustice (Doc. #0022).

b. Authority, Role, and Responsibility of Federal and State Agencies

Most commenters supported EPA's role in regulating these activities, and wished to encourage stronger authority. They urged EPA to "strengthen and finalize the guidance and make sure that its regional offices and other federal and state agencies adhere to the policy and do not issue permits that are contrary to the guidance." They also urged EPA to "assure state and federal agencies do not issue permits that are contrary to the clear science and legal requirements discussed in the guidance."

One commenter wishes to encourage federal agencies to "follow consistent and strict application of the rules and regulations that are otherwise turned over for enforcement by local/state EPA agencies (Doc. #0178)."

10. Private Citizen – Expert

As of December 1, 2010, one letter was submitted from a private citizen - expert commenting on the issue of federal authority to regulate these activities in EPA's Guidance. The commenter is a biologist, with a Masters degree in biology, and is currently a teacher teaching wildlife management and environmental earth science (Doc. #0112).

b. Authority, Role, and Responsibility of Federal and State Agencies

The commenter strongly supports the Guidance, commends EPA for issuing it, and urges EPA to "to ensure that regional staff will finally follow CWA requirements."

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns are in support of EPA's Guidance and suggest that the Guidance should be strengthened and finalized.

b. Authority, Role, and Responsibility of Federal and State Agencies

The Sierra Club urges EPA to "strengthen and finalize the guidance and make sure that its regional offices and other federal and state agencies adhere to the policy and do not issue permits that are contrary to the guidance (Doc. #0103)." This statement is echoed by many general private citizens in their comment letters.

Earthjustice urges regional staff to follow the CWA requirements and urges EPA to "assure state and federal agencies do not issue permits that are contrary to the clear science and legal requirements discussed in the guidance (Doc. #0022)." Another exact statement made by many general private citizens in their comment letters.

13. Unknown

Five comment letters received from unknown or unidentified commenters discuss federal authority to regulate these activities. Of the five comment letters, all but one letter (Doc. #0010) are in support of the Guidance.

b. Authority, Role, and Responsibility of Federal and State Agencies

Similar to the mass mailing campaign sponsored by Earthjustice, the four comment letters supporting the Guidance urge EPA not to issue permits that are "contrary to the guidance" or "contrary to the clear science and legal requirements discussed in the guidance."

The comment letter in general opposition to the Guidance states that "EPA has no right dictating to the states how to administer their water quality programs and it is the states who shall determine what criteria is to be met (Doc. #0010)."

Stefania Shamet/R3/USEPA/US
01/03/2011 06:43 AM

To Carrie Traver
cc
bcc
Subject MORE Spruce references

Do we have all of these? Thanks

WVDEP studies on the effects of selenium on aquatic (fish) communities came to our full attention in February 2009 with the publication of the WVDEP Document: Selenium Bioaccumulation Among Select Stream and lake Fishes in West Virginia. In addition, a January 2010 WVDEP document provided to the WV legislature entitled: Selenium-Induced Developmental Effects Among Fishes in Select West Virginia Waters added to EPA's understanding. In addition, POTESTA & Associates and West Virginia University have implemented studies on selenium in West Virginia waters. Finally, SETAC convened a PELLSTON Workshop entitled: Ecological Assessment of Selenium in the Aquatic Environment (February 2009). Other studies that have contributed to a greater understanding of the adverse effects of selenium include Additional investigations and discussions have continued increased selenium concerns including: Bonta, J .V., & Dick, W. A. (2003), Chapman et al. (2009), Diehl, S.F., et. al (2005), Ferreri, C.P. et. al (2004), Lemly, D. M. (2009), Palmer et al. (2010), Neuzil, S.G. et. al. (2005), Vesper, D. et. al. (2008).

John Forren/R3/USEPA/US
01/03/2011 09:45 AM

To Frank Borsuk
cc
bcc
Subject Thanks

Frank:

Just a quick note to thank you for your help with the Spruce selenium issues. Maggie sent me a note to express that she too appreciated all that you're doing to help with Spruce.

Your work certainly has bolstered significantly our response to the selenium issues. I really appreciate your efforts, Frank.

John

Carrie Traver/R3/USEPA/US
01/03/2011 01:00 PM

To Matthew Klasen
cc Christopher Hunter, Greg Pond, John Forren, Marcel Tchaou, Margaret Passmore, Stefania Shamet
bcc
Subject Re: Valley Fill "Foray"

Since this is new, it wasn't on the list I last sent to Chris & Marcel.

I am aware of one WVDEP 2010 reference - the selenium study, including *Selenium-induced developmental effects among fishes in select West Virginia waters*.

Thanks,
Carrie

Carrie Traver
USEPA Region 3
Office of Environmental Programs
1650 Arch Street - 3EA30
Philadelphia, PA 19103
215-814-2772
traver.carrie@epa.gov

Matthew Klasen | Thanks Carrie, Chris or Marcel: Just wanted to... | 01/03/2011 11:18:21 AM

From: Matthew Klasen/DC/USEPA/US
To: Marcel Tchaou/DC/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA
Cc: Carrie Traver/R3/USEPA/US@EPA, Greg Pond/R3/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA
Date: 01/03/2011 11:18 AM
Subject: Re: Valley Fill "Foray"

Thanks Carrie,

Chris or Marcel: Just wanted to double check that this is in the reference list, as Carrie points out? Also, are there other WVDEP 2010s -- or can we start referring to these data just as "WVDEP 2010" (or something else)?

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Margaret Passmore | This am, we decided to keep it. Thanks Carrie! | 01/03/2011 11:11:55 AM

From: Margaret Passmore/R3/USEPA/US
To: Carrie Traver/R3/USEPA/US@EPA
Cc: Greg Pond/R3/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA, Matthew

Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/03/2011 11:11 AM
Subject: Re: Valley Fill "Foray"

This am, we decided to keep it.

Thanks Carrie!

Margaret Passmore
Freshwater Biology Team
Office of Monitoring and Assessment (3EA50)
Environmental Assessment and Innovation Division
USEPA Region 3
1060 Chapline Street, Suite 303
Wheeling, WV 26003-2995
(p) 304-234-0245
(f) 304-234-0260
passmore.margaret@epa.gov

Visit our website at http://epa.gov/reg3esd1/3ea50.htm

Carrie Traver	Right now, this is what I have in the reference li...	01/03/2011 09:20:20 AM

From: Carrie Traver/R3/USEPA/US
To: Matthew Klasen/DC/USEPA/US@EPA
Cc: Greg Pond/R3/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/03/2011 09:20 AM
Subject: Re: Valley Fill "Foray"

Right now, this is what I have in the reference list for the valley fill foray or 4a:

WVDEP (unpublished data, 2010) "Valley Fill Study." Water quality data collected September and October 2009.

It can be edited or removed as necessary.

Carrie Traver
USEPA Region 3
Office of Environmental Programs
1650 Arch Street - 3EA30
Philadelphia, PA 19103
215-814-2772
traver.carrie@epa.gov

Matthew Klasen	OK, "valley fill study" it is. I'll go make that chan...	01/03/2011 08:18:52 AM

From: Matthew Klasen/DC/USEPA/US
To: Greg Pond/R3/USEPA/US@EPA
Cc: Carrie Traver/R3/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/03/2011 08:18 AM
Subject: Re: Valley Fill "Foray"

OK, "valley fill study" it is. I'll go make that change in the RD comments as currently presented. (b) (5) [redacted]

mk

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Greg Pond	Hahaha. WVDEP is clever. No, it was actually...	01/03/2011 07:48:16 AM

From: Greg Pond/R3/USEPA/US
To: John Forren/R3/USEPA/US@EPA
Cc: Carrie Traver/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/03/2011 07:48 AM
Subject: Re: Valley Fill "Foray"

Hahaha. WVDEP is clever. No, it was actually called "foray", but 4-a is their clever way to name it. I think we should re-name it to what you suggest Maggie.

Greg Pond
Office of Monitoring and Assessment
U.S. EPA Region 3
1060 Chapline Street, Suite 303
Wheeling, WV 26003-2995
(p) 304-234-0243
(f) 304-234-0260
pond.greg@epa.gov
Website: http://epa.gov/reg3esd1/3ea50.htm

John Forren	Lol. Nice pun fun. _____...	01/03/2011 07:43:39 AM

From: John Forren/R3/USEPA/US
To: Margaret Passmore/R3/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA
Cc: Greg Pond/R3/USEPA/US@EPA, Carrie Traver/R3/USEPA/US@EPA
Date: 01/03/2011 07:43 AM
Subject: Re: Valley Fill "Foray"

Lol. Nice pun fun.

_____

John Forren
Office of Monitoring & Assessment
USEPA Philadelphia
http://epa.gov/reg3esd1/3ea50.htm

Sent from EPA's Wireless Services

_____

Margaret Passmore

----- Original Message -----
From: Margaret Passmore
Sent: 01/03/2011 07:36 AM EST
To: Stefania Shamet; Matthew Klasen
Cc: John Forren; Greg Pond; Carrie Traver
Subject: Valley Fill "Foray"

Matt,

For the pun of the day, we realized that the Valley Fill "Foray" dataset is actually called Valley Fill 4-a.

I suggest that if we decide to use it, we call it the WVDEP Valley Fill Study.

M

Margaret Passmore
Freshwater Biology Team
Office of Monitoring and Assessment (3EA50)
Environmental Assessment and Innovation Division
USEPA Region 3
1060 Chapline Street, Suite 303
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(p) 304-234-0245
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Visit our website at http://epa.gov/reg3esd1/3ea50.htm

Gregory Peck/DC/USEPA/US
01/03/2011 08:41 PM

To Matthew Klasen
cc
bcc
Subject Re: Re: Fw: 1/4/11Mining call agenda-call is MOVED to 10:30 to 11:30

Let's talk about this tomorrow.

Gregory E. Peck
Chief of Staff
Office of Water
U.S. E.P.A.

From: Matthew Klasen
Sent: 01/03/2011 08:36 PM EST
To: Gregory Peck
Subject: Fw: Re: Fw: 1/4/11Mining call agenda-call is MOVED to 10:30 to 11:30

FYI from Mike Slimak. We may need to summarize ourselves at some point, but we'll see how he responds. I suspect Bob or Nancy may directly ask what the reports say, which may prompt ORD to develop a summary.

I got through about the first half of the conductivity report, and nothing profoundly new. I mentioned the ephemeral stream cautions before; it also says that the benchmark should not be applied beyond KY and WV without additional verification of background concentrations/ionic signatures/etc., and also includes a new discussion detailing how OH conductivity levels may be higher than KY/WV.

Generally, however, it looks really similar to the last version.

mk

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]
-----Forwarded by Matthew Klasen/DC/USEPA/US on 01/03/2011 08:34PM -----

To: Michael Slimak/DC/USEPA/US@EPA
From: Matthew Klasen/DC/USEPA/US
Date: 01/03/2011 08:34PM
Cc: Susan Norton/DC/USEPA/US@EPA, Susan Cormier/CI/USEPA/US@EPA
Subject: Re: Fw: 1/4/11Mining call agenda-call is MOVED to 10:30 to 11:30

OK, that works -- but I expect that Bob or others will be asking for a summary of what the draft SAB reports actually say. Is ORD pulling together a summary that might be appropriate to share with the AO or senior OW folks (or at least a summary of what's different since the last time around)?

Greg and I have talked about the need to pull something together, and your investment in this is much greater than ours, but we could certainly pull together a summary ourselves if we need to (but likely not till after Spruce gets done).

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

-----Michael Slimak/DC/USEPA/US wrote: -----

To: Matthew Klasen/DC/USEPA/US@EPA
From: Michael Slimak/DC/USEPA/US
Date: 01/03/2011 02:35PM
Cc: Susan Norton/DC/USEPA/US@EPA, Susan Cormier/CI/USEPA/US@EPA
Subject: Re: Fw: 1/4/11Mining call agenda-call is MOVED to 10:30 to 11:30

Yes, I can provide a brief summary of next steps. I don't plan to summarize the SAB reports.

Matthew Klasen---01/03/2011 02:24:58 PM---Hi Mike, I'd suggested to OWOW this morning that ORD could give a quick summary tomorrow morning of

From: Matthew Klasen/DC/USEPA/US
To: Michael Slimak/DC/USEPA/US@EPA
Cc: Susan Cormier/CI/USEPA/US@EPA, Glenn Suter/CI/USEPA/US@EPA, Jeff Frithsen/DC/USEPA/US@EPA, Susan Norton/DC/USEPA/US@EPA
Date: 01/03/2011 02:24 PM
Subject: Fw: 1/4/11Mining call agenda-call is MOVED to 10:30 to 11:30

Hi Mike,

I'd suggested to OWOW this morning that ORD could give a quick summary tomorrow morning of the updated SAB reports and next steps, and it's on the draft agenda for tomorrow morning (10:30-11:30. Does that work for you?

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

----- Forwarded by Matthew Klasen/DC/USEPA/US on 01/03/2011 02:24 PM -----

From: CynthiaN Johnson/DC/USEPA/US
To: Ann Campbell/DC/USEPA/US@EPA, Ben Ghosh/R4/USEPA/US@EPA, Beth Walls/R4/USEPA/US@EPA, Bharat Mathur/R5/USEPA/US@EPA, Bob Sussman/DC/USEPA/US@EPA, Brian Frazer/DC/USEPA/US@EPA, Chris Thomas/R4/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA, Cliff Rader/DC/USEPA/US@EPA, Daniel Holliman/R4/USEPA/US@EPA, Darren Reid/DC/USEPA/US@EPA, David Evans/DC/USEPA/US@EPA, Denis Borum/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA,

Duncan Powell/R4/USEPA/US@EPA, Evelyn MacKnight/R3/USEPA/US@EPA, Georgia Bednar/DC/USEPA/US@EPA, Grace Robiou/DC/USEPA/US@EPA, Gregory Peck/DC/USEPA/US@EPA, Janice Donlon/R3/USEPA/US@EPA, Jeffrey Lapp/R3/USEPA/US@EPA, Jim Giattina/R4/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA, John Pomponio/R3/USEPA/US@EPA, Jon Capacasa/R3/USEPA/US@EPA, Jordan Dorfman/DC/USEPA/US@EPA, Justin Wright/DC/USEPA/US@EPA, Karyn Wendelowski/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA, Kevin Pierard/R5/USEPA/US@EPA, Larinda Tervelt/R4/USEPA/US@EPA, Mahri Monson/DC/USEPA/US@EPA, Marcus Zobrist/DC/USEPA/US@EPA, Mark Nuhfer/R4/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Melissa Raack/DC/USEPA/US@EPA, Michael Dunn/R3/USEPA/US@EPA, Michael Slimak/DC/USEPA/US@EPA, MichaelG Lee/DC/USEPA/US@EPA, Naimah Karim/R5/USEPA/US@EPA, Nanci Gelb/DC/USEPA/US@EPA, Nancy Stoner/DC/USEPA/US@EPA, Palmer Hough/DC/USEPA/US@EPA, Peter Silva/DC/USEPA/US@EPA, Peter Swenson/R5/USEPA/US@EPA, Philip Mancusi-Ungaro/R4/USEPA/US@EPA, Rebecca Cover/R4/USEPA/US@EPA, Robert Klepp/DC/USEPA/US@EPA, Rosemary Hall/DC/USEPA/US@EPA, Ross Geredien/DC/USEPA/US@EPA, Sharmin Syed/DC/USEPA/US@EPA, Shawn Garvin/R3/USEPA/US@EPA, Stan Meiburg/R4/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA, Stephanie Fulton/R4/USEPA/US@EPA, Susan Cormier/CI/USEPA/US@EPA, Susan Norton/DC/USEPA/US@EPA, Tanya Code/DC/USEPA/US@EPA, Timothy Landers/R6/USEPA/US@EPA, Tinka Hyde/R5/USEPA/US@EPA, Todd Bowers/R4/USEPA/US@EPA, Tom Laverty/DC/USEPA/US@EPA, Tom Welborn/R4/USEPA/US@EPA, Wendy Melgin/R5/USEPA/US@EPA, William Early/R3/USEPA/US, Elaine Suriano/DC/USEPA/US@EPA, Caroline Whitehead/DC/USEPA/US@EPA, Amy Newbold/R4/USEPA/US@EPA, Brian Topping/DC/USEPA/US@EPA, Bridget Staples/R4/USEPA/US@EPA, Eric Somerville/R4/USEPA/US@EPA, Chad Harsh/R3/USEPA/US@EPA, Jessica Martinsen/R3/USEPA/US@EPA, Susan Hansen/R4/USEPA/US@EPA, Tom Marshall/DC/USEPA/US@EPA, Larry Long/R4/USEPA/US@EPA, Kip Tyler/R4/USEPA/US@EPA, Sonia Alteri/DC/USEPA/US@EPA, Glenn Suter/CI/USEPA/US@EPA

Date: 01/03/2011 11:06 AM

Subject: 1/4/11Mining call agenda-call is MOVED to 10:30 to 11:30

All,

I have attached the agenda for tomorrow's mining call. Please note that the call starts at 10:30 instead of 10 tomorrow morning.

[attachment "Mining Call Agenda 1-4-11.doc" deleted by Michael Slimak/DC/USEPA/US]

--

Cynthia N. Johnson
Program Analyst
U.S. Environmental Protection Agency
Office of Wetlands, Oceans and Watersheds
Wetlands Division
Johnson.CynthiaN@EPA.gov
Phone: (202) 566-1679
Fax: (202) 566-1349

Mailing Address:
1200 Penn. Ave, NW MC: 4502T
Washington, DC 20460

Jessica Martinsen/R3/USEPA/US
01/04/2011 12:15 PM

To Alaina DeGeorgio
cc
bcc
Subject Fw: NSF539 -- Surface Mine No. 45

More info.

Jessica Martinsen
U.S. EPA Region III
Office of Environmental Programs
1650 Arch St. (3EA30)
Philadelphia, PA 19103
215-814-5144 (office)
215-814-2783 (fax)
----- Forwarded by Jessica Martinsen/R3/USEPA/US on 01/04/2011 12:15 PM -----

From: Joy Gillespie/R3/USEPA/US
To: Stevie Wilding/ESC/R3/USEPA/US
Cc: Jessica Martinsen/R3/USEPA/US@EPA
Date: 12/29/2010 02:28 PM
Subject: Re: NSF539 -- Surface Mine No. 45

Hi Stevie,

Here is our proposed schedule for our next two sampling events.

1/11-14/2011
Stop by Fort Meade to collect supplies (containers, sample tags and lab water)
Pine Creek No. 1 surface mine (located in Logan County): 1/12/2011
Wiley Branch surface mine (located in Wayne County): 1/13/2011
Deliver samples to Fort Meade on 1/14/11

1/25-27/2011
Stop by Fort Meade to collect supplies (containers, sample tags and lab water) (might not be necessary)
Peg fork surface mine (located in Mingo County):1/26/2011
Deliver samples to Fort Meade on 1/27/11

Hopefully these dates work for you all. I'm sure we make some adjustments to our schedule if needed. Tomorrow I'll send you a sample plan for each site.

Attached are the analytical request forms.

AnalyticalRequestWiley.doc AnalyticalRequestCoal mac.doc AnalyticalRequestPeg fork.doc

Once again, Thanks for all your help!!!!!

Joy

Joy Gillespie

EPA Region III
Environmental Assessment & Innovation Division
Office of Monitoring and Assessment (3EA50)

215-814-2793
gillespie.joy@epa.gov

Learn more about the Office of Monitoring & Assessment at:
http://epa.gov/reg3esd1/3ea50.htm

Stevie Wilding	Attached is the request form with three sampling...	12/27/2010 04:36:56 PM

From: Stevie Wilding/ESC/R3/USEPA/US
To: Joy Gillespie/R3/USEPA/US@EPA
Date: 12/27/2010 04:36 PM
Subject: NSF539 -- Surface Mine No. 45

Attached is the request form with three sampling events.

I don't think another request is necessary -- I will check on the lab pH.

[attachment "NSF539.doc" deleted by Joy Gillespie/R3/USEPA/US]

U.S. EPA Region III Analytical Request Form

ASQAB USE ONLY		
CASE	CT5262	Analytical TAT
DAS#		30 Days
NSF#	NSF539	

Date: 12/28/2010	Site Activity: Mountain Top Mining		
Site Name: Pine Creek No. 1 Surface Mine, Coal Mac, Inc		Street Address: n/a	
City: Omar	State: WV	Latitude:	Longitude:
Program: CWA	Acct. #: N/A	CERCLIS #: N/A	
Site ID: N/A	Spill ID: N/A	Operable Unit: N/A	
Site Specific QA Plan Submitted: ☒ No ☐ Yes Title: N/A		Date Approved:	
EPA Project Leader: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Request Preparer: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Site Leader: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Contractor: N/A		EPA CO/PO: N/A	
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Metals; ICP-AES (Ca,K,Mg,Na,)	Method: EPA 200.7
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Total, HCO3 and CO3 Alkalinity, Lab pH	Method: SM 2320B
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Sulfate and Chloride by IC	Method: EPA 300.0
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: TDS	Method: SM 2540C
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: TSS	Method: SM 2540D
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Metals; ICP-AES (Al,Fe,Mn,Se,Zn)	Method: EPA 200.8
#Samples	Matrix:	Parameter:	Method:
Ship Date From: December 7, 2010	Ship Date To: January 30, 2011	Org. Validation Level	Inorg. Validation Level
Unvalidated Data Requested: ☒ No ☐ Yes If Yes, TAT Needed: ☐ 24hrs ☐ 48hrs ☐ 72hrs ☐ 7days ☐ Other (Specify)			
Validated Data Package Due: ☐ 14 days ☐ 21 days ☒ 30days ☐ 42 days ☐ Other (Specify)			
Electronic Data Deliverables Required: ☐ No ☒ Yes (EDDs will be provided in Region 3 EDD Format)			

Special Instructions:
Sampling Event #2: 10 – 20 samples shipped to lab on 01/14/2011

The ESC Routine Reporting Limits for NSFs are needed. *[I: Drive ASQAB_AT Team/Sample Manager Information/QL Table/1-OASQA RLs/ESC Routine RLs for NSF.XLS]*
Selenium, need detection limit of 1 µg/L (instead of 5 µg/L)

FORM ARF- 03/05

U.S. EPA Region III Analytical Request Form

ASQAB USE ONLY		
CASE	CT5262	Analytical TAT
DAS#		30 Days
NSF#	NSF539	

Date: 12/28/2010	Site Activity: Mountain Top Mining		
Site Name: Peg Fork Surface Mine, CONSOL of Kentucky Inc		Street Address: n/a	
City: Chattaroy	State: WV	Latitude:	Longitude:
Program: CWA	Acct. #: N/A	CERCLIS #: N/A	
Site ID: N/A	Spill ID: N/A	Operable Unit: N/A	
Site Specific QA Plan Submitted: ☒ No ☐ Yes Title: N/A		Date Approved:	
EPA Project Leader: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Request Preparer: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Site Leader: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Contractor: N/A		EPA CO/PO: N/A	
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Metals; ICP-AES (Ca,K,Mg,Na,)	Method: EPA 200.7
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Total, HCO3 and CO3 Alkalinity, Lab pH	Method: SM 2320B
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Sulfate and Chloride by IC	Method: EPA 300.0
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: TDS	Method: SM 2540C
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: TSS	Method: SM 2540D
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Metals; ICP-AES (Al,Fe,Mn,Se,Zn)	Method: EPA 200.8
#Samples	Matrix:	Parameter:	Method:
Ship Date From: December 7, 2010	Ship Date To: January 30, 2011	Org. Validation Level	Inorg. Validation Level
Unvalidated Data Requested: ☒ No ☐ Yes If Yes, TAT Needed: ☐ 24hrs ☐ 48hrs ☐ 72hrs ☐ 7days ☐ Other (Specify)			
Validated Data Package Due: ☐ 14 days ☐ 21 days ☒ 30days ☐ 42 days ☐ Other (Specify)			
Electronic Data Deliverables Required: ☐ No ☒ Yes (EDDs will be provided in Region 3 EDD Format)			

Special Instructions:
Sampling Event #3: 10 – 20 samples delivered to lab on 01/27/2011

The ESC Routine Reporting Limits for NSFs are needed. *[I: Drive ASQAB_AT Team/Sample Manager Information/QL Table/1-OASQA RLs/ESC Routine RLs for NSF.XLS]*
Selenium, need detection limit of 1 µg/L (instead of 5 µg/L)

FORM ARF- 03/05

U.S. EPA Region III Analytical Request Form

ASQAB USE ONLY		
CASE	CT5262	Analytical TAT
DAS#		30 Days
NSF#	NSF539	

Date: 12/28/2010	Site Activity: Mountain Top Mining		
Site Name: Wiley Branch Surface Mine, Argus Energy WV, LLC		Street Address: n/a	
City: Wilsondale	State: WV	Latitude:	Longitude:
Program: CWA	Acct. #: N/A	CERCLIS #: N/A	
Site ID: N/A	Spill ID: N/A	Operable Unit: N/A	
Site Specific QA Plan Submitted: ☒ No ☐ Yes Title: N/A		Date Approved:	
EPA Project Leader: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Request Preparer: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Site Leader: Joy Gillespie	Phone#: 215-814-2793	Cell Phone #: 215-266-4688	E-mail: Gillespie.Joy@epa.gov
Contractor: N/A		EPA CO/PO: N/A	
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Metals; ICP-AES (Ca,K,Mg,Na,)	Method: EPA 200.7
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Total, HCO3 and CO3 Alkalinity, Lab pH	Method: SM 2320B
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Sulfate and Chloride by IC	Method: EPA 300.0
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: TDS	Method: SM 2540C
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: TSS	Method: SM 2540D
#Samples 30 - 60	Matrix: Non Potable Water	Parameter: Metals; ICP-AES (Al,Fe,Mn,Se,Zn)	Method: EPA 200.8
#Samples	Matrix:	Parameter:	Method:
Ship Date From: December 7, 2010	Ship Date To: January 30, 2011	Org. Validation Level	Inorg. Validation Level
Unvalidated Data Requested: ☒ No ☐ Yes If Yes, TAT Needed: ☐ 24hrs ☐ 48hrs ☐ 72hrs ☐ 7days ☐ Other (Specify)			
Validated Data Package Due: ☐ 14 days ☐ 21 days ☒ 30days ☐ 42 days ☐ Other (Specify)			
Electronic Data Deliverables Required: ☐ No ☒ Yes (EDDs will be provided in Region 3 EDD Format)			

Special Instructions:
Sampling Event #2: 10 – 20 samples delivered to lab on 01/14/2011

The ESC Routine Reporting Limits for NSFs are needed. *[I: Drive ASQAB_AT Team/Sample Manager Information/QL Table/1-OASQA RLs/ESC Routine RLs for NSF.XLS]*
Selenium, need detection limit of 1 µg/L (instead of 5 µg/L)

FORM ARF- 03/05

Christopher Hunter/DC/USEPA/US

01/04/2011 02:31 PM

To Brian Frazer

cc

bcc

Subject revised UMW

UMW outline.docx

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

EPA Statutory, Regulatory, & Environmental Responsibilities

- Clean Water programs that regulate the discharge of pollutants and fill material into waters of the United States (Section 404 and Section 402)
- National Environmental Policy Act EIS review
- Executive Order on Environmental Justice

Why EPA's Role and Level of Review Has Increased

- A growing body of scientific literature, including previous and new studies performed by EPA, show significant damage to local streams that are polluted with the mining runoff from mountaintop removal.
- A recent EPA study found that nine out of every 10 streams downstream from surface mining operations were impaired based on an assessment of aquatic life.
- In June 2009, the Department of the Army, EPA, and the Department of the Interior (DOI) signed a Memorandum of Understanding (MOU) to minimize the harmful consequences of Appalachian surface coal mining practices. The MOU reflects an agreement among the agencies to strengthen the environmental reviews of Appalachian surface coal mining projects under the CWA, NEPA, and the Surface Mining Control and Reclamation Act (SMCRA).
- On April 1, 2010 EPA issued guidance to its field offices on the review of mining permits. Three key considerations motivated the Agency's development of this guidance.
    - First has been the collection and publication of technical information documenting the scope and significance of adverse environmental and water quality effects associated with surface coal mining practices.
    - Second, EPA has recently completed reviews of permitting actions under CWA Sections 402 and 404 for Appalachian surface coal mining. These reviews demonstrate that current permitting practices can be more effective in addressing adverse environmental and water quality effects associated with coal mining by more robustly conducting analyses required by the CWA.
    - Third, EPA scientific offices are conducting extensive work evaluating the relationship between pollutants in streams associated with surface coal mining and impacts from these pollutants on aquatic ecosystems.

EPA's Mining Review & Mining Jobs

- Administrator Jackson has stated "Let me be clear: this *[EPA's actions in coal mining permit review]* is not about ending coal mining. This is about ending coal mining pollution."
- Referring to the April 1 guidance, Administrator Jackson said "The people of Appalachia shouldn't have to choose between a clean, healthy environment in which to raise their families and the jobs they need to support them. That's why EPA is providing even greater clarity on the direction the agency is taking to confront pollution from mountain top removal."
- Our goal in the review of new proposed permits has been to work with the Corps, State regulatory agencies, and mining companies to reach agreement on projects that comply with the law, result in the least environmental impact possible, and are able to mine the maximum amount of coal possible.

- EPA is asking that mining companies comply with the Clean Water Act by conducting their operations in a way that is protective of water quality.
- In the case of the Hobet 45 Mine, EPA advised the Army Corps of Engineers that, as a result of changes agreed to by Hobet Mining after discussions with EPA, the proposed mine met the requirements of the Clean Water Act, following which a permit was issued by the Corps of Engineers.
    - EPA worked closely with Hobet Mining LLC and the Corps to redesign the proposed Hobet 45 mine to eliminate nearly 50 percent of stream impacts, reduce anticipated stream contamination, and protect public health, while continuing to mine nearly the same quantity of coal.
    - The Hobet 45 operation is expected to employ 460 United Mine Workers of America coal miners.
- Since the 2009 MOU was signed, EPA has reviewed over 100 permit applications or renewals under Section 402 and 404 of the Clean Water Act. Although EPA has raised environmental concerns and objections in many cases, to date, EPA has not used its statutory or regulatory authorities to permanently stop a new proposed project.
- The projects most likely to move quickly through the review process are those involving one or no valley fills, those that incorporate best available practices to minimize and treat effluent containing elevated levels of ions and selenium, and those which seek to recreate natural stream conditions, including aquatic life, in reclaimed sites.
- EPA is committed to keeping the regulated public as well-advised of the status of actions and decisions as possible. For the 404 permit actions, we have a website (http://water.epa.gov/lawsregs/guidance/wetlands/mining.cfm) with information on recent EPA actions and the status of all Enhanced Coordination Process projects.

Brian Frazer/DC/USEPA/US
01/04/2011 03:13 PM

To Ann Campbell
cc Denise Keehner, David Evans, Jim Pendergast, Christopher Hunter, Gregory Peck
bcc
Subject Re: URGENT: Thursday Meeting between the Administrator and United Mine Workers

Ann - Attached is the write up for Administrator Jackson meeting with the United Mine Workers of America. In order to meet the 3 pm deadline I'm sending this to you now, however, Denise is currently reviewing and might have some additional comments.

Let me know if you have any questions.

bf

UMW outline.docx

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Brian M. Frazer, Chief
Wetlands & Aquatic Resources Regulatory Branch
Office of Wetlands, Oceans and Watersheds
U.S. EPA
1200 Pennsylvania Avenue, NW (MC 4502T)
Washington, DC 20460
202-566-1652

Christopher Hunter/DC/USEPA/US
01/05/2011 07:28 AM

To Matthew Klasen, Stefania Shamet
cc Carrie Traver
bcc
Subject Re: MORE References. Do we have these?

Good morning,
Since Marcel is also in charge of making updates to the selenium appendix, I'm a little worried he's going to have a lot of work come in at once. So, if Carrie can send what she has to Marcel and I now, I'll get him working on that, and we'll catch any stragglers piecemeal.

Thanks
Chris Hunter
US EPA, Wetlands Protection Division
(202) 566-1454 (t)
(b) (6) [redacted]

Matthew Klasen

----- Original Message -----
From: Matthew Klasen
Sent: 01/04/2011 09:49 PM EST
To: Stefania Shamet; Christopher Hunter
Cc: Carrie Traver
Subject: Re: MORE References. Do we have these?

Hey Stef,

Not sure what's best, and I'll defer to Chris, because I think Marcel has been working on the references appendix from HQ. But I think the non-piecemeal idea was a great approach.

In my comments to Kevin on 68A-113A, I noted the new SAB report on conductivity from Dec. 28 in a couple responses, but didn't actually cite it directly -- so that's another one we can add to the list.

Thanks Carrie (and Stef, as always)!

mk

Matt Klasen
U.S. Environmental Protection Agency
Office of Water
(202) 566-0780
(b) (6) [redacted]

Stefania Shamet

----- Original Message -----
From: Stefania Shamet
Sent: 01/04/2011 07:33 PM EST
To: Christopher Hunter; Matthew Klasen
Cc: Carrie Traver
Subject: Fw: MORE References. Do we have these?

Chris, Matt -- As I've seen responses from the various crew citing various studies, I've been shooting the citations to the wonderful, detail-oriented Carrie Traver, who is keeping a running list of what's new and needs to be added to the references.

Awhile ago, I told her not to send piecemeal and hold til late in the game.

Any thoughts on how she should proceed (and I think we will have additions and I know of at least one subtraction) as we get close?

Carrie -- Thanks again. I've let Jeff know how terrific you've been and how much I appreciate it.

----- Forwarded by Stefania Shamet/R3/USEPA/US on 01/04/2011 07:31 PM -----

From:	Carrie Traver/R3/USEPA/US
To:	Stefania Shamet/R3/USEPA/US@EPA
Date:	01/04/2011 03:56 PM
Subject:	Re: MORE References. Do we have these?

Stef,

These are all new. I'll add them to the reference list.

Speaking of which, what should I do with it--and when?

Carrie Traver
USEPA Region 3
Office of Environmental Programs
1650 Arch Street - 3EA30
Philadelphia, PA 19103
215-814-2772
traver.carrie@epa.gov

Stefania Shamet	GUEROLD, F. 2000. Influence of taxonomic det...	01/04/2011 01:59:54 PM

From:	Stefania Shamet/R3/USEPA/US
To:	Carrie Traver/R3/USEPA/US@EPA
Date:	01/04/2011 01:59 PM
Subject:	MORE References. Do we have these?

GUEROLD, F. 2000. Influence of taxonomic determination level on several community indices. Water Research 34:487–492.

HAWKINS, C. P., R. H. NORRIS, J.N.HOGUE, AND J. W. FEMINELLA. 2000. Development and evaluation of predictive models for measuring the biological integrity of streams. Ecological Applications 10:1456–1477.

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David Rider/R3/USEPA/US
01/05/2011 12:02 PM

To David Kargbo
cc
bcc
Subject Fw: WV selenium plan - task force report

----- Forwarded by David Rider/R3/USEPA/US on 01/05/2011 12:03 PM -----

From: David Rider/R3/USEPA/US
To: Stefania Shamet/R3/USEPA/US@EPA
Cc: John Forren/R3/USEPA/US, Frank Borsuk/R3/USEPA/US@EPA
Date: 12/23/2010 09:58 AM
Subject: WV selenium plan - task force report

Stef,

Here is a report that outlines the WV method for control. Perhaps this will help.

Dave

WV_selenium_plan.pdf

THE OCCURRENCE OF SELENIUM IN THE UPPER KANAWHA FORMATION OF THE PENNSYLVANIAN SYSTEM IN THE SOUTHERN WEST VIRGINIA COAL FIELDS

George Jenkins and Nick Schaer
WVDEP

ABSTRACT A search of the literature on selenium reveals that there are little or no studies available on the concentrations of selenium in rock overburden anywhere in the United States. The Environmental Protection Agency's (EPA) concern with the in-stream concentrations of selenium in the Draft Programmatic Environmental Impact Statement conducted in 6 watersheds in West Virginia for mountaintop mining, brought the lack of data on selenium to the attention of West Virginia's Department of Environmental Protection (DEP). To acquire data for a mining National Pollution Discharge Elimination System Permit (NPDES), the DEP's Water Resource section required the drilling of holes to secure data on selenium in the overburden of selected surface mine permits. The results, procedures and conclusions drawn from the initial drilling under this requirement are presented in this paper.

DISCUSSION

The EPA conducted extensive water testing in 6 watersheds in West Virginia in conjunction with the mountaintop mining EIS (*28).* This study was started in 1999 and a draft report on findings is available. In addition to the typical metals that are analyzed for in a surface mine (SMCRA) permit, selenium was noted as a trace metal of concern by the EPA. This concern arose from selenium concentrations in excess of the 5 ppb in-stream chronic water quality limit that exists in West Virginia (*39*). Because the EIS study purposely picked areas that were/are being surface mined in the state, the conclusion has been drawn that surface mining areas, particularly valley fills, are contributing to the selenium concentrations noted. A literature search on selenium revealed that extensive research on selenium in fly ash (Lemly) and soils (Vance) were available, but no papers or research was noted on the concentrations of selenium in rock overburden. This was important to the WVDEP, because we needed to know where the selenium was concentrated on a surface mine job to suggest ways to handle overburden or use other techniques to mine the coal without harming the aquatic environment with toxic selenium, which can cause harm to fish tissue, animals etc. through bio-concentration *30,31,40).* A study by the West Virginia Geologic Survey (WVGS) was posted on the internet that indicated that coal seams of the Upper Kanawha Formation of the Pennsylvanian System (*34,35)* was much higher in selenium than other strata in the coal areas of the Appalachians. The principal mineable seams in this geological section are the Winifrede, Coalburg, Stockton and #5 Block seams.

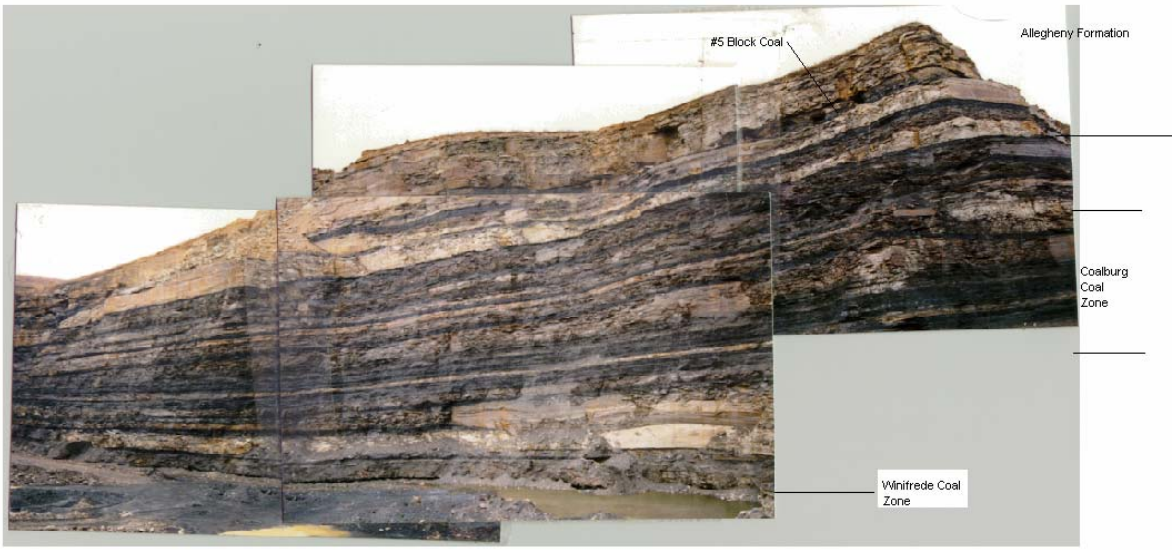

Figure1. Highwall covering the Winifrede to 6-Block coal seams. Picture taken near Sharples, West Virginia at the now inactive Dal-Tex strip mine complex.

This WVGS study was done by measuring the trace metals in the fly ash of the coal seams that were burned in the state, and back calculating the amount of selenium in the total coal seam. The WVGS study, and other research reviewed, plus conversations with analytical laboratory personnel (*41,42)*, indicated that the selenium was associated with organic/carbon based material, like coal seams, carbonaceous shale, etc. Previous work on coal ash and associated materials by one of the authors of this paper for various coal companies also indicated that the coal seams and associated "pit cleanings" (carbonaceous roof, floor and parting material) held the highest concentrations of selenium in the overburden. If the vertical location of the selenium in the "pit cleanings" was correct, then it was possible to design a materials handling plan to isolate this material that would be not cost prohibitive in the mining sequence.

PROTOCOL USED TO ACQUIRE AND ANALYZE THE OVERBURDEN SAMPLES FOR SELENIUM

1. Since 1999, the WVDEP has required that all of the baseline water sites that are submitted for a surface mine permit be tested for trace metals and other compounds, such as phenols, on a one time basis. This data, plus data from several other sources (1.) NPDES renewal Table IV-C analyses. (2.) Data from the Department of Environmental Protection (DEP) trend sites. (3) Data from the EIS in certain watersheds. (4) Data from Water Resources for TMDL's (Total Maximum Daily Loads) etc. (5) and the latest 303(d)

impaired streams list from the Division of Water Resources are checked to see if Selenium or any other metal is above the Title 46-1 State Water Quality Limits (*39)* or of concern.. Any area that has had previous mining and reflects over 5 ppb selenium (current instream chronic water quality standard for selenium) will be selected for drilling to sample the overburden.

2. The drilling will be on approximately 2000' spacing, or other spacing required by the geologist reviewing the surface mining (SMCRA) permit. The holes will be located on the tops of the ridges and drilled down to 10' below the lowest seam to be mined. This will insure that all the overburden to be removed is covered in it's entirety.
3. The core from the drilling will be broken down into vertical sections of 5' or less if the strata type changes. The object is to break the core down into small recognizable sections that can be separated by high selenium content in the mining sequence. This breakdown will also mirror the acid/base testing breakdown, which has been used for decades in surface mining in WV.
4. Each 5' or less section is then analyzed for total selenium by the 3050B (for Acid digestion of Solids) method. Any strata that has a total selenium concentration of 1mg/kg (*25,33,36)* or greater is considered potentially toxic and will have to undergo further testing or an encapsulation/isolation plan provided to deal with the selenium laden overburden.
5. There are several leachate tests available for the next level, if the applicant does not want to do the materials handling plan based on the total selenium analyses. They are (1) Column Leaching (2) Soxhlet (3) Phosphate(*25)* etc. Any leachate test that results in a reading of greater that 5 ug/kg will be considered toxic for selenium and will be included in a specific materials handling plan.

RESULTS FROM DRILLING IN LOGAN AND MINGO COUNTIES IN SOUTHERN WEST VIRGINIA

The protocol was applied to 3 mining areas in the spring of 2004. The results of 1 hole from northern Logan County, 5 holes from southern Logan County and 1 hole from Mingo County (locations shown in figure 2) are included in this report. All of these drilling areas were or are going to be mountaintop mined for the Coalburg and above/Upper Kanawha strata The cross section of the Phoenix #4 area in southern Logan County, and the drill logs with selenium content in the other two areas indicate that the selenium is concentrated in the "pit cleanings" as theorized at the beginning of the study. These "pit cleanings" are the immediate dark shale roof of the Coalburg, Stockton and Five Block coal seams, partings in the coal seams and sometimes the immediate floor of the coal seams. These strata exhibit selenium concentrations of almost one order of magnitude above the background concentrations of selenium in the sandstones, limestones and other strata encountered in the mining sequence. That is .05 to .25 mg/kg in the sandstones and .5 to 1+ mg/kg in the carbonaceous shales, coal partings, floor of the coal seam and the seam itself (see Table 1). The potentially toxic selenium concentrations of 1mg/kg and above are almost solely concentrated in the coal seams, partings and roof and floor of the seams to be mined. Leachate tests on these holes are in

progress and could be the subject of a follow-up paper. The current results definitively indicate that the selenium has an affinity for organic material in the overburden column.

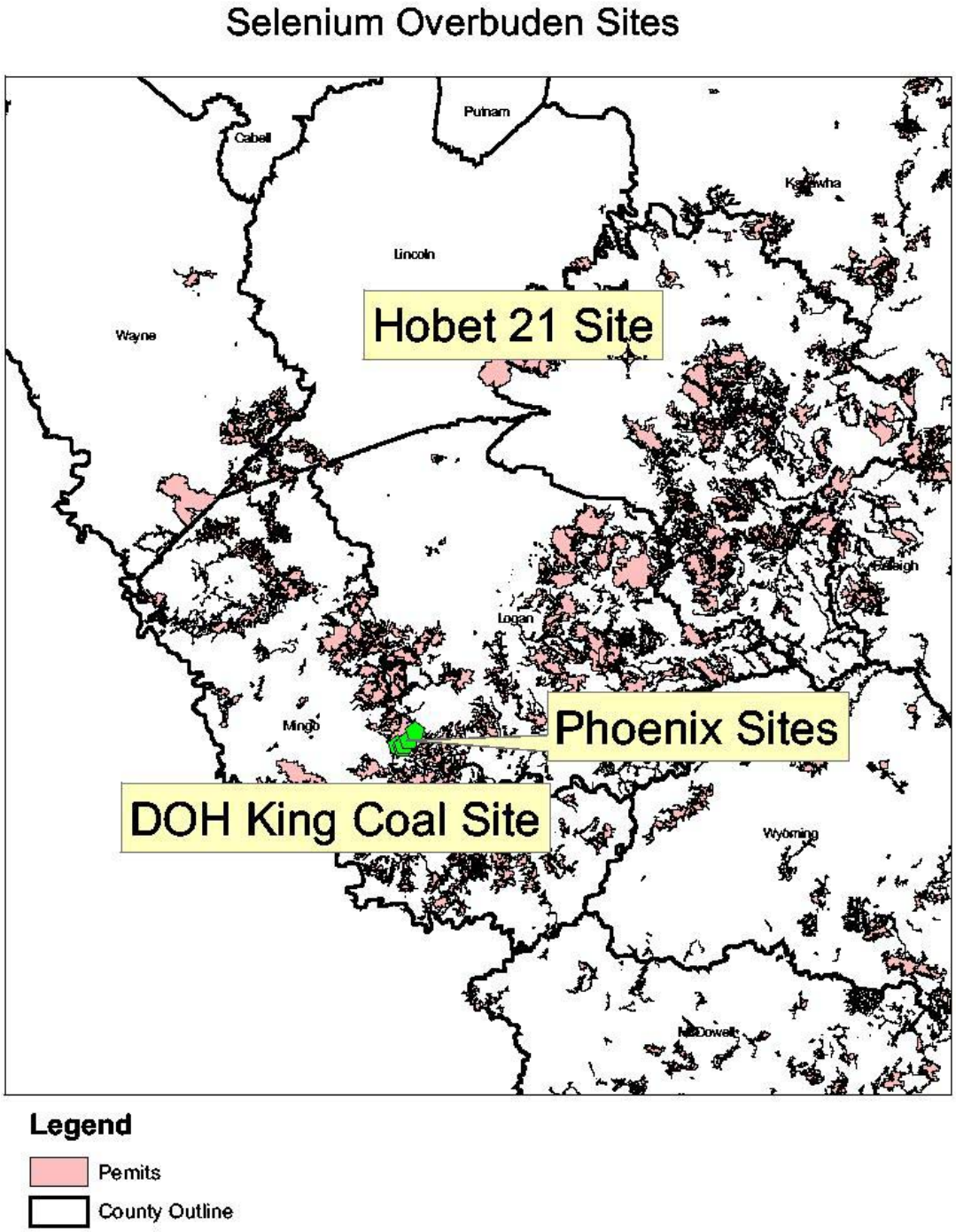

Figure 2. Location of selenium overburden sampling in southern West Virginia.

RECOMMENDED MATERIALS HANDLING PLAN

1. Because the toxic selenium material that needs to be isolated is concentrated in small vertical zones that have to be set aside to recover the coal seam, and the material is a black/dark gray material that is visibly differentiated in the field, the mining company can split this material out in the coal pits. (see figure 3).

Figure 3. #5 Block coal and other black "Pit Cleanings" gathered in piles for removal to special handling areas. Pen Coal strip mine in Wayne County, West Virginia.

2. It is important to rip up 6" to 1' of the floor of the bottom coal seam so that no selenium laden material is left to contaminate the water/rock interface.
3. The toxic material should be removed to an area on the job that is high and dry away from water courses, and under no circumstance should any of this material be put in a valley fill.
4. The material should then be put on a free draining pad of @10' of coarse non-selenium laden material and covered with at least 4' of the most impervious material on the surface mine job. This method will keep water from leaching through the selenium laden overburden.

CONCLUSIONS

It is apparent from the analytical results and research to date that the selenium is concentrated in the "pit cleanings" and particularly in the Upper Kanawha strata in West Virginia. The cut-off of 1 mg/kg limit for identifying the material that has to

undergo further leachate testing looks valid in differentiating the high selenium material to be isolated from the lower concentration material. The visual difference of the black /darker selenium laden material from the other overburden in the Upper Kanawha series is very useful in separating the toxic material from the non-toxic in the field. Further work needs to be done on the different methods of leachate tests to calculate what percentage of selenium in the overburden will be mobilized into the hydrologic environment. Also, it is imperative that a study of how selenium is dispersed in flowing streams versus standing bodies of water is critical to the understanding of what impact selenium may have to the aquatic environment. The moral to the story is to isolate the black/darker selenium laden material and to keep any of this material from the valley fills. This material, besides having high concentrations of selenium, is also typically high in iron and manganese and other trace metals, as well as more acidic, so that the materials handling plan suggested will pay extra dividends.

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40. Participation of both authors in the Federal and State Interagency meetings on Selenium in April 2004 at Charleston, WV.

41. Private conversations with John Sturm of Sturm Environmental Services, Anmoore, WV

42. Private conversations with personnel at REIC laboratories, Beckley, WV

Table 1. Sample Selenium Data from Phoenix Coal site shown in figure 2. Data from core PX-04-10. REIC Job#: 0405081

SAMPLE NUMBER	SAMPLE INTERVAL	THICKNESS (feet)	ROCK TYPE	SELENIUM (mg/kg)
1	23.00-27.50	4.50	Sandstone	ND
2	43.00-45.00	2.00	Sandstone	ND
3	45.00-45.90	0.90	Shale	0.82
4	45.90-46.15	0.25	Coal	0.94
5	46.40-46.65	0.25	Shale	2.74
6	**46.65-51.25**	**4.60**	**Coal**	**1.14**
7	51.25-52.20	0.95	Shale/Sandstone	1.80
8	52.20-57.00	4.80	Sandstone	ND
9	57.00-62.00	5.00	Sandstone	ND
10	62.00-67.00	5.00	Sandstone	ND
11	67.00-72.00	5.00	Sandstone	ND
12	72.00-77.00	5.00	Sandstone	ND
13	77.00-82.00	5.00	Sandstone	ND
14	82.00-87.00	5.00	Sandstone	ND
15	87.00-92.00	5.00	Sandstone	ND
16	92.00-95.70	3.70	Sandstone	ND
17	95.70-96.60	0.90	Sandstone/ Mudstone/ Coal	0.40
18	96.60-99.75	3.15	Sandstone	0.20
19	99.75-100.30	0.55	Shale	0.34
20	**100.30-101.80**	**1.59**	**Coal**	**0.48**
21	101.80-102.30	0.50	Mudstone	2.28*
22	102.30-105.00	2.70	Shale	0.42
23	105.00-108.00	3.00	Shale	0.20
24	108.00-111.00	3.00	Shale	0.24
25	111.00-114.00	3.00	Shale	0.36
26	114.00-117.00	3.00	Shale	0.36
27	117.00-120.00	3.00	Shale	0.46
28	120.00-123.00	3.00	Shale	0.40
29	123.00-125.00	2.00	Shale	0.44
30	125.00-126.95	1.95	Shale	0.38
31	126.95-129.30	2.35	Shale	1.32
32	129.30-129.50	0.20	Shale	2.12
33	129.50-131.03	1.53	Coal	1.82
SAMPLE NUMBER	SAMPLE INTERVAL	THICKNESS (feet)	ROCK TYPE	SELENIUM (mgflcg)
34	131.03-131.37	0.34	Shale/Coal	3.00

35	131.37-131.70	0.33	Coal	1.90
36	131.70-132.90	1.20	Shale	0.82
37	132.90-135.00	2.10	Mudstone/ Shale	ND
38	135.00-137.00	2.00	Sandstone/ Mudstone	0.20
39	137.00-139.85	2.85	Shale	0.54
40	139.85-140.60	0.75	Shale/Coal	2.60
41	140.60-141.60	1.00	Coal	5.08
42	141.60-143.00	1.40	Mudstone	1.48
43	143.00-146.00	3.00	Mudstone	ND
44	146.00-149.35	3.35	Sandstone	ND
45	149.35-150.40	1.05	Shale	ND
46	150.40-155.00	4.60	Sandstone	ND
47	155.00-160.00	5.00	Sandstone	ND
48	160.00-165.00	5.00	Sandstone	ND
49	165.00-170.00	5.00	Sandstone	ND
50	170.00-175.00	5.00	Sandstone	ND
51	175.00-180.00	5.00	Sandstone	ND
52	180.00-183.65	3.65	Sandstone	ND
53	183.65-184.50	0.85	Shale/Sandstone	ND
54	184.50-189.00	4.50	Sandstone	ND
55	189.00-194.00	5.00	Sandstone	ND
56	194.00-199.00	5.00	Sandstone	ND
57	199.00-204.00	5.00	Sandstone	ND
58	204.00-209.00	5.00	Sandstone	ND
59	209.00-213.00	4.00	Sandstone	0.30
60	213.00-217.00	4.00	Sandstone	ND
61	217.00-220.20	3.20	Mudstone/Sandstone	0.32
62	220.20-225.00	4.80	Sandstone	ND
63	225.00-230.00	5.00	Sandstone	ND
64	230.00-235.00	5.00	Sandstone	ND
65	235.00-240.00	5.00	Sandstone	ND
66	240.00-244.90	4.90	Sandstone	ND
67	244.90-248.60	3.70	Sandstone	ND
68	248.60-250.70	2.10	Sandstone	1.26
69	250.70-251.64	0.94	Coal	3.98
70	251.64-253.10	1.46	Coal	1.60
71	253.10-253.55	0.45	Carbolith	2.64
72	253.55-254.46	0.91	Carbolith/Coal	2.66

73	254.46-254.93	0.47	Coal	2.80
74	254.93-256.45	1.52	Coal	2.54

SAMPLE NUMBER	SAMPLE INTERVAL	THICKNESS (feet)	ROCK TYPE	SELENIUM (mg/kg)
75	256.45-257.05	0.60	Shale	3.28
76	257.05-260.00	2.95	Sh	0.62
77	260.00-260.85	0.85	Shale/Coal	2.38
78	260.85-261.15	0.30	Coal	1.20
79	261.15-261.45	0.30	Carbolith	1.40
80	261.45-263.50	2.05	Coal	0.92
81	263.50-264.25	0.75	Shale	0.62
82	264.25-267.10	2.85	Shale	0.28
83	267.10-269.95	2.85	Shale	ND
84	269.95-271.95	2.00	Sandstone/ Shale	0.26
85	271.95272.41	0.46	Coal	1.86
86	272.41-274.10	1.69	Shale	0.26
87	274.10-277.00	2.90	Mudstone	ND
88	277.00-280.00	3.00	Sandstone/Shale	ND
89	280.00-283.00	3.00	Shale	ND
90	283.00-285.50	2.50	Shale	0.38
91	**285.50-285.92**	**0.42**	Coal	**1.60**
92	**285.92-286.15**	**0.23**	Carbolith	**8.64**
93	**286.15-287.55**	**1.40**	Coal	**2.10**
94	287.55-287.75	0.20	Shale	0.76
95	287.75-293.00	5.25	Sandstone	0.20
96	293.00-298.00	5.00	Sandstone	ND
97	298.00-303.00	5.00	Sandstone	ND
98	303.00-308.00	5.00	Sandstone	ND
99	308.00-313.00	5.00	Sandstone	ND

ND - Not Detected at the MDL of 0.2 mg/kg.

* - The matrix spike for selenium exceeded method control limits due to matrix interference.

David Rider/R3/USEPA/US
01/05/2011 02:17 PM

To Frank Borsuk
cc Stefania Shamet
bcc
Subject Fw: Scan Spruce MHP

Frank,

The selenium report from Sturm is:

Sturm Environmental Services. 2010 Soil and Overburden Sampling Protocol for Core Holes DT0727, DT0739, and DT0417 - Permit WV1017021. Memo report from John Sturm to John McDaniel, Director of Engineering, and Technical Services, Eastern Operations. October 22.

Dave

----- Forwarded by David Rider/R3/USEPA/US on 01/05/2011 02:13 PM -----

From: David Rider/R3/USEPA/US
To: Stefania Shamet/R3/USEPA/US@EPA
Cc: John Forren/R3/USEPA/US@EPA
Date: 01/04/2011 04:55 PM
Subject: Fw: Scan Spruce MHP

Stef,

Here is the Special Handling Plan - Potentially Selenium Toxic Material from the SMCRA permit correction for IBR #2, dated 7-14-04, (O-15.2). It is not much but is the section directly referenced on page 3-2 of Appendix A: Technical Evaluation Document, CH2M Hill, November 29, 2010.

I expected to find more information.

I have not found the Sturm Environmental Services 2010 document referenced on page 3-2. Was it attached to a previous submittal perhaps?

Let me know if you have questions.

Dave

David E. Rider
US Environmental Protection Agency
1650 Arch Street (3EA50)
Philadelphia, PA 19103-2029
215-814-2787

Learn more about the Office of Monitoring & Assessment at http://epa.gov/reg3esd1/3ea50.htm

----- Forwarded by David Rider/R3/USEPA/US on 01/04/2011 04:35 PM -----

From: EPA SCANNERS@EPA
To: David Rider/R3/USEPA/US@EPA
Date: 01/04/2011 04:32 PM

Subject: Scan Spruce MHP

Please open the attached document. It was scanned and sent to you using a Xerox WorkCentre Pro.

Sent by: Guest [EPASCAN12-426A@EPA.GOV]
Number of Images: 4
Attachment File Type: PDF

WorkCentre Pro Location: 12-426
Device Name: XRX0000AA6F50E3

For more information on Xerox products and solutions, please visit http://www.xerox.com

Scan001.PDF

Spruce # 1

O-15.2
Corr
7-14-04

IBR #2

Special Handling Plan-Potentially Acid Toxic Material

Blending Method

Since there is an excess of neutralization potential available in the units to be excavated by this mining operation, the permittee proposes to blend the potentially toxic materials with those units having an excess neutralization potential. This is and will be accomplished by the mixing occurring during the excavation process. Care will be exercised to insure that the overburden is placed such that the potentially acid toxic material is blended with equal or greater volumes of material having an excess neutralization potential.

Isolation

Pit cleanings, partings, and other potentially acid-toxic materials that cannot be neutralized by blending shall be identified and segregated during the mining process and promptly placed in an isolation zone for final disposal.
A pad composed of non-toxic, on-acidic durable material at least ten feet in thickness will be placed on the basal seam pit floor. This pad shall be at least twenty feet from the nearest highwall. Potentially acid-toxic material will be placed on this pad and compacted then covered with at least four feet of non-toxic alkaline material that is suitably compacted to reduce its permeability. Such isolation zones will be covered with at least ten feet of ordinary backfill material and revegetated in accordance with the approved plan.

Special Handling Plan – Potentially Selenium Toxic Material

Hobet Mining will treat any stratum that is identified through sampling and testing as a source of leachable selenium in concentrations that would likely constitute a violation of water quality standards as an acid-toxic material. Such materials will be placed in isolation zones as described above. This does not apply to the coal seams to be mined.

Other Requirements- Potentially Acid or Toxic Material

In addition to complying with the special handling techniques defined above, all handling and placement of the overburden or strata defined as potentially acid or toxic, including potentially selenium toxic will adhere to following general guidelines.

Potentially acid or toxic material will:

1. Not be placed in close proximity to drainage courses.
2. Be placed such that a minimum of ten feet of non-toxic, non-acidic durable material separates the potentially toxic material from the floor of the basal seam and at least four feet of non-toxic alkaline material covers the isolated material.
3. Not be placed within a durable rock fill.
4. Be separated from the final regraded surface by a minimum of ten feet of overburden with an excess neutralization potential.
5. Be handled and placed in accordance with time and acreage requirements of the contemporaneous reclamation plan.

O-15.1
Corr
7-14-04

Attachment O-8

The acid-base accounting (ABA) data provided in Attachment I of this permit application provide a tabulation of the strata to be mined on the proposed permit area as identified in coreholes S-93-7, S-93-11, S-93-15, and S-93-19. This analysis identifies isolated strata that have a net deficiency, as well as the strata with an excess neutralization potential, measured in tons $CaCO_3$ per thousand tons of material. In addition to evaluation of the ABA of strata to be excavated, test results of paste pH and presence of pyrite is considered in estimating potential contribution of acid-toxic discharge. Several cores within the permit area were tested and analyzed for potential toxicity and presented in the original permit application, however no new drilling and overburden testing has been done in recent months*.

*The ABA data included herein is representative of the entire permit area & core locations are shown on the Proposal Map.

A limited amount of overburden/interburden strata has been identified as potentially acidic and/or toxic material in the area to be mined. This material is a very thin coal or shale typically associated with coal seams. The other two strata that do not exhibit alkalinity are soil and sand stone at a depth above weathered surface material. However the overwhelming majority of material to be excavated is alkaline. These materials will be mixed in the excavation process to insure that the overburden is placed such that potential acid toxic material is well blended with material having an excess neutralization potential.

Attachment O-8

Strata which have been identified as being potentially acidic are shown on the stratigraphic sections in Section I. The strata which have been identified are not consistently acidic across the permit area and are relatively thin. Specific sites for placement of these materials have not been designated due to their inconsistent nature and thinness. These materials will be placed in areas out of a natural or constructed watercourse and either be blended with material having excess CaCO3 for neutralization or encapsulated by a minimum of 4' thick of non-toxic, non-acid producing material. Coal pit cleanings and coal materials from pits of seams which may be potentially acidic or toxic will not be placed in valley fill areas but placed on the mined areas out of natural or constructed watercourses and either blended with material having excess CaCO3 for neutralization or encapsulated by a minimum of 4' thick of non-toxic, non-acid producing material. Whether these materials are blended or encapsulated they will be placed a minimum of 4' above the seam pavement.

Coal pit cleanings, coal remaining in the pit, and other black pit materials remaining from the coal removal on the Stockton seams, Buffalo A or Chilton A seams will be specially handled. This special handling will include not placing any of these materials in valley fill areas and the placement of these materials on previously mined benches at least 4' above the seam pavement.

Matthew Klasen/DC/USEPA/US
01/05/2011 03:12 PM

To Christopher Hunter
cc
bcc
Subject Re: Feedback on press release

Hey Chris,

This should be good to use at 4. I'll spend the next 15 minutes or so scribbling down comment #s for each of the points so we can find the specific comments if necessary. I'll bring my laptop, and I'll send you the updated compiled summary at 3:50 or so so you can have it, too.

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Christopher Hunter | I'm going to be in a lot of meetings today, so I th... | 01/05/2011 08:45:07 AM

From: Christopher Hunter/DC/USEPA/US
To: Matthew Klasen/DC/USEPA/US@EPA
Date: 01/05/2011 08:45 AM
Subject: Re: Feedback on press release

I'm going to be in a lot of meetings today, so I thought I would get this done early. We'll see if Tanya has any response, but feel free to combine this doc with yours.

Chris
[attachment "Comments and Responses for Denise.docx" deleted by Matthew Klasen/DC/USEPA/US]

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

Matthew Klasen | Ok -- I put together a really basic outline to talk fr... | 01/05/2011 08:37:06 AM

From: Matthew Klasen/DC/USEPA/US
To: Christopher Hunter/DC/USEPA/US@EPA
Date: 01/05/2011 08:37 AM
Subject: Re: Feedback on press release

Ok -- I put together a really basic outline to talk from yesterday on the comments; I'll send that to you shortly if that helps.

I'm also not exactly sure what Denise is looking for, but an idea that came to my head is giving her a brief outline, the table of contents from H&W comments, and then for each basic topic in the outline (e.g., selenium and Seng Camp), picking out a key comment/response to show how we dealt with it.

But just an idea. I could help find the "model" comments/responses while you're at FHWA.

Matt Klasen
U.S. Environmental Protection Agency
Office of Water
(202) 566-0780
(b) (6) [redacted]

Christopher Hunter

----- Original Message -----
From: Christopher Hunter
Sent: 01/05/2011 08:31 AM EST
To: Matthew Klasen
Subject: Re: Feedback on press release

Thanks Matt.

Also, we've got the meeting this afternoon with Denise on the comments and responses, and I'm trying to put together a 1 pager of bullets to help frame the discussion. I'm still not entirely sure what Denise wants out of the meeting, but once I'm done (20 min or so), I'll forward to you. See what you think and edit as you like,

Chris

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

Matthew Klasen	I'll pick it up when I get in (about 20 min -- later t...	01/05/2011 08:28:38 AM

From: Matthew Klasen/DC/USEPA/US
To: Christopher Hunter/DC/USEPA/US@EPA
Date: 01/05/2011 08:28 AM
Subject: Re: Feedback on press release

I'll pick it up when I get in (about 20 min -- later than usual -- must be lack of sleep).

I'll scan them and send to you, Dave, and Denise, and leave the hard copy with Greg to make changes and re-send to OEA.

Matt Klasen
U.S. Environmental Protection Agency
Office of Water
(202) 566-0780
(b) (6) [redacted]

Christopher Hunter

----- Original Message -----
From: Christopher Hunter
Sent: 01/05/2011 08:15 AM EST
To: Nancy Stoner

Cc: David Evans; "Denise Keehner" <keehner.denise@epa.gov>; Matthew Klasen
Subject: Re: Feedback on press release

Thanks Nancy,
Matt or I will be by later today to pick up the edits. Also, we should have a revised draft of the executive summary for your review later today or tomorrow morning.

Chris

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

Nancy Stoner	My proposed line edits will be on Martha's desk...	01/05/2011 07:44:53 AM

From: Nancy Stoner/DC/USEPA/US
To: "Denise Keehner" <keehner.denise@epa.gov>, David Evans/DC/USEPA/US@EPA, "Christopher Hunter" <Hunter.Christopher@epamail.epa.gov>
Date: 01/05/2011 07:44 AM
Subject: Feedback on press release

My proposed line edits will be on Martha's desk when I get in (by 9). Not difficult. Thx

Matthew Klasen/DC/USEPA/US
01/05/2011 03:50 PM

To Stefania Shamet
cc Christopher Hunter
bcc
Subject Re: Spruce "Selenium Day"

Hey Stef,

Chris and I will chat during/after the 4 pm and confirm that this works. I know Chris had a concern that waiting on (2) till Friday doesn't give us much wiggle room on the FD itself.

But I know the biggest priority for you right now is (and should be) getting through 114-242 so we can get to Kevin as early as possible tomorrow, so waiting till Friday on the FD is probably the only reasonable approach.

I'm going to start reviewing Kevin's edits more closely tonight, so I can try to prioritize what he's identified for more technical work tomorrow and Friday.

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Stefania Shamet | Matt, Chris -- Plan is to spend Friday focused sol... | 01/05/2011 03:39:07 PM

From: Stefania Shamet/R3/USEPA/US
To: Christopher Hunter/DC/USEPA/US@EPA
Cc: Matthew Klasen/DC/USEPA/US@EPA
Date: 01/05/2011 03:39 PM
Subject: Spruce "Selenium Day"

Matt, Chris -- Plan is to spend Friday focused solely on Selenium. This would include the following:

(1) Loop back through the Se-related comments to close all outstanding issues. FYI -- we have folks poring over the Se handling plan now to see what we can say. Also will address Kevin's remaining concerns at that time.

(2) Make changes to FD responsive to Se comments and also to clean up v. loose language on water quality criterion, standards, etc. will work from the Se comments that Karyn sent today, so we have a consolidated FD language.

(3) THEN make sure the Se comments are consistent with the FD changes.

Does that make sense?

Matthew Klasen/DC/USEPA/US
01/05/2011 05:23 PM

To Carrie Traver
cc Christopher Hunter, Marcel Tchaou, Stefania Shamet, Julia McCarthy
bcc
Subject Re: Reference List

The new SAB report on conductivity is here:

http://yosemite.epa.gov/sab/sabproduct.nsf/ea5d9a9b55cc319285256cbd005a472e/fe8d8dacd68e2a7385257807006a589b!OpenDocument

(b) (5) [redacted]

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Carrie Traver | Here is the latest reference list that I have. Item... | 01/05/2011 05:09:48 PM

From: Carrie Traver/R3/USEPA/US
To: Marcel Tchaou/DC/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA
Cc: Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/05/2011 05:09 PM
Subject: Reference List

Here is the latest reference list that I have. Items added or updated since the last list I sent out are in blue. The red items are spreadsheets of raw data.

I don't think Matt's "SAB report on conductivity from Dec. 28" on the list.

[attachment "Revised Reference List.doc" deleted by Matthew Klasen/DC/USEPA/US]
Carrie Traver
USEPA Region 3
Office of Environmental Programs
1650 Arch Street - 3EA30
Philadelphia, PA 19103
215-814-2772
traver.carrie@epa.gov

Christopher Hunter | Good morning, Since Marcel is also in charge of... | 01/05/2011 07:28:18 AM

From: Christopher Hunter/DC/USEPA/US
To: Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Cc: Carrie Traver/R3/USEPA/US@EPA
Date: 01/05/2011 07:28 AM
Subject: Re: MORE References. Do we have these?

Good morning,
Since Marcel is also in charge of making updates to the selenium appendix, I'm a little worried he's going to have a lot of work come in at once. So, if Carrie can send what she has to Marcel and I now, I'll get him working on that, and we'll catch any stragglers piecemeal.

Thanks
Chris Hunter
US EPA, Wetlands Protection Division
(202) 566-1454 (t)
(b) (6)

Matthew Klasen

----- Original Message -----
From: Matthew Klasen
Sent: 01/04/2011 09:49 PM EST
To: Stefania Shamet; Christopher Hunter
Cc: Carrie Traver
Subject: Re: MORE References. Do we have these?

Hey Stef,

Not sure what's best, and I'll defer to Chris, because I think Marcel has been working on the references appendix from HQ. But I think the non-piecemeal idea was a great approach.

In my comments to Kevin on 68A-113A, I noted the new SAB report on conductivity from Dec. 28 in a couple responses, but didn't actually cite it directly -- so that's another one we can add to the list.

Thanks Carrie (and Stef, as always)!

mk

Matt Klasen
U.S. Environmental Protection Agency
Office of Water
(202) 566-0780
(b) (6)

Carrie Traver/R3/USEPA/US
01/06/2011 11:37 AM

To Matthew Klasen
cc Christopher Hunter, Greg Pond, Marcel Tchaou, Stefania Shamet
bcc
Subject Re: Fw: Spruce References list

Greg/Matt:

Here's my copy - it's the same one I sent to Chris & Marcel last night, with the addition of the SAB report.

Maybe two weeks ago, I had gone through the existing drafts and sent out several lists of references that I had found that either weren't in the FD, Appendices, and Comment/Response. I'll send out the compiled list for good measure. These were not resolved to my knowledge. However, things have changed, so I'm not sure if these are still in the latest documents.

Revised Reference List.doc References not on the list.doc

Carrie Traver
USEPA Region 3
Office of Environmental Programs
1650 Arch Street - 3EA30
Philadelphia, PA 19103
215-814-2772
traver.carrie@epa.gov

Matthew Klasen | Chris, Marcel, and Carrie: See Greg's note belo... | 01/06/2011 11:16:25 AM

From: Matthew Klasen/DC/USEPA/US
To: Marcel Tchaou/DC/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA, Carrie Traver/R3/USEPA/US@EPA
Cc: Greg Pond/R3/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/06/2011 11:16 AM
Subject: Fw: Spruce References list

Chris, Marcel, and Carrie:

See Greg's note below. Can someone send Greg the most recent reference list?

This begs the question of what the most effective process should be for both verifying the reference list itself, and ensuring that all our responses (FD, PD comments, RD comments) don't cite new things and cite the right things (including things that are actually in the list).

I'm interested in hearing suggestions on what seems best to folks. We're getting close to the point where a significant portion of the RD responses are nearly done, following OGC review and resolution of OGC comments. I'd be willing to start sending out chunks of the compiled OGC-reviewed RD responses to folks to start checking references, which is something that needs to be done but that I'm probably not most qualified to do.

That said, for version control, Chris and I still need to maintain the compiler roles throughout this process.

Thoughts on process?

Thanks.
Matt
.

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]
----- Forwarded by Matthew Klasen/DC/USEPA/US on 01/06/2011 11:08 AM -----

From:	Greg Pond/R3/USEPA/US
To:	Matthew Klasen/DC/USEPA/US@EPA
Date:	01/06/2011 11:07 AM
Subject:	Spruce References list

Matt, it's dawning on me more and more that there are probably errors in the references. Can you send me the "list"? When I go the ESC, there are all the references, but no list.

Thanks,

Greg

Greg Pond
Office of Monitoring and Assessment
U.S. EPA Region 3
1060 Chapline Street, Suite 303
Wheeling, WV 26003-2995
(p) 304-234-0243
(f) 304-234-0260
pond.greg@epa.gov
Website: http://epa.gov/reg3esd1/3ea50.htm

Christopher Hunter/DC/USEPA/US
01/07/2011 10:37 AM

To Julia McCarthy
cc
bcc
Subject Please read this if you have a chance

(b) (5) [redacted]

Thanks

Patnode_et_al_2005.pdf

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE
REGION 5

FY05 ENVIRONMENTAL CONTAMINANTS PROGRAM
Off Refuge Investigations Sub-Activity
FINAL REPORT

SALAMANDER ASSEMBLAGE SURVEY OF MERCURY AND SELENIUM CONTAMINATED HEADWATER SITES IN THE APPALACHIAN MOUNTAINS OF PENNSYLVANIA, VIRGINIA, AND WEST VIRGINIA

Project ID:5f37/20035002
(file name: FINALSALLY.DOC)

Submitted by:

Kathleen Patnode
Cindy Kane
Dan Ramsey
Jessica Rhodes
Brian Evans
Environmental Contaminants Specialists

For:

David Densmore
Pennsylvania Field Office Supervisor

Karen Mayne
Virginia Field Office Supervisor

August 1, 2005

ABSTRACT

Headwater streams comprise 60-75 percent of the total stream length and watershed area in the Mid-Atlantic region. Due to their diverse and complex life histories and abundance in the Mid-Atlantic Highlands, Stream Plethodontid salamanders are a potential biological endpoint to assess headwater impairment and degradation from contaminant exposure, especially where traditional species assemblages (macroinvertebrates, fishes) are poorly developed or absent. In this study, we conducted salamander assemblage surveys of headwater sites and determined contaminant exposure in the highlands of Pennsylvania, Virginia, and West Virginia to assess potential effects of inorganic contaminant exposure on the salamander community, and potential risk of selenium and mercury to upper trophic level predators. We conducted salamander surveys on 32 study areas and analyzed 182 salamander samples from 50 study areas. Mean concentrations exceeded the respective toxicity reference values selected for salamanders at multiple study areas for selenium, mercury, aluminum, and copper. Selenium concentrations in salamanders from study areas downstream of mining valley fills were significantly higher than study areas exposed to high air emissions or no reported emissions according to the USEPA Toxic Release Inventory. The proportions of reference, intermediate, and impaired salamander assemblages are significantly different ($p = 0.038$) between study areas where selenium exceeds the toxicity reference value and those that do not. The proportions of reference, intermediate, and impaired salamander assemblages are significantly different ($p = 0.005$) between study areas downstream of mining valley fills versus those exposed only to selenium air emissions deposition. Selenium exceeded toxicity reference values at 11 study areas for Louisiana waterthrush, while one study area was below the toxicity reference value for northern water shrew. Mercury toxicity reference values were exceeded at two study areas for waterthrush and at no study area for water shrew. Our data indicate that selenium exposure may be a factor affecting headwater biota downstream of mining valley fills. Our ecological risk assessment demonstrates that high-exposure risk scenarios with relevant receptors, particularly State-status species, should be considered in establishing aquatic selenium and mercury criteria that are protective of birds and mammals. Our data substantiate the need to couple salamander sampling with fish sampling to monitor ecological health in headwater streams and to protect their complex aquatic and aquatic-dependent animal communities.

PREFACE

This report summarizes salamander tissue analytical and population survey results performed for study areas located throughout Pennsylvania, West Virginia, and Virginia. Questions, comments, suggestions, and data requests related to this report are encouraged. Written inquiries should refer to Project ID:5f37/20035002 and be directed to:

Kathleen Patnode
U.S. Fish and Wildlife Service
c/o U.S. EPA
1060 Chapline St Suite 303
Wheeling WV 26003-2995
kathleen_patnode@fws.gov

ACKNOWLEDGEMENTS

Gian Rocco and technicians from Penn State Cooperative Wetlands Center of the Pennsylvania State University performed salamander assemblage surveys and habitat assessments for some of the study areas. Rocco also trained USFWS staff on the survey method and graciously permitted USFWS to use population data that were collected for Rocco and Brooks (2000) and Rocco *et al.* (2004). He also provided the formulae for applying the SPAR Index of Biotic Integrity to our habitat and salamander data, and assisted with interpretation of the scores. Without his body of research, this study would not have been possible.

Dr. Tom Pauley, Linh Phu, Michael Osbourn, and Dr. Mark Watson of Marshall University provided salamander population data for study areas in West Virginia that were surveyed for Pauley *et al.* 2004. Jeff Bailey of WVDEP provided habitat data for the study areas surveyed by Marshall University.

Bruce Pluta and Kathryn Davis of the U.S. Environmental Protection Agency assisted with the development of the ecological risk assessment conceptual site and food chain models. They were also instrumental in interpretation of the resulting HQs.

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LIST OF ACRONYMS/ABBREVIATIONS

ARMI	Amphibian Research and Monitoring Initiative
HQ	Hazard Quotient = tissue concentration/LOED
HQ<1	Below potential risk level
HQ>1	Above potential risk level
IBI	Index of Biotic Integrity
LOED or LOEL	Lowest observed effect dose or level
mg/kg	milligrams per kilogram
NOED or NOEL	no observed effect dose or level
SPAR	Stream Plethodontid Assemblage Response
TRVs	toxicity reference values
TRI	USEPA Toxic Release Inventory
WAS	West Virginia Division of Environmental Protection Watershed Assessment Section

I. INTRODUCTION

A. Background and Justification

Small headwater streams are vital components of rivers. They are where water initially leaves the soil, enters the channel, and begins its journey downstream. As a result of this close association with the surrounding landscape, headwaters are a critical source of water, food, natural sediments, and nutrients for lower stream reaches (Gomi *et al.* 2002). They also represent areas of potentially high geological and biological diversity, providing habitat for numerous species and natural communities (Meyer and Wallace 2001).

Headwater streams comprise 60-75 percent of the total stream length and watershed area in the Mid-Atlantic region (Rocco *et al.* 2004). In this region, many headwater watersheds are heavily forested; a majority of watersheds have at least 60 percent forest cover (based on 7-digit USGS Hydrologic Unit Code boundaries) (Jones *et al.* 1997). Although these streams and their associated riparian areas play a major role in determining downstream water quality, and are vital habitat for terrestrial and aquatic species, relatively little effort has been made to include them in watershed pollution assessments. Encompassing large surface areas, Mid-Atlantic headwater forests receive a significant proportion of atmospheric pollutant deposition from both local and distant air emission (emission) sources. In addition, many Mid-Atlantic Highland headwaters overlay major coal deposits. The practice of "valley filling," or depositing mining overburden in headwater ravines, has physically affected salamander communities (Williams 2003). Water monitoring downstream of these valley fills has demonstrated that contaminants leach into headwater streams in some locations (Bryant *et al.* 2002). However, the impact of these contaminants in headwater streams in the Mid-Atlantic has not been thoroughly investigated.

Traditional methods of assessing aquatic ecosystem health using fish communities are often unsuitable for headwater streams, where flow or habitat often limits fish populations. A suitable ecological indicator is needed for forested headwaters that could provide a reliable expression of environmental stress or change that can help scientists, managers, and policymakers document trends, establish priorities, and target restoration activities. Stream Plethodontid salamanders are abundant and populations are stable and geographically widespread in the Northeast and Mid-Atlantic (Stuart *et al.* 2004). By virtue of their diverse and complex life histories, these salamanders are a potential biological endpoint to assess headwater impairment and degradation, especially where traditional species assemblages (macroinvertebrates, fishes) are poorly developed or absent. In this study, we conducted salamander assemblage surveys of headwater sites and determined contaminant exposure in the highlands of Pennsylvania, Virginia, and West Virginia to assess the potential effects of contaminant exposure on the salamander community, and the potential risk of bioaccumulative contaminants to upper trophic level predators.

B. Mercury

Emissions from coal-fired power plants are the largest identified contributor to atmospheric deposition of mercury in the United States (USEPA 1998). Mercury emissions are related to the age of the power plant, as well as the volume and source of coal combusted. Coal-fired power plants in Virginia, West Virginia, and Pennsylvania contribute nearly 17 percent of the 48 tons mercury/year emitted nationwide from coal-fired power plants and other mercury-emitting industries. Under the U.S. Environmental Protection Agency (USEPA) Clear Skies Initiative, mercury emissions would be reduced to a 26-ton annual cap by 2010 with a national trading program, and a 15-ton presumptive annual cap in 2018 (USEPA 2002a). Voluntary reduction encouraged under the Clear Skies Initiative will be undertaken while coal production from the Mid-Atlantic Highlands is expected to increase by 40 million tons and the contribution of coal combustion to electric power generation is likely to remain at 45 percent (USEPA 2002b). Details are lacking in the Clear Skies Initiative on expected mercury emission reductions in high deposition areas, and the biological impact reduction for this bioaccumulative substance. Existing mercury contamination and continued mercury deposition have ramifications for the Clean Water Act Section 303(d) Total Maximum Daily Load program, particularly in watersheds where mercury uptake to aquatic biota has already been documented (USEPA 2000a, Cherry *et al.* 2000).

The highest deposition rates occur in the Ohio River valley and northeastern United States due to the location of sources and climate (e.g., high humidity). High elevation areas receive significant mercury deposition that has resulted in fish consumption advisories in lakes, reservoirs and ponds (USEPA 1998). The relative contributions of local versus distant sources depend on numerous factors and remain a controversial issue. The USEPA does not consider atmospheric depositions to be a leading source of water quality impairment in streams and rivers. However, research in the headwaters of Lake Champlain (Rea *et al.* 1996) demonstrates that measurement of mercury concentrations in precipitation underestimates the deposition of mercury in forests. Throughfall water (i.e., precipitation falling on leaves and running off onto the forest floor) had twice the concentration of mercury than rainwater. In addition, mercury loading from litterfall (i.e., contaminated leaves depositing on the forest floor) was an order of magnitude greater than precipitation loading. Further study in the same area (Scherbatskoy *et al.* 1998) demonstrated that forests can capture and retain as much as 95 percent of the atmospheric mercury they receive. Their data indicate that in-stream organic matter may be a significant factor in mercury retention in headwater streams. In a USEPA-funded study in New York, Driscoll *et al.* (2001) have made similar observations on the contribution of litterfall to mercury on the forest floor and in leachate. Since leaf drop each fall contributes significant litter to headwater tributaries, it is reasonable to conclude that significant mercury loading occurs each year.

The chemical form of mercury influences both its uptake and toxicity. Mercury deposition occurs predominantly in the elemental form, while mercury bioaccumulation is most significant in the methylated form. Conversion of elemental to methylmercury occurs in anaerobic conditions, predominantly in sediments (Wiener *et al.* 2003). The primary route of exposure in vertebrates is through ingestion of contaminated prey. Methylmercury is readily absorbed from prey by the gastrointestinal tract lining and easily crosses biological membranes, such as the blood-brain barrier. Methylmercury impairs reproduction, development, and neurological

function (Eisler 1987). Elemental and methylmercury have no known biological function in vertebrates (i.e., they are not micronutrients), and the difference between tolerable natural background concentrations and toxic exposures is exceptionally small (Eisler 1987).

C. Selenium

Selenium is another inorganic substance known to bioaccumulate (Hamilton 2002) and impair fish and wildlife health (Lemly 2002). As with mercury, the form of selenium affects both uptake by and toxicity to biota. Selenite is the predominant form of selenium in soils of humid regions such as those found in the eastern United States (Ohlendorf 1989). Besser *et al.* (1989) demonstrated that selenite and organic selenium compounds (e.g., Se-methionine) are far more bioaccumulative than selenate. Selenite uptake is higher in shallow waters, fine sediments, and high organic matter. These conditions exist in headwater streams, particularly those streams that receive organic matter loading from deciduous leaf drop. Selenite is also more acutely toxic than selenate (Canton 1999).

Selenium is emitted into the atmosphere by coal combustion and other chemical industry processes. It can also be released into the environment from coal mining operations that deposit overburden into valley fills, thereby increasing leaching potential. States receiving a high proportion of emissions from local and distant sources also include large areas of past and current coal mining. Surface water monitoring in West Virginia indicates that exceedances of selenium water quality criteria are closely related to placement of upstream valley fills (Bryant *et al.* 2002).

Selenium is a known micronutrient in vertebrates, but the range between dietary requirements and toxic levels is relatively narrow (Ohlendorf 1989). Selenium causes embryo mortality, deformities, growth impairment, infertility, and aberrant behaviors (Lemly 2002). The primary route of exposure is via ingestion of contaminated prey, although maternal transfer to eggs is a significant route for effects on embryos.

D. Other Inorganic Contaminants

Air emissions from coal burning and chemical processes are not limited to mercury and selenium. Depending on the particular industry, a suite of inorganic contaminants is commonly released to the air. USEPA's Toxic Release Inventory (TRI) clearly demonstrates the potential for mixtures of contaminants from local and regional sources to be deposited in Mid-Atlantic forested headwaters. Contaminants released in appreciable mass in Pennsylvania, West Virginia, and Virginia, in addition to mercury and selenium, include aluminum, arsenic, barium, cobalt, chromium, copper, lead, manganese, nickel, and zinc. Exposure to biota in headwater streams would vary with each contaminant. Risk to biota would, in turn, depend on the toxicity of each contaminant, as well as any interactions resulting from exposure to combinations of contaminants.

E. Plethodontid Salamanders

Plethodontidae is the most diverse family of salamanders in the world, with over 200 species. Thirty-four species of these lungless amphibians are found in Appalachian forests, giving this ecoregion the highest salamander diversity in the world. Pennsylvania has 15 species, West Virginia 27 species (including one federally-listed, threatened species), and Virginia 32 species (including one federally-listed, endangered species), with the greatest diversity occurring in the Mid-Atlantic Highlands. They thrive and reproduce in seeps, brooks, and small streams, sometimes occurring in extremely high densities. Life histories within this group are highly variable, and consist of aquatic and terrestrial egg-laying species with variable aquatic larval periods (8 months to 4.5 years). They are called lungless salamanders because they absorb oxygen through the skin and the lining of the mouth. Unlike species that breed in vernal pools, populations of most stream-dwelling salamanders tend to be remarkably stable over time.

In the Mid-Atlantic Highlands Stream Assessment (USEPA 2000b), contaminant exposure and higher trophic level health were not determined in 44 percent of first and second order streams due to the absence of fish. In headwater streams, several Plethodontid salamanders replace fish and become the dominant vertebrate predator. They also serve as prey for higher trophic level birds and mammals. In these environments, this group becomes the preferred, if not the only, vertebrate bioindicator for assessing stream health.

Benthic macroinvertebrates can be used to identify direct toxicity from contaminant exposure. However, this assessment endpoint is of minimal use for contaminants such as mercury and selenium which pose the greatest risk due to bioaccumulation and biomagnification. Commonly, concentrations of bioaccumulative contaminants will not exceed sediment criteria protective of aquatic invertebrates. Consequently, organisms survive, but also accumulate the contaminants, thus exposing upper trophic level species (e.g., fish and amphibians) to concentrations that have the potential to cause population-level effects (USEPA 2000b).

Salamander toxicity reference values for tissue are severely limited. Sufficient acute toxicity data are available to demonstrate that salamander sensitivity is comparable to that of commonly tested amphibians (i.e., *Xenopus, Rana, Bufo*) and fish. As with other amphibian and fish species, the egg and larval stages of salamanders appear to be the most sensitive life stages (Schuytema and Nebeker 1996).

Assessment of the salamander community may also be more efficient than macroinvertebrate assessments. The number of species of salamanders at multiple life stages is relatively small compared to the species of invertebrates. Identification for most can be completed in the field with minimal laboratory verification of voucher specimens. This field-based approach is an advantage over the extensive laboratory time needed to accurately identify macroinvertebrate taxa.

In response to global concerns about amphibian health and survival, Congress appropriated funds to the U.S. Geological Survey in 1999 to establish the Amphibian Research and Monitoring

Initiative (ARMI). Two major objectives of the ARMI are to determine the status and trends of amphibian populations on Department of the Interior lands, and determine causes of declines, malformations and diseases. These efforts have included salamander monitoring in two national parks in the Appalachian region (Jung *et al.* 2001). Recent USGS studies have examined potential impacts due to acid deposition, but metal exposure and effects have not been evaluated.

The Stream Plethodontid Assemblage Response (SPAR) Index of Biotic Integrity, developed under USEPA's Science to Achieve Results Program, was designed to evaluate the impacts of multiple stressors on salamander communities occupying headwaters and seeps in the USEPA's Mid-Atlantic Highlands Environmental Monitoring and Assessment Program Area. A pilot project conducted in 1997-98 in 14 headwaters in the Allegheny Plateau, Pennsylvania (Rocco and Brooks 2000), showed significant salamander community responses to various forms of stream impairment, specifically acid mine drainage, episodic acidification, and riparian corridor degradation. More recently, the Stream Salamander Index of Biotic Integrity, developed for Maryland, shows a remarkable ability to distinguish degraded from non-degraded streams (Southerland *et al. in prep.*).

Availability of an assessment tool for seeps and headwaters such as SPAR would dramatically improve the ability to quantify ecological risk from exposure to these bioaccumulative contaminants in these ecologically critical headwater streams. Documentation of impacts to salamanders (e.g., changes in community structure, life stages, and biomass) in these habitats would facilitate the development of measures to reduce exposure and protect or restore headwater communities. Appropriate protections for headwater streams may also prevent future downstream contamination by removing sources that could contribute to stream and river contaminant loading. We report on efforts to test the use of the SPAR Index of Biotic Integrity on seeps and headwater streams receiving mercury, selenium, and other inorganic contaminants from atmospheric deposition and valley fill leaching.

F. Study Objectives

1. Document the spatial distribution of selenium, mercury, and other inorganic contaminants in Plethodontid salamanders in headwater streams of Pennsylvania, West Virginia, and Virginia.

2. Use the Stream Plethodontid Assemblage Response (SPAR) Index of Biotic Integrity to assess the potential impacts of mercury, selenium, and other inorganic contaminants over a broad exposure range on salamander abundance, species diversity, and life stage presence in headwater streams

3. Perform an ecological risk assessment to identify watersheds where the bioaccumulation of mercury and selenium in salamanders results in tissue concentrations that exceed levels known to produce toxic effects in aquatic and terrestrial predators.

II. METHODS

A. Study Area Selection

We selected 50 study area watersheds within the Mid-Atlantic Highlands of Pennsylvania, Virginia, and West Virginia. Study area headwaters fell into one of four categories: 1) within 50 km of a coal-fired power plant with no known history of mining; 2) within 50 km of a coal-fired power plant with a history of mining; 3) more than 100 km from a coal-fired power plant with a history of mining; and 4) more than 100 km from a coal-fired power plant with no known history of mining. We selected study areas and transects within study areas to minimize terrestrial and aquatic habitat differences for parameters that influence stream salamanders such as acid mine drainage, and riparian corridor degradation (Rocco and Brooks 2000, Pauley *et al.* 2004). We targeted sites with documented mercury or selenium contamination along with sites suitable as regional reference areas. The USEPA Mid-Atlantic Highlands Assessment Habitat database, USGS National Water Quality Assessment database, Bryant *et al.* (2002), and State water quality databases were screened for all relevant watersheds in the Appalachian ecosystem. Investigators selected study areas in partnership with State natural resource agencies, Gian Rocco (Pennsylvania State University), Dr. Jung (USGS), Dr. Pauley (Marshall University, West Virginia), and the U.S. Forest Service based on evaluation of known media and fish contamination, mining operations, coal-fired power plant sources, and salamander community data.

B. Stream and Seep Salamander Surveys

We conducted salamander surveys within 32 of the 50 study areas according to the protocol of either Rocco and Brooks (2000) or Pauley *et al.* (2004). Riffle/run portions of each headwater stream were sampled along a 100-200 m reach. For seeps, one continuous 10 m reach was sampled. Within each reach, three (Rocco and Brooks 2000) or two (Pauley *et al.* 2004) 4-m^2 rectangular plots were thoroughly searched. Each plot encompassed the land-water interface of the stream within riffle/run habitat. We removed all rocks, logs, and debris within each plot and raked the substrate by hand to search for concealed animals. Adults and larvae were captured by hand or net until the entire plot had been searched. Sites surveyed using the methods of Pauley *et al.* (2004) also included two-pass sampling of a 15-m x 2-m transect, with 1 m on the bank and 1 m in the wet channel. Cover objects were lifted and any salamanders underneath were collected. Salamanders were identified by species and life stage. Data were recorded on size, weight, and incidence of abnormalities, by species and life stage.

Habitat assessments were either extracted from existing databases or conducted according to Ohio EPA (2001) or West Virginia Division of Environmental Protection Watershed Assessment Section (WAS) protocols. For study areas that were part of either the Mid-Atlantic Highlands Assessment or the Draft Programmatic Environmental Impact Statement on Mountaintop Mining/Valley Fills in Appalachia (USEPA 2003), water quality and physical habitat data were already available. For sites in West Virginia surveyed by Marshall University, data were collected on water quality, physical habitat, and land use using the WAS protocol. For all other

sites, habitat data were collected for parameters listed in Table 1 based on Rocco and Brooks (2000).

To account for the potential effect of salamander collection and removal conducted prior to salamander community surveys, an adjustment factor was applied to species abundance numbers. For two sites surveyed post-collection, a species collected during sampling but not documented thereafter during community assemblage surveys were identified as such. Adjustment was based on a comparison of the number of individuals of a species collected within the 3000-foot collection reach with the species and associated numbers documented in the 300-foot survey reach. Species counts were adjusted for three sites, and one species each added to two sites. The IBI score increased slightly for only one of these five study areas; however, assemblage classifications did not change.

C. Sample Collection

We collected salamanders at all 50 study areas for tissue analysis. We limited collection to adults for species that were abundant or large enough to achieve tissue mass requirements with a small number of animals. This approach was warranted to minimize sampling impacts on the salamander communities. No State or federally listed endangered species were collected for analysis.

We euthanized, measured, weighed, and segregated salamanders by species and size. Within species and size classes, we formed composites as necessary to meet tissue mass requirements. We submitted frozen samples to a USFWS Patuxent Analytical Control Facility-approved laboratory.

To assess the contribution of leaf litter contamination to in-stream contaminant levels, we collected dominant leaf litter at all sites. Samples were also submitted to a USFWS Patuxent Analytical Control Facility-approved laboratory for inorganic analyses.

D. Contaminant Analysis

In 2003, we submitted 85 samples for mercury and selenium analyses and 42 samples for selenium, mercury, and routine metals analyses representing 29 study areas. Routine metals analyses were warranted to compensate for the absence of contaminant data on these salamander species, and to address potential confounding with mercury and selenium effects on population endpoints. In 2004, we submitted 55 new samples from 21 additional study areas.

Relevant detection limits for bioaccumulative substances were difficult to achieve using routine analytical techniques. In 2003, detection limits were highly variable and often exceeded relevant criteria. Similarly, deciduous leaves collected from the streambanks were analyzed, but no

detectable concentrations were documented. Given the higher concentrations present in biota, investigators focused solely on analysis of salamander samples in 2004.

Analytical detection limits were improved by switching to the methods employed by Trace Element Research Laboratory (TERL) at Texas A&M University (College Station, Texas). All samples were freeze-dried and homogenized prior to digestion. Tissue digestion of freeze-dried, powdered tissue utilized nitric acid, hydrogen peroxide, and hydrochloric acid in a block digester. Following digestion, samples were diluted as necessary and analyzed for trace metals depending on analytical methods. Divalent mercury (Hg^{++}) in samples was reduced to the elemental state (Hg^{0}) by a strong reducing agent (stannous chloride). Mercury concentration in the sample was determined by cold vapor atomic absorption spectroscopy. Tissue digests were heated with HCl to convert Se(VI) to Se(IV) to facilitate hydride generation. Atomic fluorescence spectroscopy, one of the most sensitive methods currently available for inorganic analysis, was used to determine selenium concentrations. Silver, arsenic, cadmium, lead, and vanadium concentrations were determined using inductively coupled plasma-mass spectroscopy to achieve extremely low detection limits. All other inorganics were analyzed using inductively coupled plasma optical emission spectroscopy.

The duplicate testing of 15 samples from 2003 was used to assess the variability in analytical results between the 2003 and 2004 laboratories. The TERL methodology for selenium had lower detection limits and consistently higher concentrations were measured. Paired analytical results for selenium were used to derive a linear regression equation (Appendix A). This equation was applied to the 2003 selenium data to correct for the differences in methods between the two laboratories. These corrected values for selenium were used in all subsequent data analyses. Detection limits were also lower for mercury, but consistent differences were not observed. Therefore, no correction was made to 2003 mercury concentrations. All samples without detectable concentrations were evaluated at one half of the detection limit.

Quality assurance and quality control procedures were USFWS Patuxent Analytical Control Facility standards. Duplicates and spiked recovery results were within acceptable ranges. Contaminant concentrations were reported as milligrams per kilogram (mg/kg), wet weight. Analytes, tissue sample concentrations, and limits of detection are presented in Appendix B.

E. Data Analysis

1. Site classification:

We evaluated study areas based on the USEPA TRI for each county. This approach broadened the range of contaminants and their sources to include all reported air emissions in 2003. We documented physical evidence of mining during the habitat and salamander assessments, and verified our determinations by reviewing available water data and aerial imagery. We then categorized study areas as being beyond 50 km of any reported emissions, within 50 km of a county with low or high emissions (i.e.,first or second quantile of two quantiles), or downstream of mining valley fills (Table 2).

We used concentrations of inorganic contaminants in salamander samples to compute study area averages and maximums. We evaluated these data to determine if concentrations across all species should be pooled. We excluded data from northern spring salamanders (*G. porphyriticus*) as they are higher trophic level predators than the other species and were only available from a small number of study areas. We included data for the remaining species at each study area in the average and maximum determinations. We then compared the resulting study area averages and maximums relative to source classes.

2. SPAR IBI:

We applied the SPAR Index of Biotic Integrity that was developed for Mid-Atlantic habitats by Rocco *et al.* (2004). Rocco *et al.* used multiple discriminate analyses to develop a predictive model for the classification of sites into one of the three groups that differed with respect to geographic location and stream physical habitat. Groups 1 and 2 are steeper, have more boulder cover, and are cooler than Group 3 sites. Sites in Group 1 are northern Appalachian high-gradient streams, while Group 2 sites are southern Appalachian high-gradient streams. Group 3 consists of lower gradient sites that are geographically centered within the Mid-Atlantic region, and more widespread relative to the other groups.

We classified study areas into one of the three groups using four measurements (latitude, percent boulder cover, stream temperature, and gradient) obtained during stream habitat assessments (Table 1) or calculated from those data. Geographic coordinates for stream sites were determined from a map or by GPS on site. We estimated boulder cover by zigzag pebble count (Bevenger and King 1995) or as a percentage of each quadrant or transect. We determined stream gradient from 7.5-minute USGS topographic quadrangles, and we measured water temperature at each sampling plot with a thermometer. Using the coefficients and formula provided by Rocco *et al.*, we determined group membership for the 32 study areas surveyed.

The availability of a habitat-specific index of biotic integrity developed for salamanders in this ecoregion based on a large data set facilitated the evaluation of the small data set collected in this study. We derived IBI scores using the metric combinations that had the highest percentage of correctly classified sites in Rocco *et al.* (2004). Rocco *et al.* used Mann Whitney testing to identify the 11 best-performing metrics. Combinations of these metrics were then evaluated to determine their efficiencies at classifying salamander communities for all streams combined, degraded streams, and non-reference streams in a data set of over 130 streams. The resulting seven group-specific metrics, the IBI combinations, and their classification efficiencies are presented in Table 3. Rocco *et al.* used parametric, nonparametric, and multivariate analyses to derive habitat classification factors and habitat-specific metrics applicable to our study area. We used this habitat-specific IBI to score the 32 study areas for which salamander assemblage data were available. Although efficiencies for Group 2 sites were reduced (Table 3), we applied the group-specific IBIs as we had only one Virginia study area that classified as Group 2. IBI scores were then used to classify the salamander assemblages at each study area as reference, intermediate, or impaired.

3. Ecological risk:

We used literature-based toxicity data to classify potential risk to salamanders for each study area. Lowest observed effect dose (LOED) toxicity reference values (TRVs) for tissue concentrations (Table 4) were used to derive hazard quotients (HQs; HQ=tissue concentrations/LOED). If a LOED was not available, a level was estimated by multiplying the no observed effect dose (NOED) by a factor of ten. For chromium, a LOED was estimated by computing the geometric mean of the NOED and LD75 values. Toxicity data for salamanders were limited to cadmium. For other inorganics, we selected TRVs for other amphibians and fish. We determined HQs for each tissue sample for each contaminant. We then used average HQs for each study area to classify a study area as potentially at risk (HQ>1) or below known risk levels (HQ<1) for each contaminant. We assigned an overall HQ classification based on the highest HQ score for all contaminants. We then tallied the number of reference, intermediate, and impaired salamander assemblages based on HQ classification. We statistically compared the percentages of reference, intermediate and impaired salamander assemblages between low risk (HQ<1) and high risk (HQ>1) study areas using a Chi-square test.

Salamander contaminant concentrations were also used to assess the risk to predators inhabiting headwater streams. We selected the northern water shrew (*Sorex palustris*) as the mammalian ecological receptor. The water shrew is found in high elevation forests near mountain streams bordered by rocks, logs and over-hanging banks. The diet of the water shrew consists of aquatic insects, larvae, spiders, worms, small fish, fish eggs, amphibians, amphibian larvae (Jones and Birney 1988). We chose the Louisiana waterthrush (*Seiurus motacilla*) as the avian ecological receptor. The waterthrush lives in deciduous or mixed forests with rapid flowing streams. Their diet includes aquatic and terrestrial insects, small fish and small frogs (Cornell Laboratory of Ornithology). In highland headwaters where fish and frogs are often absent, it is reasonable to assume that aquatic salamanders would be included in their diet; Mulvihill (1999) has reported Louisiana waterthrush feeding immature terrestrial salamanders to their nestlings.

We derived the contaminant exposure value using a standard food chain model equation. We based the value on four parameters: food ingestion rate, contaminant in prey, body weight, and area use factor (Table 5). The northern water shrew body weight may range from 9 to 18 g (Burt and Grossenheider 1980, Pennsylvania Game Commission, Virginia Department of Game and Inland Fisheries). We used an average of the lowest body weights from these sources (10.3 g). According to Warrington (2001), due to their small size and high metabolic rate, the water shrew's food ingestion rate is equivalent to its own body weight. The Louisiana waterthrush weight averages 21.5 g (Environment Canada, Smithsonian National Zoological Park). The food ingestion rate formula for passerine birds (USEPA 1993) was used to derive an ingestion rate for the waterthrush. Media contaminant concentrations were not included because water exposures are highly transient and these headwaters do not accumulate significant amounts of fine sediment.

We compared the calculated contaminant exposures to NOAEL and LOAEL TRVs for the two ecological receptors (Table 5). For water shrew, we selected the mercury NOAEL and LOAEL

values from a mink study with mortality, weight loss and ataxia endpoints (Wobeser *et al.* 1976). We based the selenium NOAEL and LOAEL values on potassium selenate in rats from Rosenfeld and Beath (1954) with a reproduction endpoint. These values were identified as the most appropriate TRVs by Oak Ridge National Laboratory (Sample *et al.* 1996). For the waterthrush, we selected the mercury NOAEL and LOAEL values from a mallard duck study with a reproduction endpoint (Heinz 1979), which was also preferred by Sample *et al.* (1996). We used selenium NOAEL and LOAEL values derived from EC_{10} and EC_{20} values for mallard egg hatchability as a function of selenium concentration in diet based on six studies (Hoffman *et al.* 2003). We used mallard body weight and food ingestion rate values from Wildlife Exposure Factors Handbook (USEPA 1993) to convert the mallard EC values to TRVs.

III. RESULTS

We collected a total of 779 animals for 182 samples (Table 6) from 50 study areas (Figure 1). Species collected were *Desmognathus fuscus, D. monticola, D. ochrophaeus, Eurycea bislineata, Gyrinophilus porphyriticus, Plethodon cinereus,* and *E. longicauda.* Thirty one animals (11 *D. monticola* , 15 *D. fuscus, and five G. porphyriticus)* were large enough to analyze without compositing. Average concentrations of selenium varied between species which likely reflects the duration of the obligate aquatic phase and dietary preferences (Figure 2). Selenium concentrations in northern spring salamander (*G. porphyriticus*) were consistently higher, which is likely due to their higher trophic level position and extended life spans. One terrestrial salamander sample (*P. cinereus)* was analyzed for comparison to species with an extended obligate aquatic life stage. Concentrations of selenium in this terrestrial salamander sample were lower than those in *E. bislineata* and *D. fuscus* of similar size from the same study area.

We computed average sample concentrations and salamander HQs for all inorganic contaminants for each study area. Selenium concentrations ranged from 1.06 to 14.32 mg/kg dry weight (dw), while mercury values were 0.031 to 0.36 mg/kg wet weight (ww) (Table 7). HQs ranged from 0.1 to 3.6 for selenium and 0.0 to 1.1 for mercury (Table 7). Average concentrations of selenium were above the respective TRVs for 16 study areas. Average mercury HQs were not greater than one at the two study areas, PA522 and PA544, where single samples exceeded the mercury TRV. Aluminum concentrations ranged from 0.01 to 550 mg/kg ww, while the range of copper concentrations was 0.01 to 18.42 mg/kg ww. Average HQs of greater than or equal to one were observed for aluminum (13 study areas) and copper (five study areas). Mean concentrations of all other inorganic contaminants were below their respective TRVs. Analytical results for samples for all analytes are presented Appendix B.

We classified study areas by proximity to potential sources of inorganic contaminants (Table 2). Spatial distribution of selenium concentrations relative to potential sources are presented in Figures 3 and 4. Similar data are presented for mercury in Figures 5 and 6, aluminum in Figure 7, and copper in Figure 8. Concentration categories in all six figures are based on salamander HQs; low and medium categories are equivalent to HQ less than one and high category is HQ greater than one. A comparison of salamander selenium concentrations between source classes is presented in Figure 9. Analysis of variance (ANOVA) indicated that both average and

maximum selenium concentrations in salamanders from study areas downstream of mining valley fills were significantly higher than those with elevated or no reported emissions. We found no difference between average or maximum selenium concentrations or salamander assemblages in study areas with high emissions or no reported emissions.

We used SPAR IBI calculations to derive scores and classifications for salamander assemblages in 32 study areas (Table 8). Ten study areas were categorized as having salamander assemblages comparable to reference conditions, four as being intermediate, and 18 as being impaired. The proportions of reference, intermediate, and impaired assemblages by HQ are depicted in Figure 10. Chi-square analysis indicated that the proportions are significantly different ($p = 0.038$) between study areas with HQ less than one and those equal to or greater than one. The proportions of reference, intermediate, and impaired assemblages by potential source class are presented in Figure 11. Chi-square analysis indicated that the proportions are significantly different ($p = 0.005$) between study areas downstream of mining valley fills versus those exposed only to emissions deposition.

We also evaluated selenium and mercury risks to avian and mammalian predators. Selenium LOAEL HQs ranged from 0.10 to 3.61 in the waterthrush and 0.83 to 29.23 in the water shrew. Selenium HQs were greater than or equal to one at 11 study areas for the waterthrush (Figure 12), while only one HQ was less than one for the water shrew (Figure 13). Risk calculations for water shrew are not directly applicable in the southwest counties of West Virginia since this area is not documented to be within the species range. Potential risks from mercury exposure were considerably lower. LOAEL HQs for all 50 study areas were less than one for both waterthrush and water shrew. HQs for NOAELs ranged from 0.17 to 2.17 for the waterthrush and 0.06 to 0.74 for the water shrew. Mercury NOAEL HQs were greater than or equal to one at only two study areas for the waterthrush (Figure 14), and at no study areas for the water shrew (Figure 15).

V. DISCUSSION

A. Selenium

This study documented selenium exposure and effects on salamander assemblages in Mid-Atlantic Highland headwaters, and demonstrated the effectiveness of salamanders as a biomonitoring tool. We found impaired salamander assemblages in study areas where selenium concentrations in tissues exceeded the TRV. Where water concentrations [as available from Bryant *et al.* (2002) or WVDEP (unpublished water quality monitoring data)] were near or above the water quality criterion of five µg/L, salamander HQs were greater than one, with only two exceptions (one area where only three animals were found, and one where selenium exceedances had only been occurring for six months). Calculations show likely risk to salamanders at 15 study areas where the average HQ exceeded one and potential risk to salamanders at an additional ten study areas where at least one sample had an HQ greater than one. Of the 15 study areas with HQ greater than one, 12 were below valley fills and three were near counties with elevated selenium emissions. For all 25 study areas, 14 were downstream of mining valley fills,

four were near counties with elevated selenium emissions, and six were in areas where no selenium emissions were reported. We found that salamander assemblages were more likely to be impaired downstream of valley fills than in other locations. We also found an elevated risk to waterthrush in eight study areas downstream of valley fills. Risk estimates are not available for a relevant mammalian receptor in southwest West Virginia. These data indicate that selenium exposure may be a factor affecting headwater biota downstream of mining valley fills.

Selenium is only one of several chemical parameters that may be elevated in streams below valley fills (Bryant *et al.* 2002). Sulfate, hardness, manganese, conductivity, and alkalinity increases ranged from 7.5- to 42-fold over reference conditions, with selenium increasing by 7.8-fold. Selenium is unique among these other parameters in that it is absorbed by and bioaccumulates in aquatic biota. We documented elevated selenium in Plethodontid salamanders downstream of valley fills, and reduced assemblages in a large proportion (nearly 60 percent) of study areas with elevated selenium in whole body samples. However, it is possible that other factors associated with valley fills are responsible for the observed effects on the salamander assemblages. Green *et al.* (2000) demonstrated that benthic macroinvertebrate communities were depressed below valley fills where conductivity was elevated. In contrast, Pauley *et al.* (2004) found that of West Virginia salamander species, only *E. cirrigera* was negatively affected by conductivities as high as 2900 Umhos/cm. The impairment of salamander assemblages could be the result of reduced prey abundance as macroinvertebrate communities were depressed. Williams (2003) concluded that salamander abundance is reduced downstream of valley fills, and associated this effect with a shift from rock to fine sediment substrate. In contrast, Green *et al.* (2000) found no difference in sediment deposition or embeddedness between valley fill and reference streams. Identification of the cause(s) of the observed effects in this study will require the derivation of salamander-specific TRVs in media and, where applicable, in tissues via laboratory testing for the chemical parameters associated with valley fills.

We also documented elevated risk to salamander communities at four study areas within and seven beyond 50 km of selenium emission sources, while eight study areas within 50 km of selenium emissions did not have elevated risk. We found no statistical difference in salamander selenium concentrations or salamander assemblages between study areas with emissions and those where none have been reported. Factors controlling selenium transport, wet and dry deposition, and bioavailability were not examined in this study, but may differ between the no risk and elevated risk study areas. In addition, the USEPA TRI data are reported on a wide spatial scale and do not distinguish between documented zero emissions and failure to report. This shortcoming may have resulted in study areas being under-classified for selenium emissions. Our data indicate that localized monitoring may be the only accurate method of identifying locations where selenium exposure is high enough to pose risks to headwater biota. Based on the correspondence between water and tissue selenium concentrations in our study, we recommend that surface water data be reviewed to identify first and second order streams where selenium from atmospheric deposition may be degrading local water quality. In these streams, headwater biota should be tested to evaluate bioaccumulation and risk.

Even in the absence of salamander-specific TRVs, selenium is a valuable indicator since it can be measured in biological tissues. Tissue concentrations integrate exposures over time compared to water samples. They also eliminate the need to estimate exposure based on water chemistry

because they measure only bioavailable selenium. Most importantly, they provide relevant doses for a bioaccumulative contaminant. It is for these reasons that USEPA has proposed fish tissue-based selenium criteria. We advocate that USEPA and State regulatory agencies couple salamander sampling with fish sampling in their approach to monitoring ecological health to address the extensive proportion of watersheds that have no fish, but support complex aquatic and aquatic-dependent communities.

We developed ecological risk assessments for higher trophic levels based on the water shrew and the waterthrush. We found potential risk to water shrew at all study areas near emissions, and all but one study area with no reported emissions, while waterthrush HQs greater than one occurred at two study areas near emissions, and one with no reported emissions. We have demonstrated that salamanders, which feed primarily on macroinvertebrates, are contaminated. It is reasonable to assume that macroinvertebrates are their primary source of selenium exposure. Water shrew and waterthrush, which consume macroinvertebrates, salamanders, and other aquatic biota, will be exposed in nearly 100 percent of their prey. We used these protective exposure parameters to broadly encompass locations in need of further evaluation in the Mid-Atlantic Highlands. Potential risk to the water shrew is of concern given their dependence on high water quality streams and their population status in West Virginia (imperiled), Pennsylvania (protected), and Virginia (imperiled). The waterthrush is an ideal indicator since it is the only obligate avian species of headwater ecosystems in the eastern United States (Brooks *et al.* 1998). Our conceptual site model results in a significantly greater exposure than for species that have larger home ranges, feed at lower trophic levels, or have a broader diet. The model generates a safe prey concentration of approximately 1 mg/kg dw in contrast to 7 mg/kg dw proposed by Lemly (2002) and 4 mg/kg dw advocated in U.S. Fish and Wildlife Service comments (USFWS 2005) on USEPA's 2004 draft tissue-based selenium criterion. While we recognize that the chosen receptors do not exist in all locations or habitats receiving selenium contamination, we recommend that similar, high-exposure risk scenarios with relevant receptors be considered in establishing selenium criteria that are protective of birds and mammals.

B. Mercury

We also documented mercury exposure in salamanders, although average mercury concentrations in salamanders did not exceed the fish TRV at any study areas. However, individual samples had HQs greater than one at two study areas in Pennsylvania. We calculated NOAEL HQs greater than one for waterthrush for these two, and one additional study area. All three study areas were near mercury emission sources. With emissions and transport of mercury well documented in the Mid-Atlantic, we expected risk to be higher and more widespread. It is possible that salamander mercury concentrations are limited by the factors controlling wet and dry deposition, and the bioavailability of mercury.

The deposition of airborne mercury is influenced by air flow pattern, land form elevation and orientation, and precipitation rate (USEPA 1998). Our study areas were located primarily in forested headwaters at elevations likely to receive significant deposition. The two study areas with mercury salamander samples exceeding TRVs were located at elevations of 1390 feet and

1140 feet. The former was on a high elevation plateau. The latter was in a valley on the west side of a southwest to northeast-running ridge. Mercury deposition could be elevated in these areas due to local topography and orientation. Further examination of regional wind patterns and local precipitation rates, as well as the addition of dry deposition monitoring will be necessary to understand the factors that influence transport of mercury into forested headwaters.

In headwater streams, the rate of methylation is the primary factor controlling mercury bioavailability. Methylation is favored in anaerobic, acidic conditions with fluctuating water levels found in wetlands (Wiener *et al.* 2003). One of the study areas with elevated mercury has significant floodplain wetlands located upstream, which may provide suitable conditions for methylation. The presence of wetlands upstream was atypical of our study areas. In typical Mid-Atlantic headwater streams, methylating conditions may also occur in intermittent stream pools with heavy leaf litter that receive acidic precipitation. As we selected streams with near neutral pH to avoid the known effects of acid mine drainage on salamanders (Rocco and Brooks 2000), it is not likely that conditions in our study areas favored methylation. Additional study areas with upstream wetlands and/or reduced pH without acid mine drainage should be sampled to determine if higher salamander mercury concentrations are more prevalent under these conditions.

C. Other Inorganic Contaminants

We documented detectable concentrations of cadmium, iron, nickel, zinc, barium, lead, aluminum, copper, arsenic and chromium in salamander tissues. Only aluminum and copper were present at levels exceeding TRVs. However, only the cadmium TRV was based on salamander testing. It is possible that salamanders are more sensitive than the surrogate receptors for which TRVs were available. As these contaminants have relatively low bioaccumulation potential, they were not evaluated in the risk assessment model for birds and mammals. Aluminum and copper were not found to be associated with valley fills (Bryant *et al.* 2002). The USEPA TRI data indicate that aluminum is not reported to be released by many industries in the Mid-Atlantic Highlands. Copper releases are far more ubiquitous, but numerous factors could reduce copper transport to and bioavailability in headwater streams. As additional tissue-based TRVs for amphibians become available, the data collected in this study should be reevaluated to improve the assessment of risk to Plethodontid salamanders due to other inorganic contaminants in headwater streams.

VI. MANAGEMENT RECOMMENDATIONS

The results of this study lead us to make the following management recommendations:

1. Advocate that USEPA and State regulatory agencies combined salamander sampling and fish sampling in their approach to monitoring ecological health in watersheds that do not have fish, but nevertheless support complex aquatic and aquatic-dependent communities.

2. Recommend that high-exposure risk scenarios with relevant ecological receptors, particularly State-status species, be considered in establishing selenium and mercury criteria that are protective of birds and mammals.

3. Support the identification of the cause(s) of the observed effects on salamander assemblages via laboratory testing to derive amphibian, particularly salamander, toxicity reference values for ubiquitous contaminants.

4. Advocate assessment of the potential for release of selenium to headwaters within the Mid-Atlantic Highlands to inform both permitting and Clean Water Act 303(d) TMDL and 305(b) assessment processes.

5. Obtain and conduct reviews of surface water data to identify first and second order streams where selenium and mercury may be degrading local water quality. Advocate that States test headwater biota in identified streams to determine bioaccumulation and risk to aquatic and aquatic-dependent biota.

6. Encourage Fish and Wildlife Service Environmental Contaminant specialists to work with peers in relevant State and Federal agencies (e.g., State environmental agencies, NOAA, USGS) to examine regional wind patterns and local precipitation rates to understand the factors that influence transport and deposition of selenium and mercury into forested headwaters.

7. Advocate the addition of contaminant dry deposition monitoring by State and Federal scientific and regulatory agencies to more completely understand sources of exposure for headwater biota.

8. Support the testing of additional study areas with upstream wetlands and/or reduced pH, but without acid mine drainage inputs, to determine if higher salamander selenium and mercury concentrations are documented, and thus if there is a higher risk to aquatic and aquatic-dependent biota.

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Table 1. Summary of physical habitat parameters collected for *Stream Plethodontid Assemblage Response* Index from study areas in Pennsylvania, West Virginia, and Virginia, 2003 - 2005 (Rocco and Brooks 2000).

Survey reach location geographic coordinates (using GPS or from maps)
Stream gradient (m/1000 m) using GPS coordinates and TopoScout (MAPTECH, www.maptech.com) or equivalent from center of survey reach
Maximum pool depth (cm) within survey plots
Wetted channel width (m) within survey plots
Stream and ambient air temperature (° C)
Riparian Zone Survey plot percent canopy cover Survey reach land cover (dominant trees, understory cover)
Survey Plot Substrate cobble cover, moss cover, bank vegetation
Survey reach pebble count (Bevenger and King 1995)

Table 2. Classification of study areas by proximity to potential contaminant sources.

	Se	Hg	Al	Cu	Source
SITE ID	Source	Source	Source	Source	CLASS*
PA 035	0	2	2	2	2
PA 082	1	2	2	2	2
PA 410	2	2	0	2	2
PA 411	0	2	2	2	2
PA 412	2	2	0	2	2
PA 413	1	2	0	2	2
PA 522	0	2	2	2	2
PA 544	0	0	0	1	1
PA 771	2	2	2	2	2
PA 787	0	0	0	1	1
PA 848	0	2	2	2	2
VA 508	0	1	0	2	2
VA 554	0	1	0	2	2
VA 990	0	2	2	2	2
VA 991	3	2	2	2	3
VA 992	3	2	2	2	3
VA 993	3	0	0	0	3
VA 994	3	2	2	2	3
VA 995	0	2	2	2	2
VA 996	0	1	0	2	2
VA 997	0	1	0	2	2
VA 998	0	2	2	2	2
VA 999	3	1	2	2	3
WV 018	3	2	0	2	3
WV 025	3	2	0	1	3
WV 039	0	2	0	1	2
WV 085	3	2	0	1	3
WV 088	3	2	0	1	3
WV 090	3	2	0	1	3
WV 092	0	2	0	1	2
WV 093	0	2	0	2	2
WV 504	2	2	2	2	2
WV 505	2	2	0	1	2
WV 982	2	2	0	2	2
WV 983	2	2	0	2	2
WV 984	2	2	0	2	2
WV 985	2	2	0	2	2
WV 986	3	2	0	1	3
WV 987	3	2	0	0	3
WV 989	0	2	0	0	2
WV 990	0	2	0	0	2
WV 991	3	2	0	0	3
WV 992	0	2	0	2	2
WV 993	3	2	0	0	3
WV 994	2	2	0	1	2
WV 995	3	2	0	0	3
WV 996	0	2	0	1	2
WV 997	3	2	0	2	3
WV 998	3	2	0	1	3
WV 999	3	2	0	2	3

* 0 = none reported, 1=first quantile, 2=second quantile, 3=up gradient mining
none reported = no report filed for the county or report has no entry

Table 3. Components of the Stream Plethodontid Assemblage Response Index used to calculate the Index of Biotic Integrity (IBI) Score and the results of the performance evaluation of the individual indices (Rocco et al. 2004).

		IBI COMBINATION		
METRIC	METRIC DESCRIPTION	Group 1	Group 2	Group 3
# species	number of Plethodontid species, including woodland species	X	X	
# two-lined	number of *Eurycea bislineata* or *E. cirrigera*	X		
# northern spring	number of *Gyrinophilus porphyriticus*			X
# salamanders	number of salamanders of all species		X	X
# intolerants	number of salamander minus number of *Eurycea spp*.		X	X
# nutrient tolerant	number of *E. spp*. plus *D. fuscus*	X		
# terrestrial	number of salamanders without gills or gill stubs		X	

% EFFICIENCY	All Sites	81	68	71
	Degraded Sites	83	67	74
	Intermediate Sites	81	78	74

Table 4. Literature sources and corresponding parameters for toxicity reference values (TRVs) based on tissue concentrations in aquatic biota used to assess risk to stream salamanders.

Source	Species	Analyte	Wet Weight Concentration (mg/kg)	Effect	Toxicity Measure	Lifestage	HQ TRV
Gillilland et al. 2001	*Rana clamitans*	Aluminum	11.4	Deformities	NOED	Adult	114.0
McGeachy and Dixon 1990	*Oncorhynchus mykiss*	Arsenic	1.5	Mortality	LOED	Juvenile	1.5
Gillilland et al. 2001	*Rana clamitans*	Barium	6	Deformities	NOED	Juvenile	60.0
Nebeker et al. 1995	*Ambystoma gracile*	Cadmium	4.7	Growth	LOED	Larval	4.7
Van De Putte et al. 1981	*Oncorhynchus mykiss*	Chromium VI	8.7	Mortality	LD75	Immature	6.9
Van De Putte et al. 1981	*Oncorhynchus mykiss*	Chromium VI	5.5	Mortality	NOED	Immature	
Gillilland et al. 2001	*Rana clamitans*	Copper	0.28	Deformities	NOED	Juvenile	2.8
Gillilland et al. 2001	*Rana clamitans*	Iron	220	Deformities	NOED	Adult	2200.0
Gillilland et al. 2001	*Rana clamitans*	Lead	0.78	Deformities	NOED	Juvenile	7.8
Fjeld et al. 1998	*Thymallus thymallus*	Mercury	0.27	Behavior	LOED	Adult	0.3
Gillilland et al. 2001	*Rana clamitans*	Nickel	0.122	Deformities	NOED	Adult	1.2
Lemly 2002	*Oncorhynchus mykiss*	Selenium	4	Reproduction	LOED	Adult	4.0
Gillilland et al. 2001	*Rana clamitans*	Zinc	4.6	Deformities	NOED	Adult	46.0

HQ TRV = geometric mean of NOED and LD75 values
selenium (mg/kg dry weight)

Table 5. Life history parameters and toxicity reference values used to calculate risk to mammalian and avian receptors.

Northern Water Shrew						
weight (kg)[a]		food ingestion rate (kg/day)[b]	NOAEL-Hg (mg/kg-day)[c]	LOAEL-Hg (mg/kg-day)[c]	NOAEL-Se (mg/kg-day)[d]	LOAEL-Se (mg/kg-day)[d]
0.0103	0.0163	0.0103	0.15	0.25	0.2	0.33

Louisiana Waterthrush					
weight (kg)[e]	food ingestion rate (kg/day)[f]	NOAEL-Hg (mg/kg-day)[g]	LOAEL-Hg (mg/kg-day)[g]	NOAEL-Se (mg/kg-day)[h]	LOAEL-Se (mg/kg-day)[h]
0.0215	0.0054	0.0064	0.064	0.279	0.336

a - Weight range is an average from three sources - Burt and Grossenheider 1980 (9-14g), PA Game Commission (9.9-17g), and the VA Department of Game and Inland Fisheries (12-18g).
b - Food ingestion rate is equivalent to the body weight as noted by the BC Ministry of Water, Land and Air Protection.
c - Values based on methyl mercury chloride in mink from Wobeser et al.1976 with an endpoint of mortality, weight loss and ataxia, mink selected over rat since both shrews and minks are carnivores. (Oak Ridge)
d - Values based on potassium selenate in rat from Rosenfeld and Beath (1954) with a reproduction endpoint (Oak Ridge)
e - Average bird weight from Environment Canada and the Smithsonian National Zoological Park
f - Rate based on ingestion rate formula for passerine birds, US EPA Wildlife Exposure Factors Handbook, 1993
g - Values based on methyl mercury dicyandiamide in mallard from Heinz (1979) with a reproduction endpoint (Oak Ridge)
h - Values from Handbook of Ecotoxicology, page 486, mallard egg hatchability as a function of selenium concentration in diet, converted to dose using average female mallard weight from US EPA Wildlife Exposure Factors Handbook and allometric equation

Table 6. Summary of salamander collections in Pennsylvania, Virginia and West Virginia, 2003 - 2004.

Species	Common Name	Aquatic Larval Period	Food Habits	Study Areas	Specimens	Samples
Desmognathus fuscus	Northern Dusky	9 months	aquatic invertebrates	43	481	108
Desmognathus monticola	Appalachian Seal	9 months	aquatic invertebrates & salamanders	12	76	34
Desmognathus ochrophaeus	Mountain Dusky	6 months	aquatic invertebrates	6	91	12
Eurycea bislineata	Northern Two-lined	2 years	aquatic invertebrates & eggs	12	113	19
Gyrinophilus porphyriticus	Northern Spring	3 years	salamanders & aquatic invertebrates	6	13	8
Plethodon cinereus	Redback	none	terrestrial invertebrates	1	5	1
				TOTAL	779	182

Table 7. Selenium, mercury, aluminum, and copper concentrations, hazard quotients (HQs), and resulting study area classifications by tissue concentrations.

	mean [Se]	Se HQ		mean [Hg]	Hg HQ		mean [Al]	Al HQ		mean [Cu]	Cu HQ		HQ
SITE ID	mg/kg dw	mean	range	mg/kg ww	mean	range	mg/kg ww	mean	range	mg/kg ww	mean	range	CLASS*
PA 035	2.49	0.6	0.5-0.9	0.049	0.2	0.1-0.4	138.3	1.2	0.8-1.9	1.78	0.6	0.3-1.2	2
PA 082	2.20	0.6	0.1-0.8	0.025	0.1	0.1-0.1	120.4	1.1	0.5-1.6	1.06	0.4	0.3-0.4	2
PA 410	4.13	1.0	1.0	0.026	0.1	0.1	112.7	1.0	1.0	0.98	0.4	0.4	2
PA 411	2.41	0.6	0.5-0.8	0.029	0.1	0.1-0.1	36.7	0.3	0.1-0.5	0.74	0.3	0.2-0.3	1
PA 412	5.24	1.3	0.9-2.7	0.026	0.1	0.1-0.2	73.6	0.6	0.1-1.0	0.90	0.3	0.2-0.5	2
PA 413	3.94	1.0	1.0-1.0	0.041	0.2	0.1-0.2	77.3	0.7	0.7	0.95	0.5	0.5	2
PA 522	2.88	0.7	0.5-1.3	0.052	0.2	0.1-1.1	178.2	1.6	0.3-4.2	1.41	0.5	0.3-1.0	2
PA 544	2.10	0.5	0.1-1.1	0.110	0.4	0.1-1.1	149.4	1.3	1.0-1.6	1.56	0.6	0.3-0.9	2
PA 771	2.49	0.6	0.5-0.9	0.025	0.1	0.1-0.1	103.6	0.9	0.7-1.1	0.86	0.3	0.3-0.3	1
PA 787	2.10	0.5	0.1-0.8	0.040	0.1	0.1-0.4	41.3	0.4	0.3-0.4	2.02	0.7	0.3-1.4	1
PA 848	2.19	0.5	0.5-0.6	0.031	0.1	0.1-0.1	27.7	0.2	0.1-0.5	0.87	0.3	0.2-0.4	1
VA 508	3.16	0.8	0.6-1.2	0.023	0.1	0.1-0.1	24.0	0.2	0.1-0.3	0.78	0.3	0.3-0.3	1
VA 554	1.57	0.4	0.1-0.9	0.025	0.1	0.1-0.10	69.6	0.6	0.4-0.9	0.84	0.3	0.3-0.3	1
VA 990	1.16	0.3	0.3-0.3	0.020	0.1	0.1-0.1	26.4	0.2	0.1-0.4	1.00	0.4	.03-0.5	1
VA 991	1.35	0.3	0.3-0.4	0.036	0.1	0.1-0.2	33.6	0.3	0.1-0.5	1.37	0.5	0.3-0.7	1
VA 992	1.94	0.5	0.3-0.7	0.019	0.1	0.0-0.1	57.0	0.5	0.2-1.2	1.19	0.4	0.2-0.8	1
VA 993	4.37	1.1	0.5-1.8	0.034	0.1	0.1-0.2	211.6	1.9	1.1-3.3	5.41	1.9	0.3-5.6	2
VA 994	3.06	0.8	0.6-1.4	0.024	0.1	0.1-0.1	69.0	0.6	0.4-.08	0.47	0.2	0.1-0.2	1
VA 995	3.02	0.8	0.6-1.0	0.027	0.1	0.1-0.1	52.6	0.5	0.4-0.5	1.16	0.4	0.3-0.5	1
VA 996	2.55	0.6	0.5-0.8	0.021	0.1	0.1-0.1	32.0	0.3	0.3	0.80	0.3	0.3	1
VA 997	2.55	0.6	0.5-0.8	0.023	0.1	0.1-0.1	114.8	1.0	1.0	0.77	0.3	0.3	2
VA 998	1.89	0.5	0.1-1.3	0.050	0.2	0.1-0.6	68.9	0.6	0.3-0.9	1.63	0.6	0.3-1.0	1
VA 999	1.77	0.4	0.1-1.0	0.044	0.2	0.1-0.5	281.3	2.5	0.5-4.8	1.39	0.5	0.3-0.8	2
WV 018	10.37	2.6	1.4-3.6	0.049	0.2	0.1-0.5	191.8	1.7	0.4-2.9	6.79	2.4	0.3-5.0	2
WV 025	5.40	1.3	0.6-2.0	0.031	0.1	0.1-0.2	143.6	1.3	0.8-1.7	1.62	0.6	0.2-0.9	2
WV 039	2.88	0.7	0.5-1.0	0.027	0.1	0.1-0.1	39.5	0.3	0.2-0.4	1.14	0.4	0.3-0.5	1
WV 085	6.56	1.6	1.4-2.2	0.051	0.2	0.1-0.3	261.5	2.3	1.5-2.7	4.24	1.5	0.4-2.5	2
WV 088	7.79	1.9	1.9	0.027	0.1	0.1	na	na	na	na	na	na	2
WV 090	4.11	1.0	0.7-1.4	0.025	0.1	0.1-0.10	21.3	0.2	0.2	0.47	0.2	0.2	2

Table 7. Selenium, mercury, aluminum, and copper concentrations, hazard quotients (HQs), and resulting study area classifications by tissue concentrations (cont.).

	mean [Se]	Se HQ		mean [Hg]	Hg HQ		mean [Al]	Al HQ		mean [Cu]	Cu HQ		HQ
SITE ID	mg/kg dw	mean	range	mg/kg ww	mean	range	mg/kg ww	mean	range	mg/kg ww	mean	range	CLASS*
WV 092	2.23	0.6	0.6	0.031	0.1	0.113	na	na	na	na	na	na	1
WV 093	2.50	0.6	0.6-0.7	0.019	0.1	0.1-0.1	na	na	na	na	na	na	1
WV 504	2.97	0.7	0.5-1.1	0.025	0.1	0.1-0.1	36.9	0.3	0.3-0.4	0.60	0.2	0.2-0.2	1
WV 505	1.27	0.3	0.3-0.3	0.036	0.1	0.1-0.1	74.5	0.7	0.2-1.2	0.68	0.2	0.2-0.3	1
WV 982	2.30	0.6	0.5-0.7	0.016	0.1	0.1-0.1	122.5	1.1	0.9-1.2	0.59	0.2	0.2-0.2	2
WV 983	2.05	0.5	0.5	0.013	0.0	0.1	40.8	0.4	0.4	0.66	0.2	0.2	1
WV 984	2.05	0.5	0.5-0.5	0.032	0.1	0.1-0.1	27.6	0.2	0.2-0.3	0.94	0.3	0.3-0.4	1
WV 985	2.23	0.6	0.6-0.6	0.025	0.1	0.1-0.1	45.5	0.4	0.4-0.4	0.57	0.2	0.2-0.2	1
WV 986	6.04	1.5	1.2-2.0	0.016	0.1	0.1-0.1	22.3	0.2	0.1-0.2	2.96	1.1	0.4-1.5	2
WV 987	3.19	0.8	0.7-0.9	0.038	0.1	0.1-0.2	101.0	0.9	0.5-1.3	3.99	1.4	0.3-2.6	2
WV 989	1.63	0.4	0.4-0.4	0.020	0.1	0.1-0.1	30.1	0.3	0.3-0.3	0.53	0.2	0.2-0.2	1
WV 990	2.31	0.6	0.6	0.017	0.1	0.1	31.5	0.3	0.3	1.29	0.5	0.5	1
WV 991	4.02	1.0	0.7-1.3	0.010	0.0	0.0-0.0	43.6	0.4	0.3-0.5	1.22	0.4	0.3-0.6	2
WV 992	2.00	0.5	0.5-0.6	0.015	0.1	0.1-0.1	60.1	0.5	0.4-0.7	1.27	0.5	0.4-0.5	1
WV 993	5.42	1.4	1.3-1.4	0.012	0.0	0.0-0.1	134.5	1.2	1.1-1.3	1.12	0.4	0.4-0.4	2
WV 994	2.61	0.7	0.4-0.9	0.027	0.1	0.1-0.1	34.3	0.3	0.1-0.8	0.85	0.3	0.2-0.4	1
WV 995	6.91	1.7	1.2-2.4	0.013	0.0	0.0-0.1	71.2	0.6	0.5-0.8	1.17	0.4	0.4-0.4	2
WV 996	3.91	1.0	0.6-1.3	0.029	0.1	0.1-0.1	67.1	0.6	0.6	1.78	0.6	0.6	2
WV 997	6.53	1.6	1.0-2.4	0.022	0.1	0.0-0.1	63.9	0.6	0.3-0.8	11.96	4.3	2.0-6.6	2
WV 998	4.48	1.1	0.7-1.5	0.023	0.1	0.1-0.1	20.8	0.2	0.2	0.94	0.3	0.3	2
WV 999	2.25	0.6	0.6	0.045	0.2	0.2	na	na	na	na	na	na	1

mean hazard quotient greater than 1

individual composites with hazard quotients greater than 1

*1=hazard quotient<1, 2=hazard quotient>1

Table 8. SPAR Index of Biotic Integrity (IBI) scores and status with respect to hazard quotient (HQ) and potential source classes.

SITE ID	HQ CLASS*	SOURCE CLASS**	HABITAT CLASS***	SPAR IBI SCORE****	STATUS
PA 544	2	1	GRP 1	1.67	IMP
PA 787	1	1	GRP 1	6.67	REF
PA 035	2	2	GRP 3	6.67	REF
PA 082	2	2	GRP 1	10.00	REF
PA 410	2	2	GRP 1	10.00	REF
PA 411	1	2	GRP 1	6.67	REF
PA 412	2	2	GRP 1	5.00	INTMED
PA 522	2	2	GRP 3	1.67	IMP
PA 771	1	2	GRP 1	1.67	IMP
PA 848	1	2	GRP 1	10.00	REF
VA 508	1	2	GRP 3	10.00	REF
VA 554	1	2	GRP 3	6.67	REF
VA 990	1	2	GRP 3	10.00	REF
VA 995	1	2	GRP 3	10.00	REF
VA 996	1	2	GRP 3	8.33	REF
VA 997	2	2	GRP 3	8.33	REF
VA 998	1	2	GRP 3	6.67	REF
WV 039	1	2	GRP 3	10.00	REF
WV 092	1	2	GRP 3	8.33	REF
WV 504	1	2	GRP 3	5.00	INTMED
WV 505	1	2	GRP 3	3.33	IMP
WV 983	1	2	GRP 3	6.67	REF
WV 994	1	2	GRP 3	6.67	REF
VA 991	1	3	GRP 3	5.00	INTMED
VA 992	1	3	GRP 3	6.70	REF
VA 993	2	3	GRP 2	1.25	IMP
VA 994	1	3	GRP 3	5.00	INTMED
VA 999	2	3	GRP 3	1.67	IMP
WV 090	2	3	GRP 3	1.67	IMP
WV 997	2	3	GRP 3	0.00	IMP
WV 998	2	3	GRP 3	0.00	IMP
WV 999	1	3	GRP 3	0.00	IMP

*1=hazard quotient<1, 2=hazard quotient>1

** 0 = none reported, 1=first quantile, 2=second quantile, 3=downstream of valley fill

***group class based on latitude, % boulder cover, stream temperature, and % slope

****scoring is group specific – see Table 3

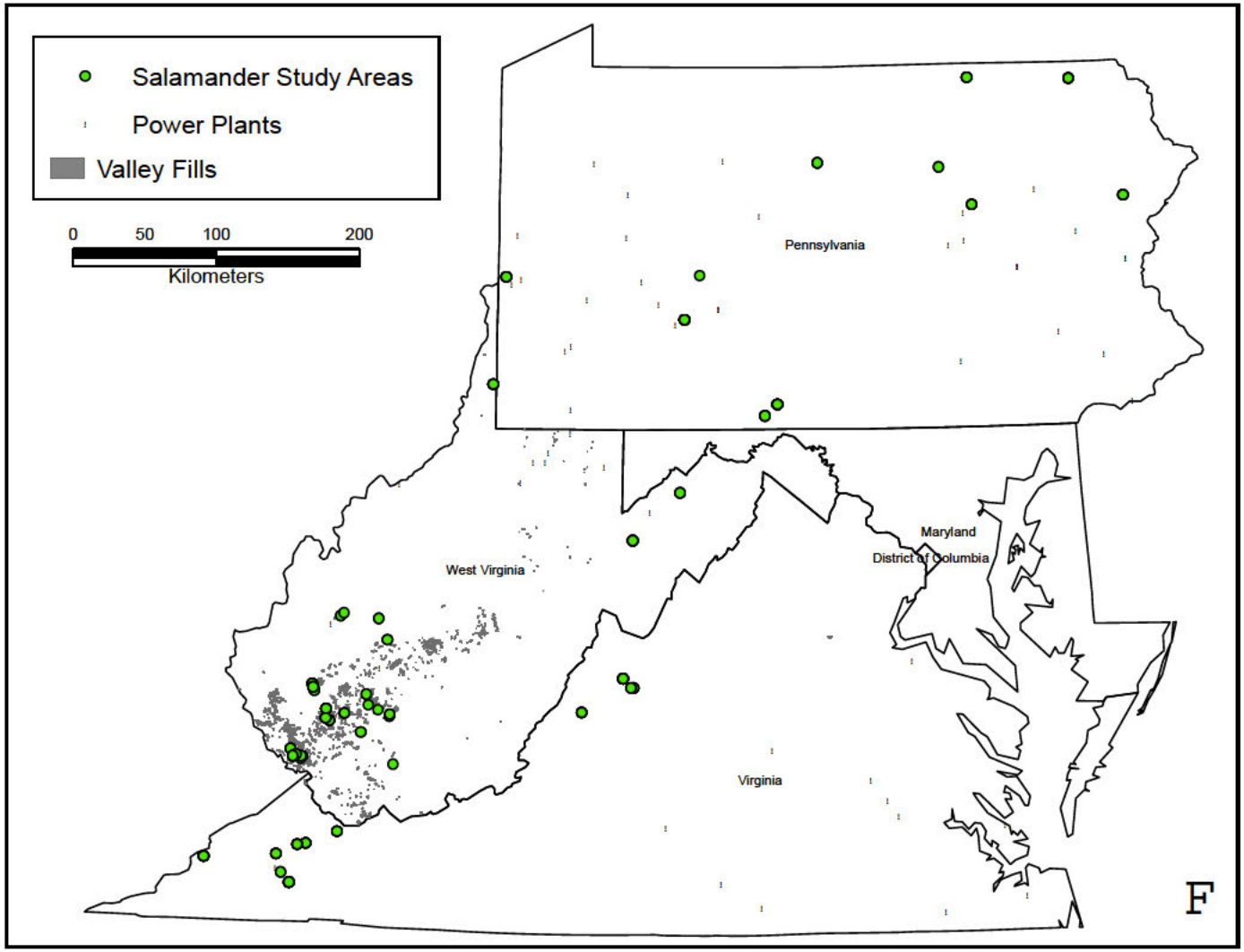


Figure 1. Study areas in Pennsylvania, West Virginia, and Virginia relative to power plants and valley fills. Note – valley fills are not depicted for Virginia sites and power plants are not depicted for Maryland.

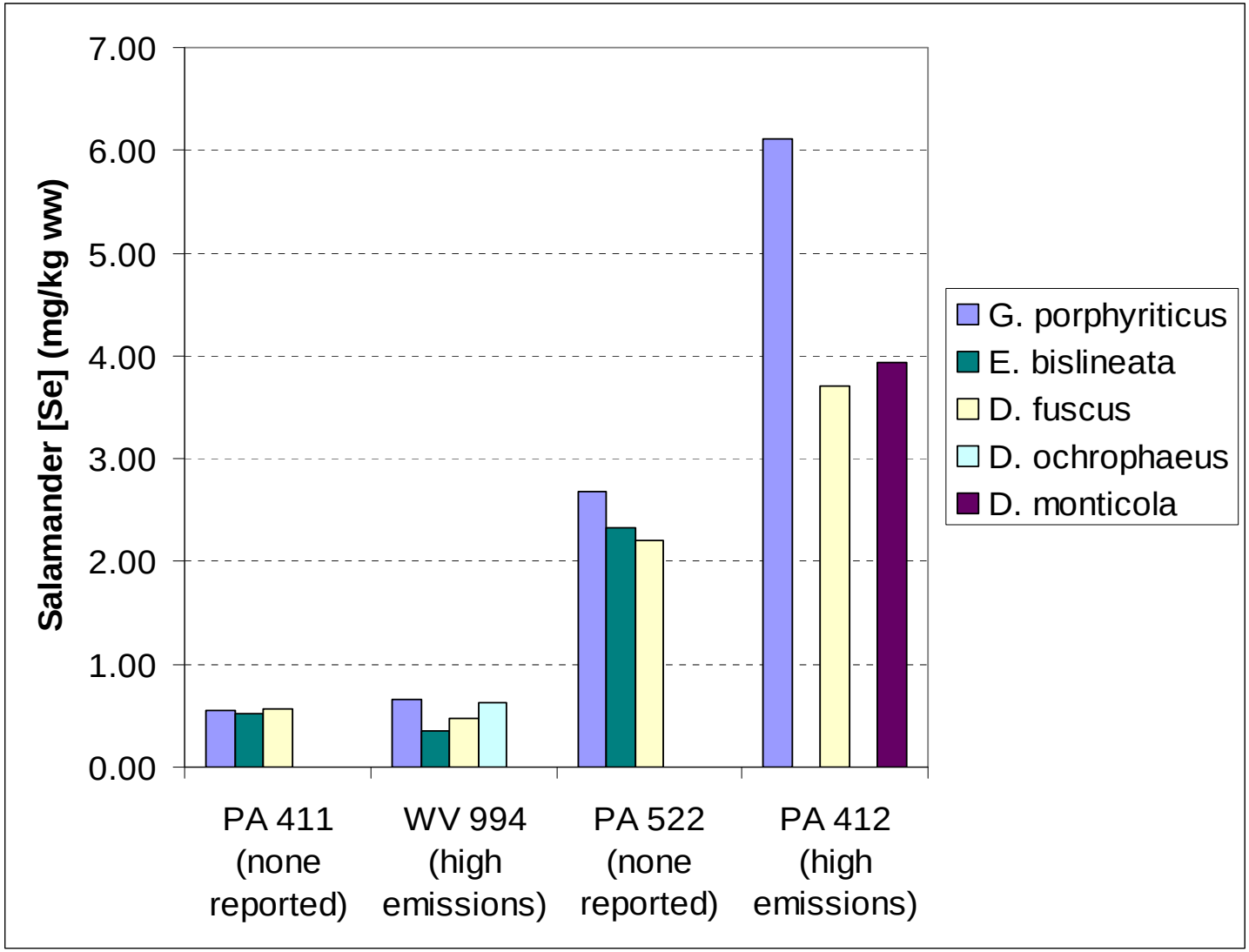


Figure 2. Comparison of average salamander selenium concentrations across species at study areas (selenium source class) which had *G. porphyriticus* and a minimum of two additional species.

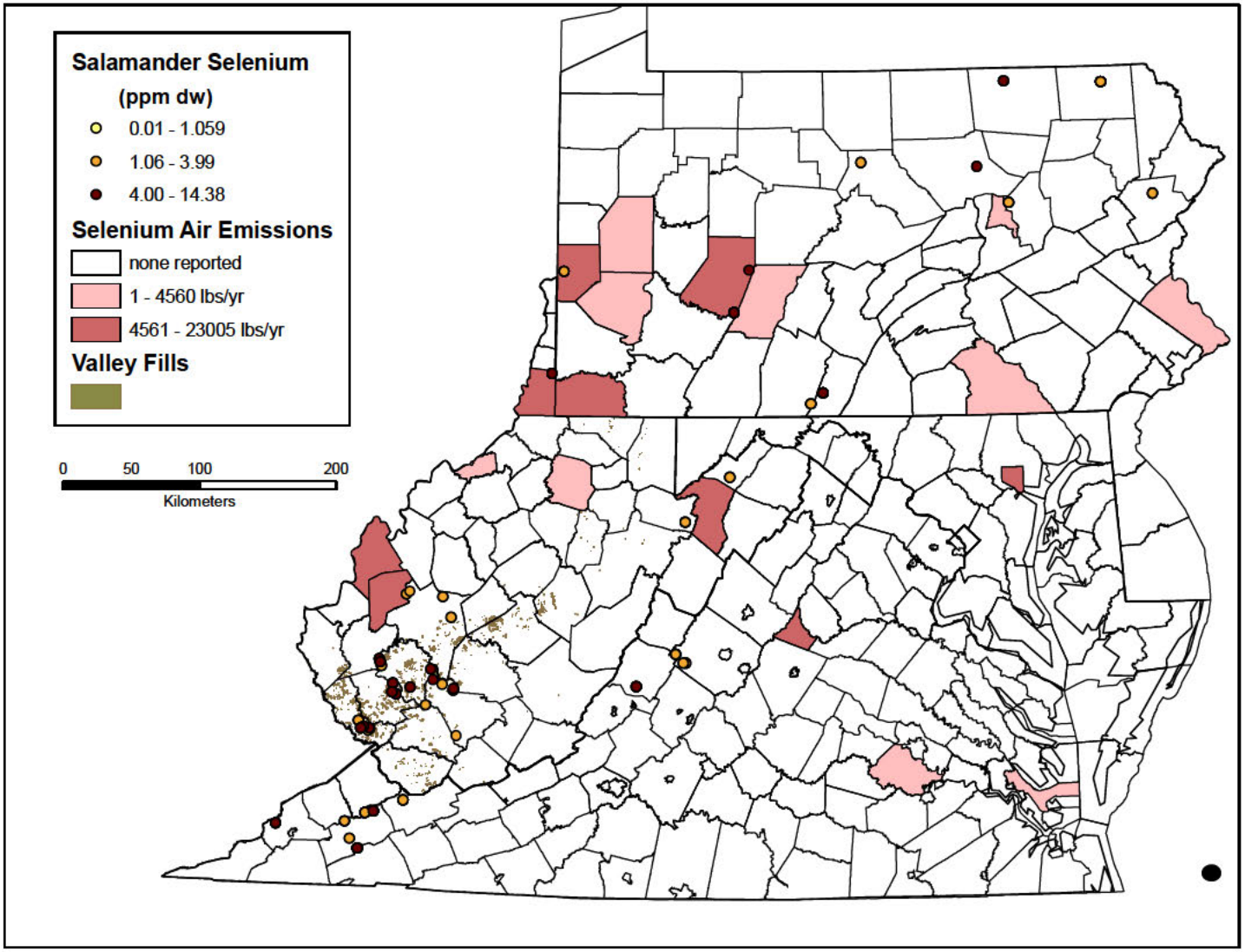


Figure 3. Concentrations of selenium in whole body samples of salamanders relative to selenium air emissions (2003 US EPA Toxic Release Inventory). Low and medium Se categories = HQ<1; high Se category = HQ>1.

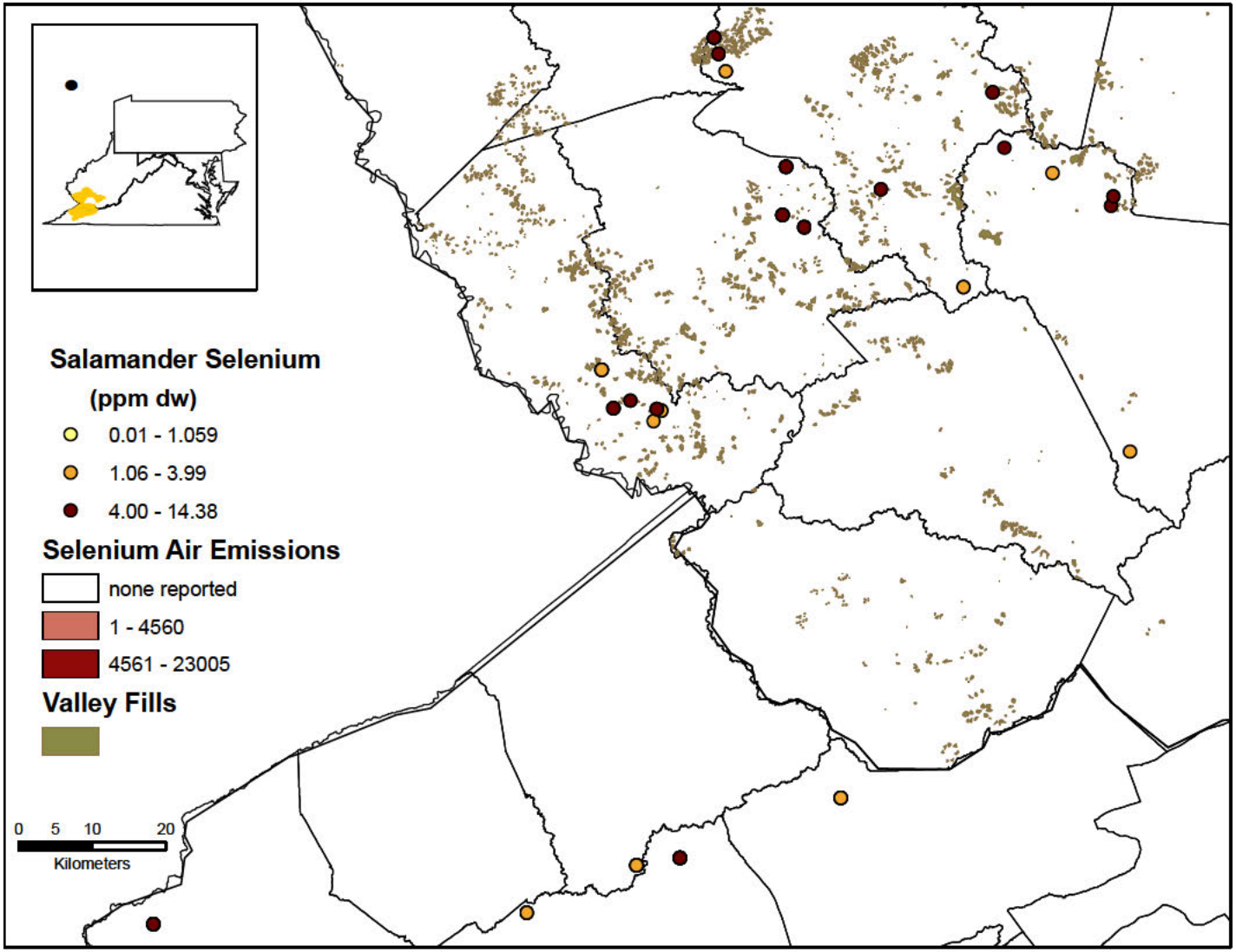


Figure 4. Expanded area of southwestern Virginia and West Virginia depicting concentrations of selenium in whole body samples of salamanders.

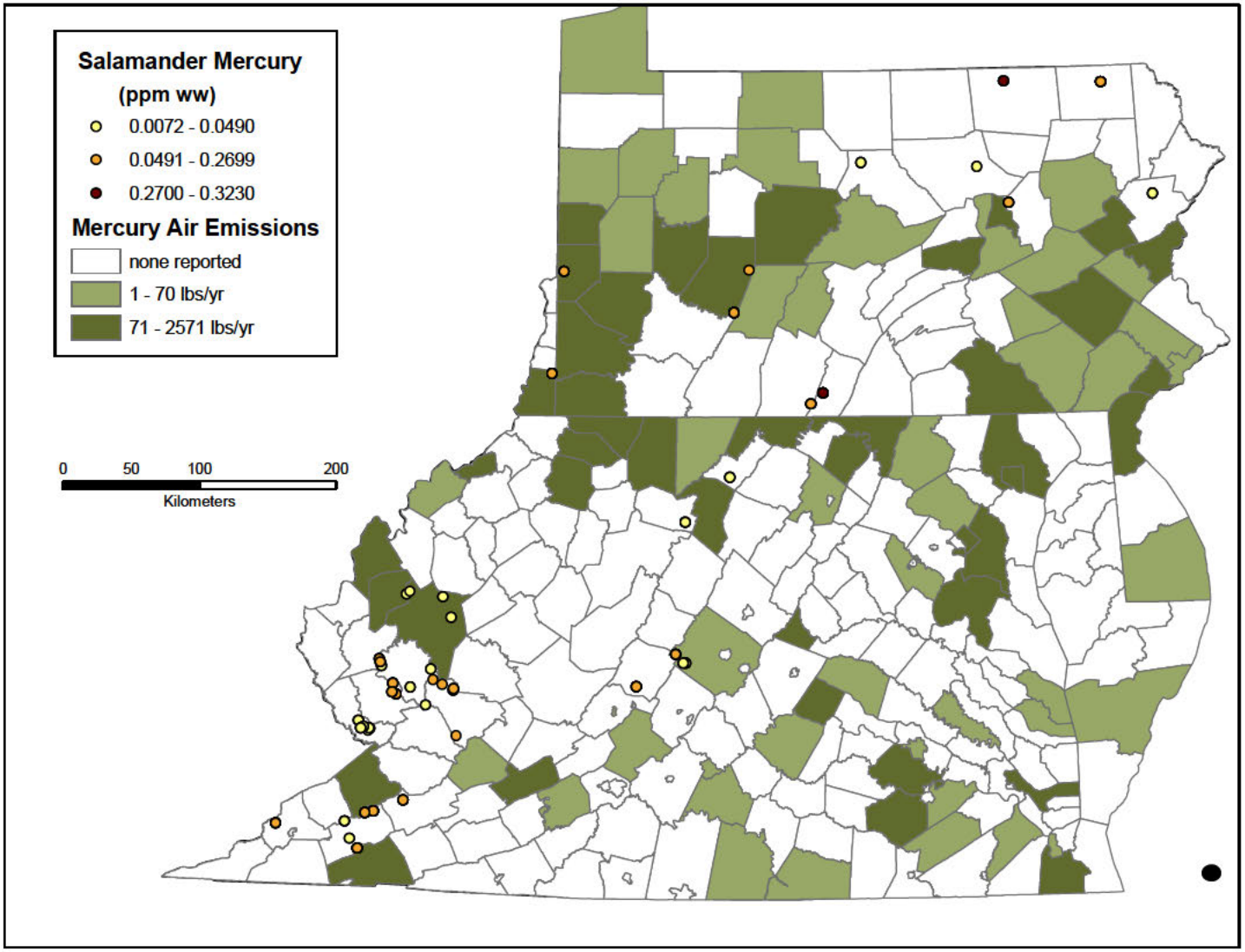


Figure 5. Concentrations of mercury in whole body samples of salamanders relative to mercury air emissions (2003 US EPA Toxic Release Inventory). Low and medium Hg categories = HQ<1; high Hg category = HQ>1.

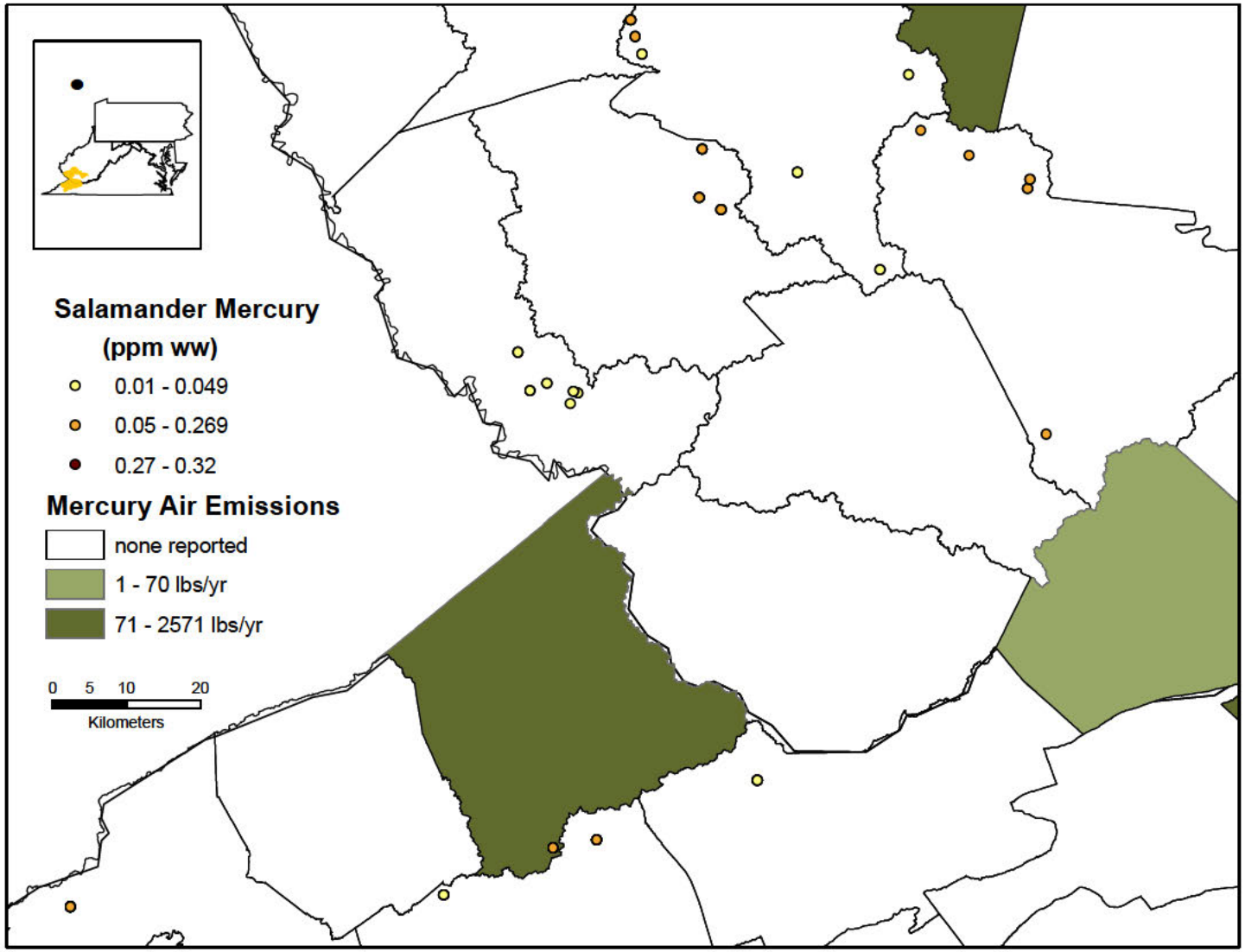


Figure 6. Expanded area of southwestern Virginia and West Virginia depicting concentrations of mercury in whole body samples of salamanders.

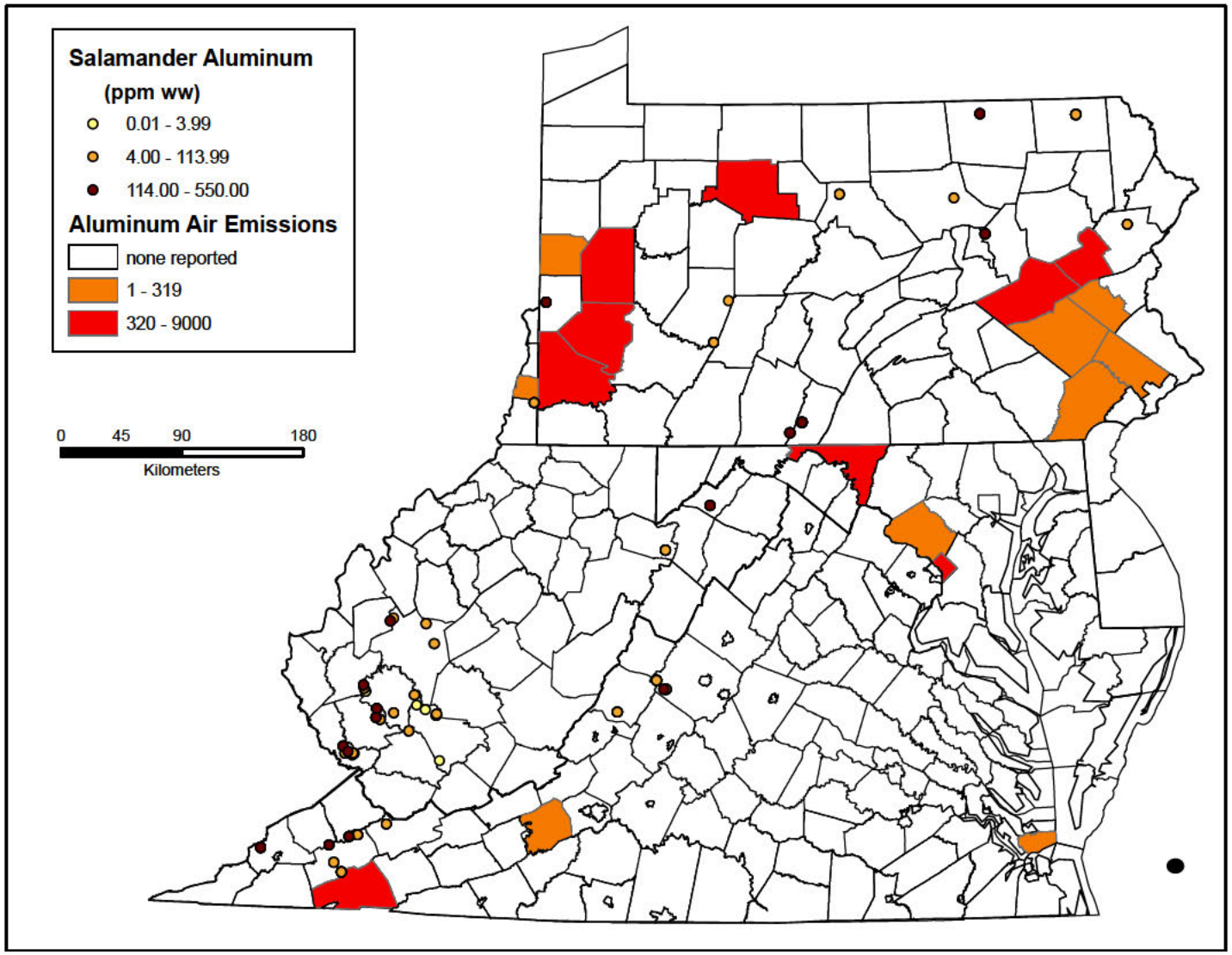


Figure 7. Concentrations of aluminum in whole body samples of salamanders relative to aluminum air emissions (2003 US EPA Toxic Release Inventory).

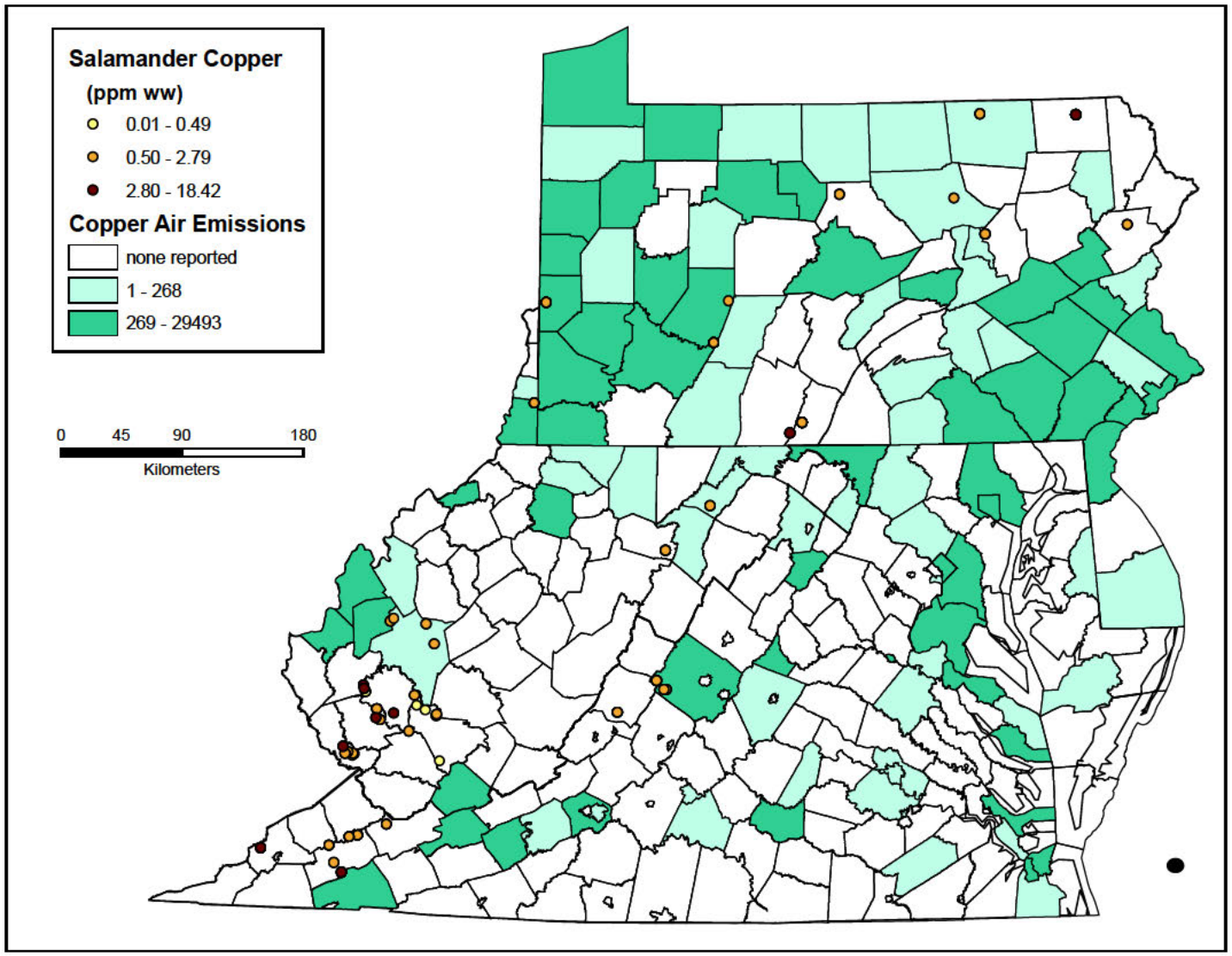


Figure 8. Concentrations of copper in whole body samples of salamanders relative to copper air emissions (2003 US EPA Toxic Release Inventory).

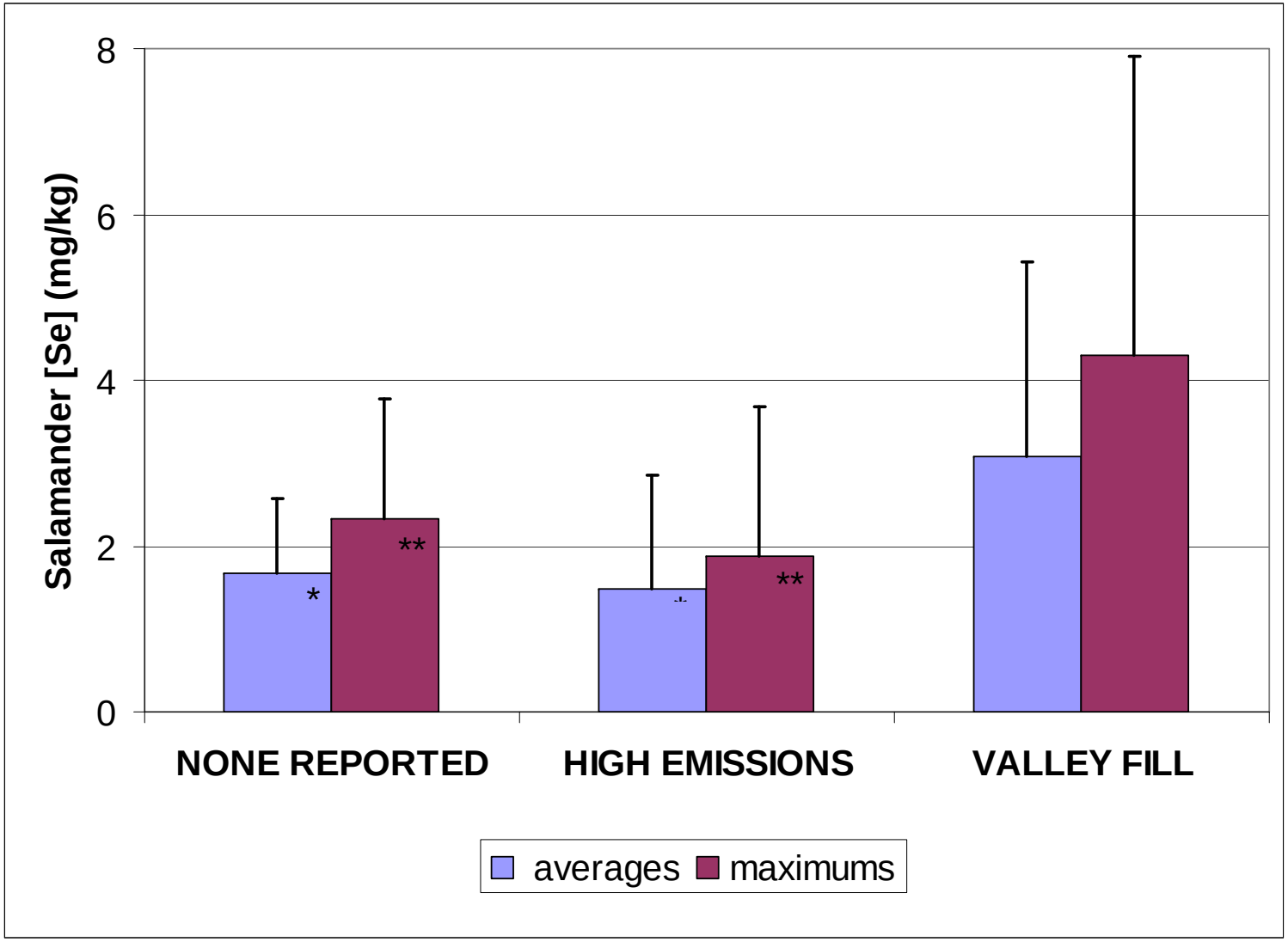


Figure 9. Mean and standard deviation for average and maximum salamander selenium concentrations based on selenium sources. * and ** None reported and high emissions study areas differ significantly from respective valley fill study areas at $p<0.05$ based on ANOVA and Dunnett's.

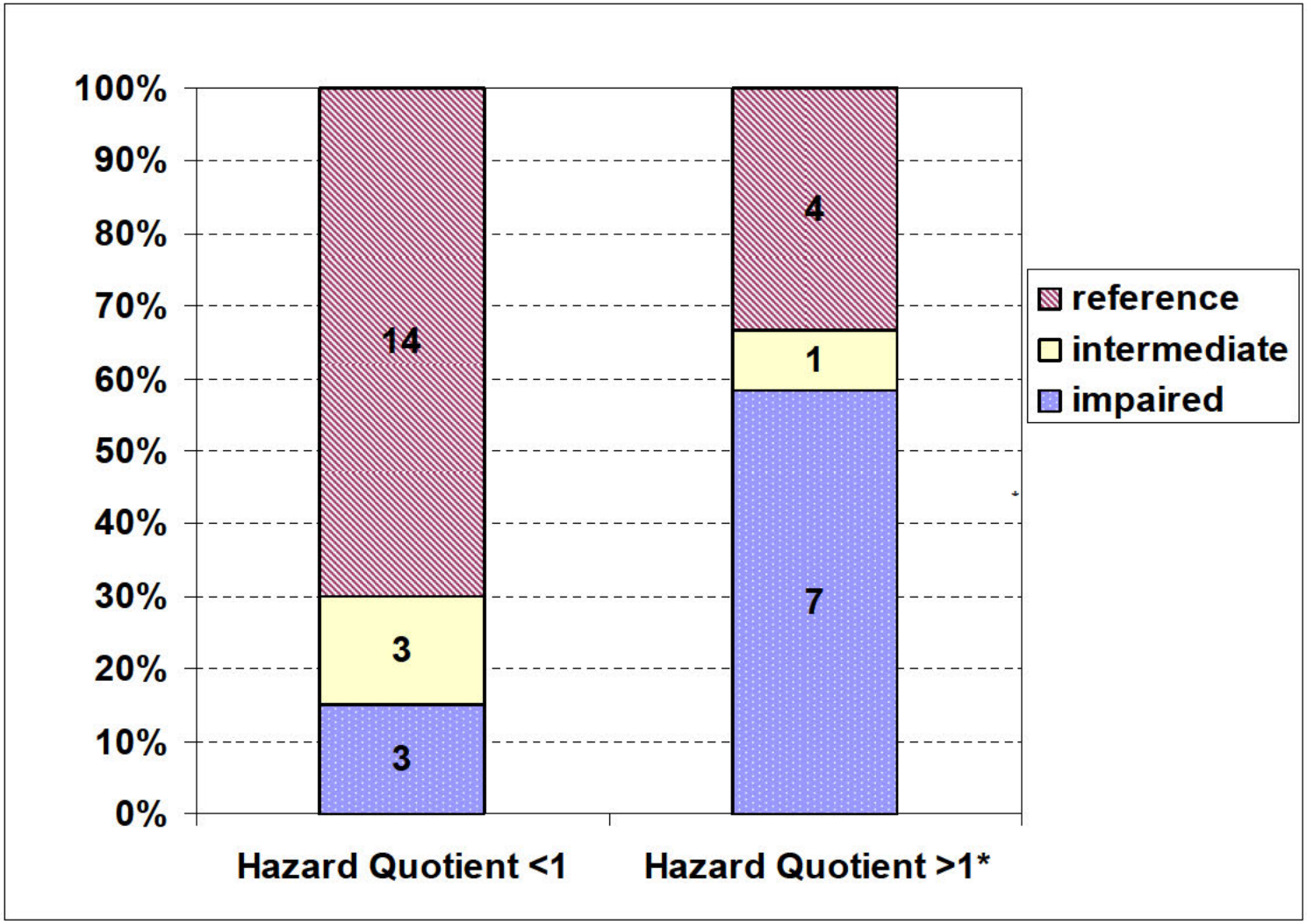


Figure 10. Proportion of salamander assemblages in each IBI category relative to combined inorganic contaminant HQs. Bold numbers represent number of salamander assemblages. * Study areas assemblages with HQs>1 differ significantly (p=0.038) from assemblages at HQ<1 study areas based on Chi-square analysis.

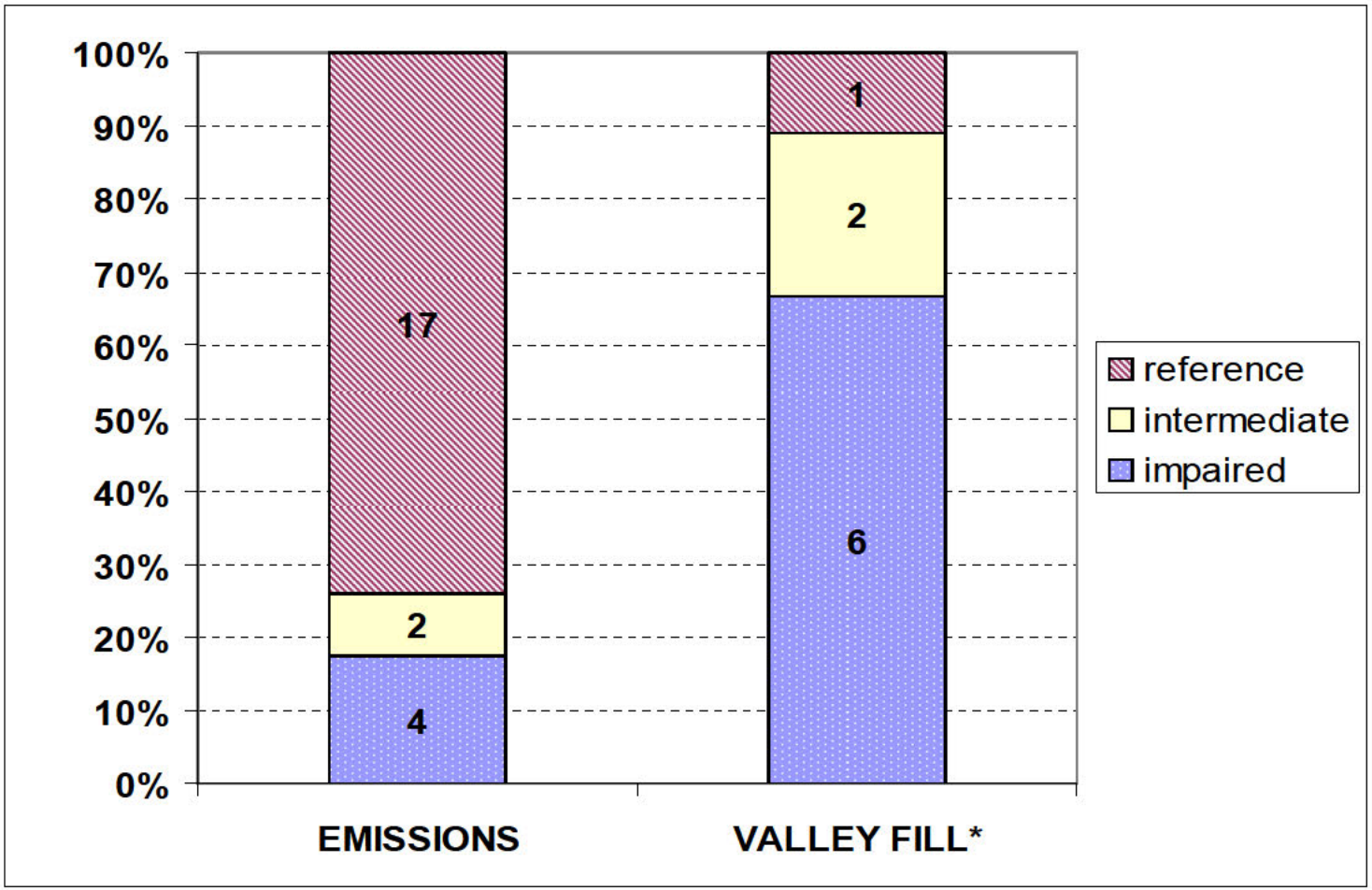


Figure 11. Proportion of salamander assemblages in each IBI category relative to potential contaminant sources. Bold numbers represent number of salamander assemblages. * Valley fill assemblages differ significantly (p=0.005) from emission source assemblages based on Chi-square analysis.

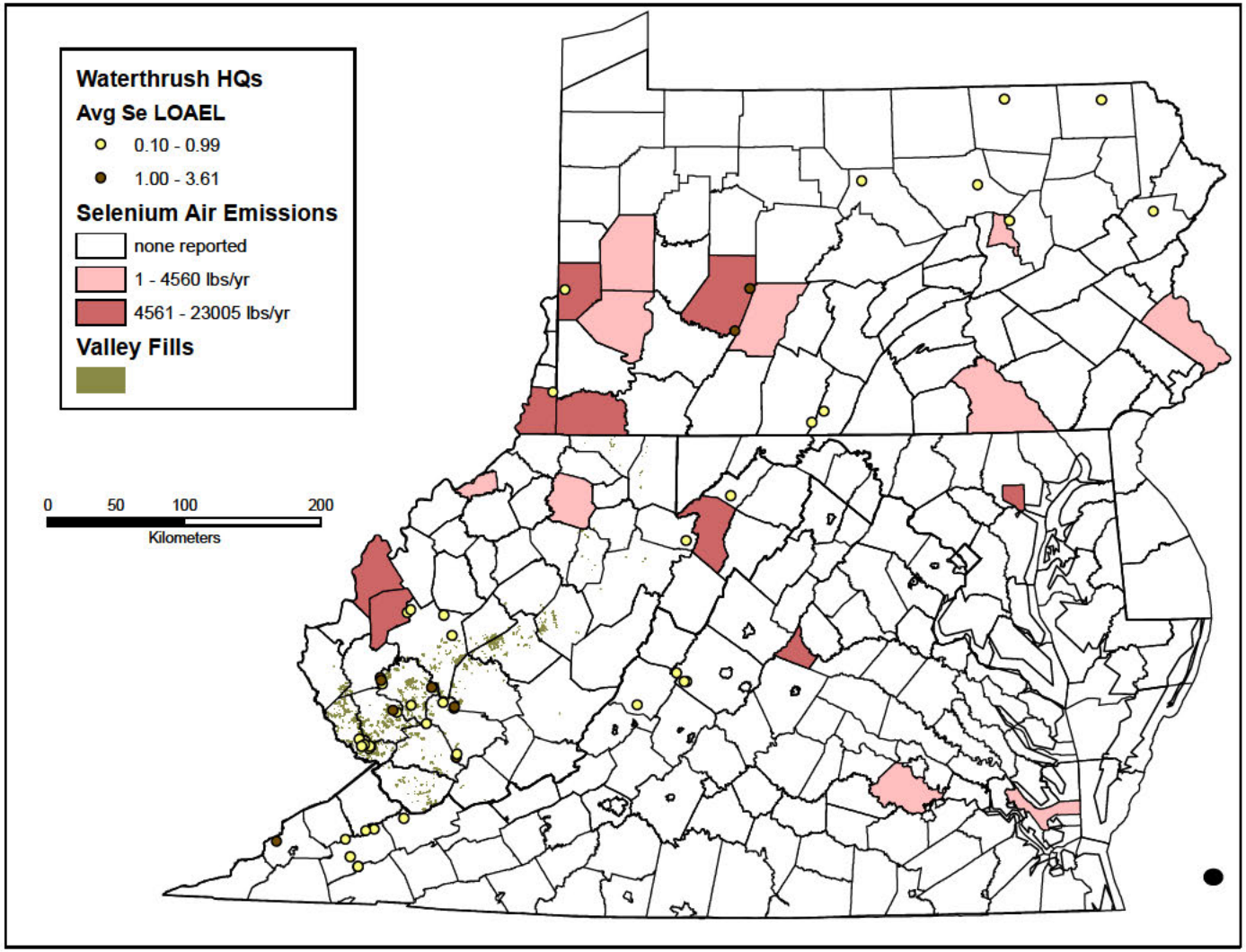


Figure 12. Waterthrush selenium hazard quotients (HQs) based on average salamander concentrations and lowest observable effect toxicity values relative to potential selenium sources. Note – valley fills are not depicted for Virginia sites.

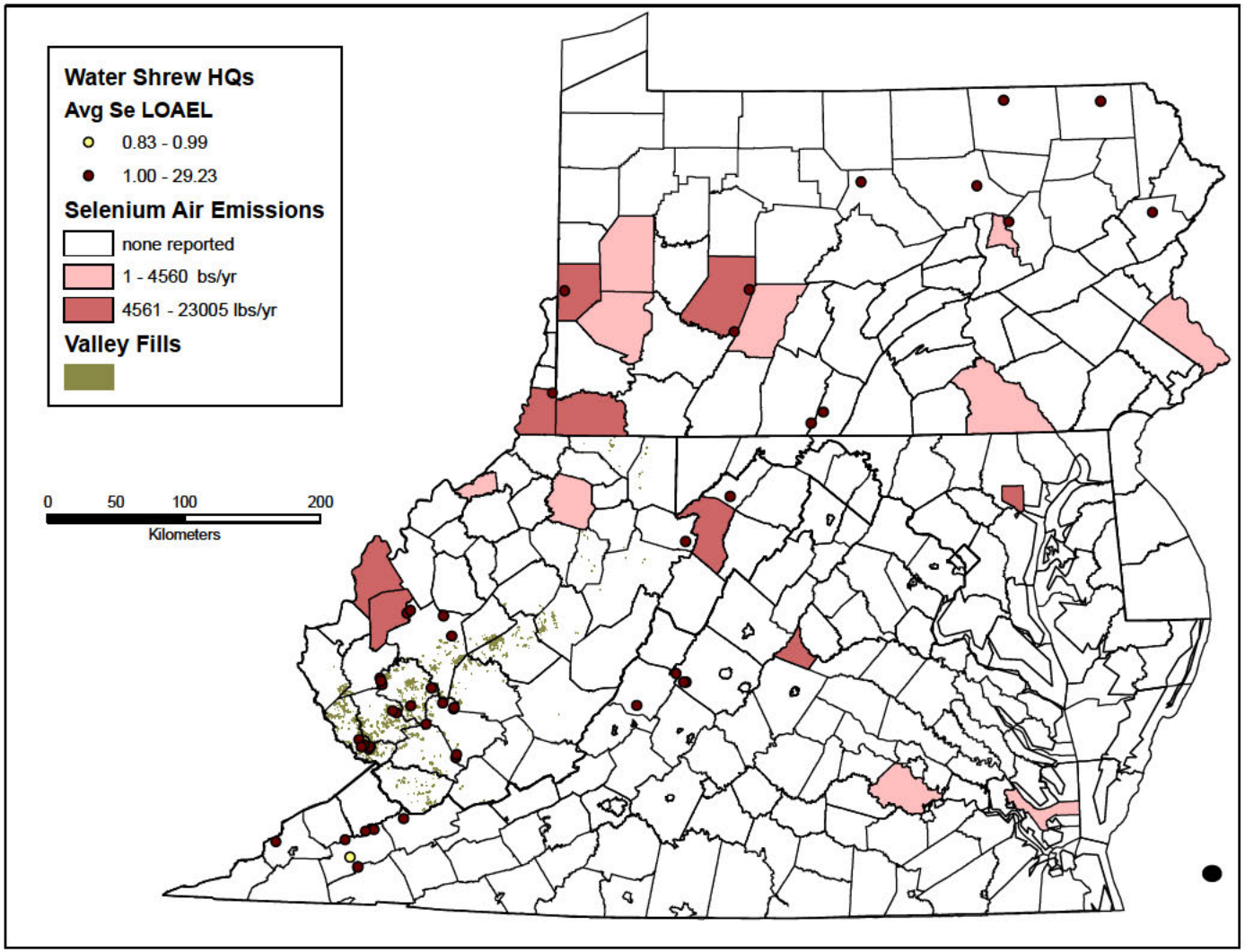


Figure 13. Water shrew selenium hazard quotients (HQs) based on average salamander concentrations and lowest observable effect level relative to potential selenium sources. Note – valley fills are not depicted for Virginia sites and water shrew not documented in southwest West Virginia counties.

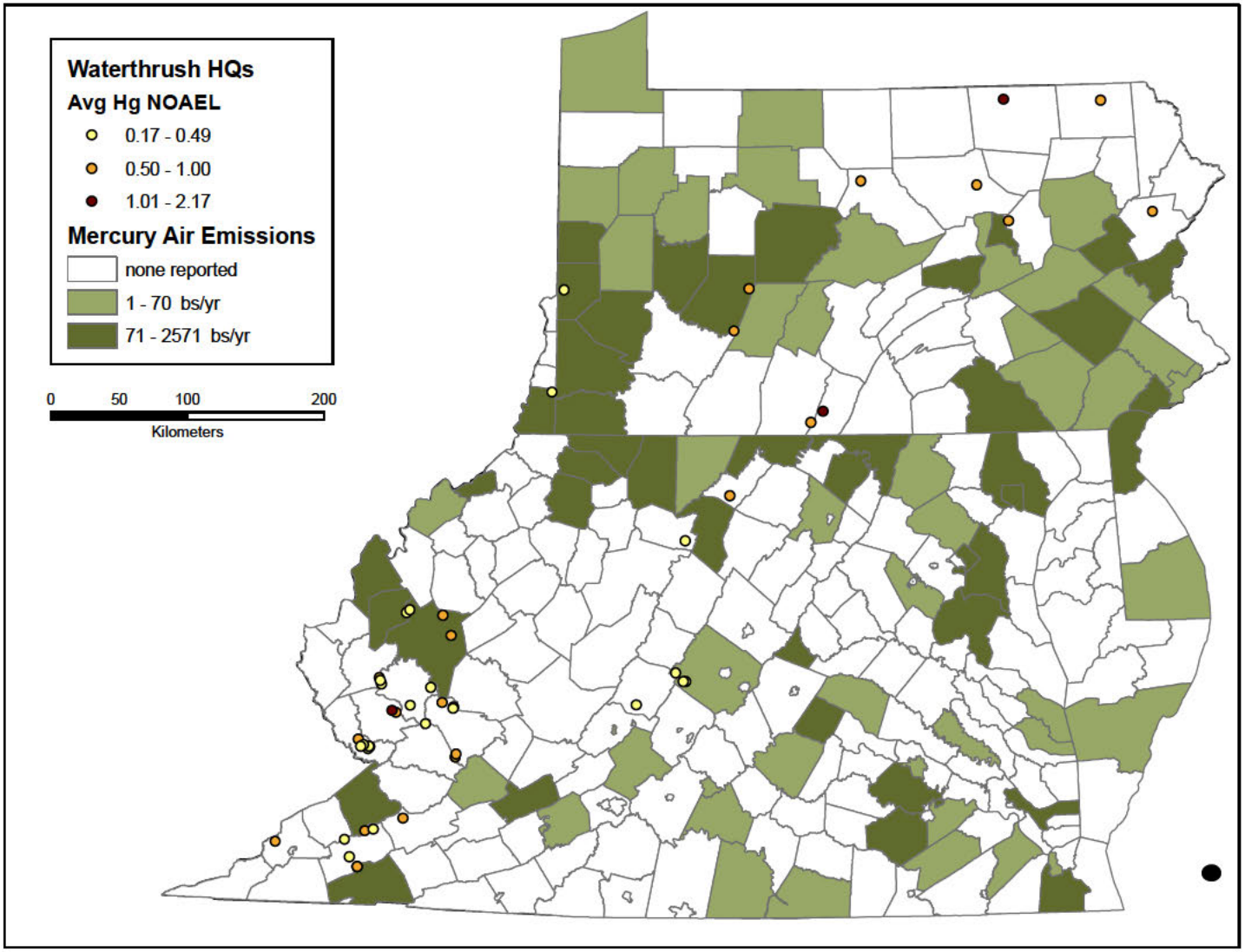


Figure 14. Waterthrush mercury hazard quotients (HQs) based on average salamander concentrations and highest no observable effect toxicity values relative to potential mercury sources.

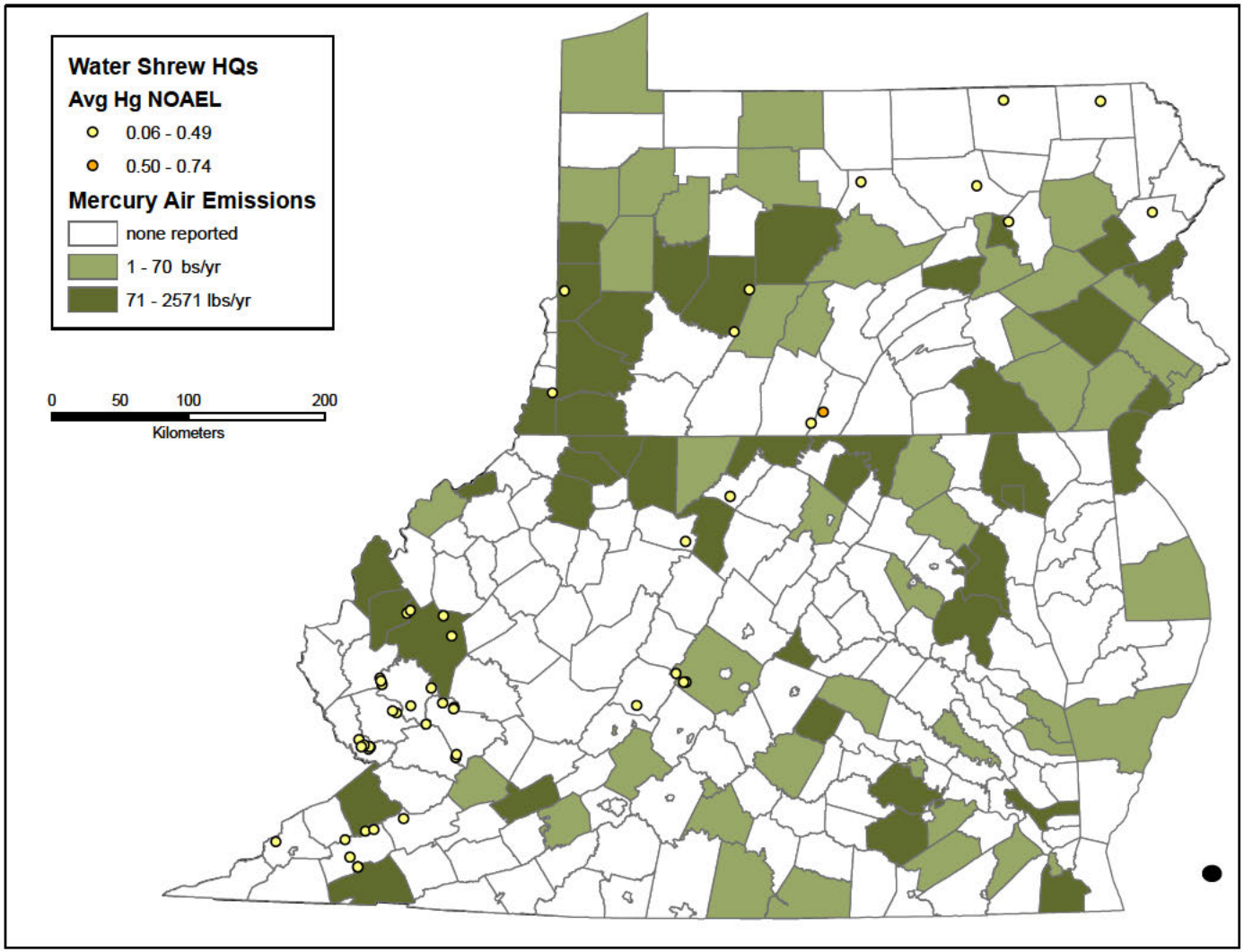
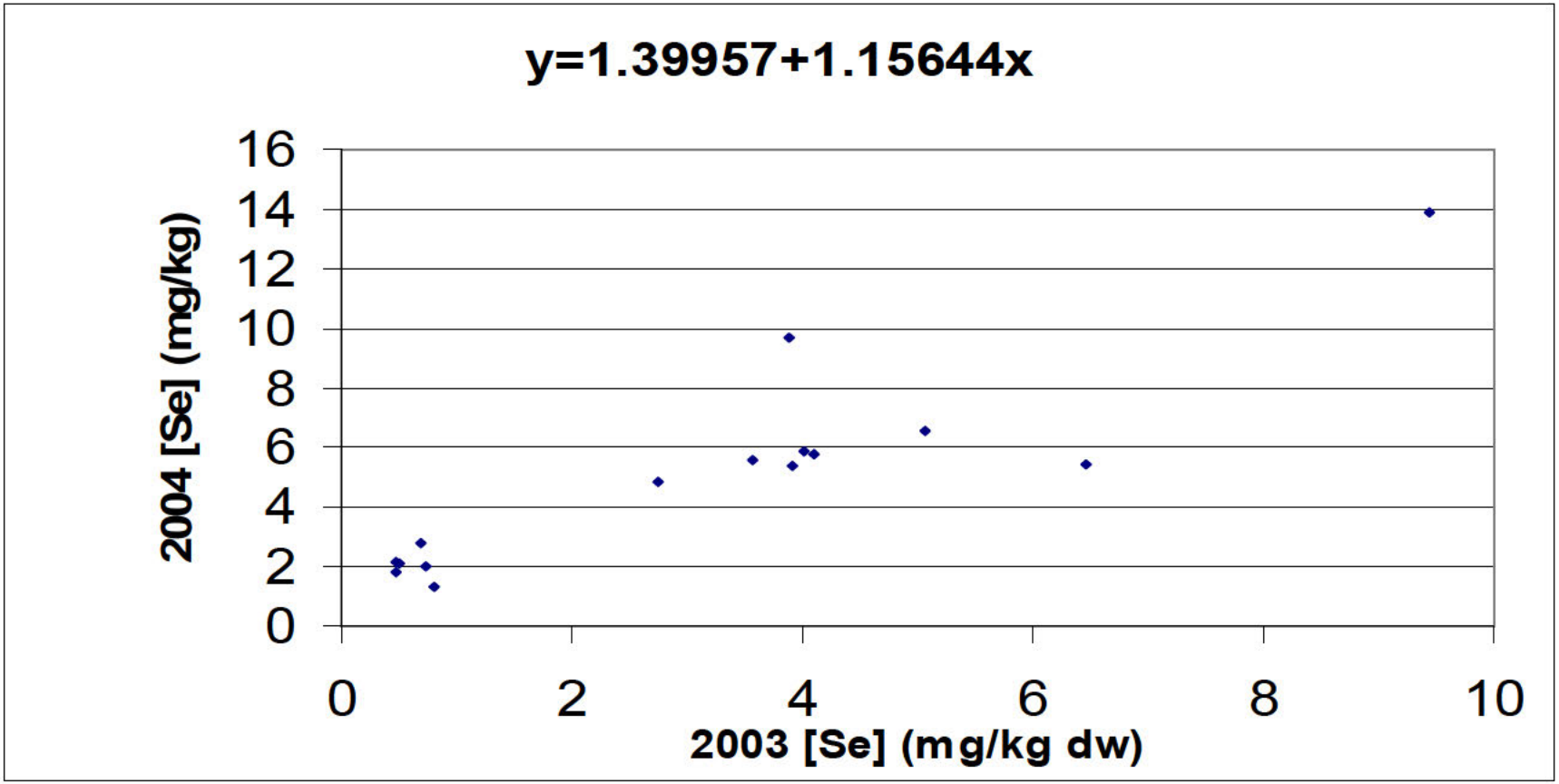


Figure 15. Water shrew mercury hazard quotients (HQs) based on average salamander concentrations and highest no observable effect toxicity values relative to potential mercury sources. Note – water shrew not documented in southwest West Virginia counties.

APPENDICES

Appendix A: Relationship between duplicate samples from laboratories used in 2003 and 2004. Regression equation used to correct for differences between the 2004 (x) and the 2003 (y) samples.



Appendix A. Linear Regression Summary Output

Regression Statistics	
Multiple R	0.897101368
R Square	0.804790864
Adjusted R Square	0.789774777
Standard Error	1.547922028
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	128.4175595	128.4176	53.59524	5.82427E-06
Residual	13	31.14881388	2.396063		
Total	14	159.5663733			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.399571338	0.635351962	2.202828	0.046257	0.026977138	2.77216554	0.026977138	2.772165538
X Variable 1	1.156438735	0.157964503	7.320877	5.82E-06	0.815177241	1.49770023	0.815177241	1.49770023

Appendix B: Analytes, tissue composite concentrations, and detection limits.

Available electronically upon request from:

Kathleen Patnode
U.S. Fish and Wildlife Service
c/o U.S. EPA
1060 Chapline St Suite 303
Wheeling WV 26003-2995
kathleen_patnode@fws.gov

Christopher Hunter/DC/USEPA/US
01/07/2011 01:57 PM

To Kevin Minoli
cc Matthew Klasen
bcc
Subject Re: Can one of you please email me the outline you guys used with Pete and Bob? Thanks!

Here's the agenda and table of contents for the briefings

1-04-11 Briefing Agenda.docx TABLE OF CONTENTS.docx

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

Kevin Minoli 01/07/2011 01:55:02 PM

From: Kevin Minoli/DC/USEPA/US
To: Christopher Hunter/DC/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA
Date: 01/07/2011 01:55 PM
Subject: Can one of you please email me the outline you guys used with Pete and Bob? Thanks!

Spruce No. 1 Mine 404(c) Final Determination

January 4, 2011 Briefing Agenda

1. Description of FD Package and Status (5 minutes) – OWOW

2. FD Summary: Findings and Major Arguments (15 minutes)

    - Handout – Executive Summary – OWOW

    - Major Comments and Responses – OW

3. Likely Opposing Arguments and Reactions (10 minutes) – OW

4. Schedule for Release of Final Determination and Next Steps (10 minutes) – OWOW

    - Receive all final comments: Jan. 6 COB
    - Final document completed: Jan. 10 COB
    - OGC concurrence: Jan. 10
    - AAOW signature and release: Jan. 11

5. Questions (20 minutes)

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Appendix 3 – Mitigation

Appendix 4 – Selenium

Appendix 5 – Cumulative Effects

Appendix 6 – Response to Comments

Appendix 7 – References

John Pomponio/R3/USEPA/US
01/07/2011 02:24 PM

To Shawn Garvin, William Early
cc Jeffrey Lapp, John Forren, Stefania Shamet
bcc
Subject Spruce final determination

Shawn, Bill,

Stef just stopped by. According to her intel the Spruce final determination will be sent out Thursday, Jan. 13.. I believe the extra two days are to allow more complete notifications.
If you've heard the same please let me know. I will try to confirm with HQ.

John R. (Randy) Pomponio, Director
Environmental Assessment & Innovation Division
U.S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103

(215) 814-2702
pomponio.john@epa.gov

Marcel Tchaou/DC/USEPA/US
01/10/2011 02:42 PM

To Stefania Shamet
cc Carrie Traver, Jeffrey Lapp, Christopher Hunter
bcc
Subject Re: Because a day without yet MORE refrences for Spruce would be like a day w/o sunshine ....

Thanks Stefania. There is s reference mismatch that must be corrected. Indeed the text makes a reference to Neuzil et al., however the reference list refers to the Author by her first name Sandra. A reader may not be able to find that reference.
Thanks

****
Marcel K. Tchaou, Ph.D., P.E., P.H.
Environmental Engineer
Wetlands & Aquatic Resources Regulatory Branch
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1200 Pennsylvania Avenue, NW (MC 4502T)
Washington, DC 20460
202-566-1904

Stefania Shamet ----- Forwarded by Stefania Shamet/R3/USEPA/... 01/10/2011 02:32:09 PM

From: Stefania Shamet/R3/USEPA/US
To: Marcel Tchaou/DC/USEPA/US@EPA, Carrie Traver/R3/USEPA/US@EPA
Date: 01/10/2011 02:32 PM
Subject: Because a day without yet MORE refrences for Spruce would be like a day w/o sunshine ....

----- Forwarded by Stefania Shamet/R3/USEPA/US on 01/10/2011 02:30 PM -----

From: David Kargbo/R3/USEPA/US
To: Jeffrey Lapp/R3/USEPA/US@EPA
Cc: Christopher Hunter/DC/USEPA/US@EPA, Dave Campbell/R3/USEPA/US@EPA, David Rider/R3/USEPA/US@EPA, Frank Borsuk/R3/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA, Stephen Field/R3/USEPA/US@EPA, John Pomponio/R3/USEPA/US@EPA
Date: 01/06/2011 06:24 PM
Subject: Comments on materials handling Plan for Spruce

Jeff;

Per your request, please see my comments on the materials handling Plan for Spruce. The referenced articles are attached.

Tomorrow id my compress day but I'll be checking my email if you need any additional help.

Dave.

[attachment "Comments on MHP_Kargbo.doc" deleted by Marcel Tchaou/DC/USEPA/US] [attachment "01 Bevans et al, Prediction & Treatment.tif" deleted by Marcel Tchaou/DC/USEPA/US] [attachment "03 Spatial Trends.pdf" deleted by Marcel Tchaou/DC/USEPA/US]

[attachment "04 Selenium Concentrations in Middle PA Coal Beds.pdf" deleted by Marcel Tchaou/DC/USEPA/US] [attachment "05 Se speciation in soils after alkaline extraction.pdf" deleted by Marcel Tchaou/DC/USEPA/US] [attachment "06 USEPA 1992_Behavior of metals in soils.pdf" deleted by Marcel Tchaou/DC/USEPA/US]
[attachment "07 Vesper_Se Location and Mode of Occurrence.pdf" deleted by Marcel Tchaou/DC/USEPA/US] [attachment "08 WV_selenium_plan.pdf" deleted by Marcel Tchaou/DC/USEPA/US]

David M. Kargbo, PhD
Office of Environmental Innovation
Environmental Assessment and Innovation Division
USEPA Region 3
1650 Arch Street
Philadelphia, PA 19103
Tel: 215 814-3319 / E-mail: kargbo.david@epa.gov

Matthew Klasen/DC/USEPA/US
01/11/2011 06:59 PM

To Christopher Hunter
cc
bcc
Subject Re: drafts

OK thanks. If it turns out there are page number references, I'll flag them for tomorrow.

Can you send me updated drafts when you're done with them for the night? Once I incorporate Kevin's edits, I'm planning to go through the RD comments question by question for references, and my plan is to hand those off to Stef before I go to sleep (likely around the time Stef starts working). So hopefully the two of us can get through at least half of the reference checking and proofreading tonight; maybe more.

And I'll look for the reference appendix from Marcel, too.

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Christopher Hunter | As long as you keep references to section numb... | 01/11/2011 06:55:59 PM

From: Christopher Hunter/DC/USEPA/US
To: Matthew Klasen/DC/USEPA/US@EPA
Date: 01/11/2011 06:55 PM
Subject: drafts

As long as you keep references to section numbers and not page numbers, these should be good
[attachment "Appendix 1 Water Quality & Widlife 011111.doc" deleted by Matthew Klasen/DC/USEPA/US] [attachment "Appendix 2 macroinvertebrates 011111.doc" deleted by Matthew Klasen/DC/USEPA/US] [attachment "Appendix 3 Mitigation 011111.doc" deleted by Matthew Klasen/DC/USEPA/US] [attachment "Appendix 4 Selenium 011111.doc" deleted by Matthew Klasen/DC/USEPA/US] [attachment "Appendix 5 Cumulative Effects 011111.docx" deleted by Matthew Klasen/DC/USEPA/US] [attachment "Spruce FD 011111 clean.docx" deleted by Matthew Klasen/DC/USEPA/US]

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

Christopher Hunter/DC/USEPA/US
01/12/2011 08:23 AM

To Marcel Tchaou
cc
bcc
Subject Fw: Spruce DMRs -- not sure these made it into the admin record

Marcel, these will need to be added.

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

----- Forwarded by Christopher Hunter/DC/USEPA/US on 01/12/2011 08:23 AM -----

From: Stefania Shamet/R3/USEPA/US
To: Christopher Hunter/DC/USEPA/US@EPA
Cc: Matthew Klasen/DC/USEPA/US@EPA, Marcel Tchaou/DC/USEPA/US@EPA
Date: 01/12/2011 04:05 AM
Subject: Spruce DMRs -- not sure these made it into the admin record

Chris -- just occurred to me that the new DMRs probably didn't make it into the admin. record. Not sure whether you are handling that or Marcel. Here's the electronic copy -- Can be titled "Discharge Monitoring Reports NPDES Permit No. WV1017021 April 2010-September 2010"

----- Forwarded by Stefania Shamet/R3/USEPA/US on 01/12/2011 04:02 AM -----

From: David Rider/R3/USEPA/US
To: Stefania Shamet/R3/USEPA/US@EPA
Cc: Frank Borsuk/R3/USEPA/US@EPA
Date: 01/11/2011 06:47 AM
Subject: Fw: DMR Request for WVNPDES WV1017021

Stef,

Here are the DMRs. They are also on paper in my cube. I thought they would be on the desk. Perhaps in an in-box?

Dave

----- Forwarded by David Rider/R3/USEPA/US on 01/11/2011 06:47 AM -----

From: "Dorsey, Angela H" <Angela.H.Dorsey@wv.gov>
To: David Rider/R3/USEPA/US@EPA
Date: 12/29/2010 05:09 PM
Subject: DMR Request for WVNPDES WV1017021

Mr. Rider,

I have also printed these, so if you need hard copies please let me know.

Angela Dorsey Rider request WV1017021.xls

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WV1017021	UWOB	1/31/2010 00:00:00	NORML	01045
WV1017021	UWOB	2/28/2010 00:00:00	NORML	01045
WV1017021	UWOB	3/31/2010 00:00:00	NORML	01045
WV1017021	UWOB	4/30/2010 00:00:00	NORML	01045
WV1017021	UWOB	5/31/2010 00:00:00	NORML	01045
WV1017021	UWOB	6/30/2010 00:00:00	NORML	01045
WV1017021	UWOB	7/31/2010 00:00:00	NORML	01045
WV1017021	UWOB	8/31/2010 00:00:00	NORML	01045
WV1017021	UWOB	1/31/2010 00:00:00	NORML	01055
WV1017021	UWOB	2/28/2010 00:00:00	NORML	01055
WV1017021	UWOB	3/31/2010 00:00:00	NORML	01055
WV1017021	UWOB	4/30/2010 00:00:00	NORML	01055
WV1017021	UWOB	5/31/2010 00:00:00	NORML	01055
WV1017021	UWOB	6/30/2010 00:00:00	NORML	01055
WV1017021	UWOB	7/31/2010 00:00:00	NORML	01055
WV1017021	UWOB	8/31/2010 00:00:00	NORML	01055
WV1017021	UWOB	1/31/2010 00:00:00	NORML	01105
WV1017021	UWOB	2/28/2010 00:00:00	NORML	01105
WV1017021	UWOB	3/31/2010 00:00:00	NORML	01105
WV1017021	UWOB	4/30/2010 00:00:00	NORML	01105
WV1017021	UWOB	5/31/2010 00:00:00	NORML	01105

WV1017021	UWOB	6/30/2010 00:00:00	NORML	01105
WV1017021	UWOB	7/31/2010 00:00:00	NORML	01105
WV1017021	UWOB	8/31/2010 00:00:00	NORML	01105
WV1017021	UWOB	1/31/2010 00:00:00	NORML	01106
WV1017021	UWOB	2/28/2010 00:00:00	NORML	01106
WV1017021	UWOB	3/31/2010 00:00:00	NORML	01106
WV1017021	UWOB	4/30/2010 00:00:00	NORML	01106
WV1017021	UWOB	5/31/2010 00:00:00	NORML	01106
WV1017021	UWOB	6/30/2010 00:00:00	NORML	01106
WV1017021	UWOB	7/31/2010 00:00:00	NORML	01106
WV1017021	UWOB	8/31/2010 00:00:00	NORML	01106

quantity_minimum	quantity_minimum_mdl	quantity_average	quantity_average_mdl	quantity_maximum

637.000	796.000	955.000
575.000	662.500	750.000
665.000	713.500	762.000
277.000	408.500	540.000
195.000	644.500	1094.000
150.000	210.500	271.000
	350	927
	233.25	468
	32.29	88

0.880	1.739	2.598
1.913	2.133	2.352
0.614	1.323	2.032
0.401	0.775	1.149
0.407	0.610	0.813
0.352	0.481	0.610
	0.149	0.213
	0.252	0.256
	0.092	0.153

3.393	4.081	4.768
1.664	1.760	1.856
0.848	1.524	2.199
1.154	1.372	1.590
1.073	1.344	1.615
0.612	1.472	2.332
	0.812	0.931
	0.554	0.811
	0.365	0.539

6.403 6.921 7.439

3.868	3.868	3.868
3.449	4.603	5.757
0.512	2.322	4.131
2.627	5.110	7.593
1.176	3.393	5.610
	2.434	2.896
	1.651	1.762
	0.344	0.358

60.294	64.897	69.500
17.807	20.916	24.024
19.191	29.841	40.490
16.334	21.681	27.027
18.959	21.660	24.360
6.143	16.320	26.497
	18.9045	21.392
	5.4065	5.586
	3.748	3.959

4.979	12.720	20.461
10.846	13.183	15.519
11.934	12.337	12.740
6.082	8.809	11.535
12.782	15.526	18.270
4.768	5.854	6.940
	7.915	7.954
	5.170	6.272
	2.213	2.339

5.416	5.648	5.880
0.929	3.333	5.737
1.069	1.704	2.339
0.670	1.383	2.096
2.883	3.889	4.895
0.893	1.164	1.434
	0.973	1.343
	0.515	0.548
	0.247	0.365

1.127	10.364	19.601
7.473	10.401	13.328
6.270	7.410	8.549
2.687	3.833	4.979
4.913	5.107	5.300
2.130	3.610	5.089
	4.5815	5.565
	2.554	2.914
	1.708	1.735

0.487	1.478	2.468
1.172	1.972	2.771
0.699	0.961	1.223
0.436	0.880	1.323
0.659	1.715	2.771
0.249	0.428	0.606
	0.679	0.891
	0.3885	0.539

quantity_maximum_mdl	quantity_code	concentration_minimum	concentration_minimum_mdl

78
78
78
78
78
78
78
78
78
7.70
8.40

7.40	
7.10	
8.30	
7.80	
8.3	
7.8	
8.1	
2	
2	
3	
2	<
13	
4	
4	
4	
2	
0.1	<
0.2	<
0.2	<
3.40	
3.80	
4.70	
3.80	
4.70	
11.40	
6.4	
4.8	
4.8	
0.36	
0.25	
0.27	
0.21	
0.27	
0.20	
0.14	
0.19	
0.18	
0.36	
0.49	
0.40	
0.41	
0.32	
0.53	
0.38	
0.26	

0.52	
0.14	
0.06	
0.07	
0.05	
0.09	
0.05	
0.13	
0.05	
0.05	
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<

08		
08		
08		
08		
08		
08		
08		
08		
08		
	7.00	
	6.40	
	6.30	
	7.50	
	7.70	
	6.30	
	8.2	
	7.9	
	7.7	
	0.60	<
	0.60	<
	0.60	<
	0.60	<
	0.60	<
	0.60	<
	.6	<
	.6	<
	.6	<
	0.10	
	0.15	
	0.13	
	0.09	
	0.07	
	0.12	
	0.12	
	0.10	
	0.05	
	0.01	<

	0.01	<
	0.01	
	0.01	<
	0.01	<
	0.01	<
	0.01	<
	0.01	<
	0.01	<
	0.10	
	0.15	
	0.25	
	0.05	
	0.05	<
	0.05	<
	0.05	<
	0.05	
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
08		
08		
08		
08		
08		
08		
08		
08		
08		
	7.90	
	7.10	
	7.30	
	7.00	
	7.60	
	7.30	
	7.4	
	7.7	
	7.8	
	0.60	<

0.60	<
0.60	<
0.60	<
0.60	<
0.60	<
.8	
1.2	
1.0	
0.14	
0.06	
0.06	
0.09	
0.06	
0.12	
0.14	
0.11	
0.05	<
0.01	<
0.01	<
0.01	<
0.01	<
0.01	<
0.01	<
0.01	<
0.01	
0.01	<
0.14	
0.07	
0.05	
0.05	<
0.05	<
0.05	<
0.06	
0.06	
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<

08		
08		
08		
08		
08		
08		
08		
08		
	7.80	
	7.40	
	7.10	
	7.30	
	7.90	
	7.00	
	8.0	
	8.0	
	7.7	
	0.80	
	0.80	
	0.60	
	0.70	
	2.30	
	0.60	<
	2.1	
	2.2	
	.6	<
	0.22	
	0.14	
	0.15	
	0.17	
	0.12	
	0.16	
	0.18	
	0.20	
	0.15	
	0.09	
	0.14	
	0.13	
	0.14	
	0.11	
	0.17	
	0.17	
	0.22	
	0.30	
	0.17	

	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
08		
08		
08		
08		
08		
08		
08		
08		
08		
	7.80	
	7.50	
	7.40	
	7.40	
	8.00	
	7.90	
	8.3	
	8.2	
	8.2	
	1.10	
	1.00	
	1.00	
	0.60	
	2.00	
	0.60	<
	2.0	
	1.4	
	.6	<
	0.24	

	0.12	
	0.15	
	0.16	
	0.13	
	0.21	
	0.17	
	0.15	
	0.10	
	0.07	
	0.10	
	0.01	
	0.12	
	0.09	
	0.11	
	0.09	
	0.10	
	0.07	
	0.19	
	0.05	
	0.08	
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
08		
08		
08		
08		
08		
08		
08		
08		
08		
	7.00	

7.30	
7.20	
7.80	
7.30	
8.10	
8.0	
7.9	
7.0	
2.10	
3.20	
4.70	
4.20	
5.20	
8.40	
6.2	
6.8	
6.1	
0.35	
0.39	
0.42	
0.38	
0.43	
0.51	
0.26	
0.32	
0.35	
0.05	
0.04	
0.05	
0.05	
0.05	
0.07	
0.06	
0.06	
0.12	
0.30	
0.33	
0.31	
0.28	
0.34	
0.21	
0.19	
0.15	
0.13	
0.05	<

	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
08		
08		
08		
08		
08		
08		
08		
08		
08		
	8.00	
	8.00	
	7.40	
	6.90	
	8.10	
	7.70	
	8.1	
	7.8	
	6.5	
	0.60	<
	0.60	<
	0.60	<
	0.70	
	0.60	<
	0.60	<
	.6	<
	.6	<
	.6	<
	0.09	
	0.05	<
	0.07	
	0.05	<
	0.09	
	0.05	
	0.05	
	0.05	<
	0.05	<
	0.01	<

	0.01	<
	0.01	
	0.01	<
	0.01	<
	0.01	<
	0.01	<
	0.01	<
	0.01	<
	0.08	
	0.05	<
	0.05	<
	0.05	<
	0.05	
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
	0.05	<
08		
08		
08		
08		
08		
08		
08		
08		
08		
	7.00	
	7.60	
	7.80	
	7.80	
	7.50	
	8.00	
	7.8	
	7.8	
	7.1	
	2.20	

3.60	
0.60	<
7.20	
5.50	
8.40	
.6	<
6.7	
6.8	
0.33	
0.46	
0.10	
0.43	
0.49	
0.66	
0.30	
0.37	
0.57	
0.04	
0.04	
0.01	
0.05	
0.04	
0.06	
0.06	
0.06	
0.13	
0.30	
0.40	
0.10	
0.29	
0.32	
0.27	
0.27	
0.16	
0.18	
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.06	
0.05	<
0.05	
0.05	<

08		
08		
08		
08		
08		
08		
08		
08		
	7.10	
	7.70	
	7.90	
	8.00	
	7.80	
	7.50	
	8.1	
	7.9	
	0.60	<
	0.60	<
	0.60	<
	0.60	<
	0.60	<
	0.60	<
	.6	<
	.6	<
	0.05	<
	0.07	
	0.08	
	0.05	<
	0.27	
	0.07	
	0.13	
	0.09	
	0.01	<
	0.01	<
	0.01	
	0.01	<
	0.04	
	0.02	
	0.04	
	0.02	
	0.05	<
	0.06	
	0.25	
	0.05	<
	0.41	

0.05	<
0.05	
0.07	
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<
0.05	<

concentration_average	concentration_average_mdl	concentration_maximum

7.85	8.00
8.45	8.50

7.90		8.40
7.65		8.20
8.30		8.30
8.00		8.20
8.4		8.7
8.2		8.4
8.3		8.5
12		21
4		6
8		13
1.5		3
17		20
10		15
4		5
11		19
4		6
0.1	<	0.1
0.2	<	0.2
0.2	<	0.2
3.80		4.20
4.50		5.20
6.10		7.50
4.40		5.00
7.60		10.50
11.50		11.60
8.5		10.4
10.65		14.8
9.4		11.0
0.38		0.39
0.27		0.29
0.36		0.45
0.26		0.30
0.27		0.27
0.26		0.31
0.20		0.24
0.20		0.22
0.21		0.24
0.36		0.36
0.54		0.58
0.55		0.69
0.52		0.63
0.33		0.33
0.56		0.59
0.48		0.60
0.49		0.59

0.56		0.60
0.15		0.15
0.07		0.07
0.12		0.17
0.05		0.05
0.11		0.12
0.07		0.08
0.23		0.40
0.16		0.33
0.07		0.08
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.02		0.06
0.04		0.09
0.05	<	0.05

7.50		8.00
7.55		8.70
7.35		8.40
7.55		7.60
7.90		8.10
7.30		8.30
8.2		8.2
8.0		8.1
7.8		7.9
0.60	<	0.60
0.60	<	0.60
0.60	<	0.60
0.60	<	0.60
0.60	<	0.60
0.60	<	0.60
.6	<	.6
.6	<	.6
.6	<	.6
0.16		0.21
0.17		0.18
0.22		0.30
0.13		0.16
0.08		0.09
0.18		0.23
0.16		0.20
0.14		0.18
0.08		0.10
0.01	<	0.01

0.01	<	0.01
0.01		0.01
0.01	<	0.01
0.01	<	0.01
0.01	<	0.01
0.01	<	0.01
0.01	<	0.01
0.01	<	0.01
0.16		0.21
0.16		0.17
0.42		0.59
0.09		0.12
0.05	<	0.05
0.07		0.13
0.06		0.11
0.07		0.09
0.03		0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05

7.90		7.90
7.90		8.70
7.70		8.10
7.55		8.10
7.95		8.30
7.75		8.20
7.7		8.0
7.9		8.1
7.8		7.8
0.60	<	0.60

0.60	<	0.60
0.60	<	0.60
0.60	<	0.60
0.60	<	0.60
0.60	<	0.60
2.7		4.6
2.6		4.0
1.4		1.7
0.21		0.28
0.08		0.09
0.17		0.28
0.14		0.18
0.08		0.09
0.42		0.71
0.18		0.21
0.12		0.13
0.44		0.88
0.01	<	0.01
0.01	<	0.01
0.01		0.01
0.01	<	0.01
0.01	<	0.01
0.02		0.03
0.01		0.01
0.01		0.01
0.01		0.02
0.23		0.31
0.10		0.12
0.14		0.22
0.07		0.13
0.05	<	0.05
0.23		0.46
0.10		0.13
0.11		0.15
0.03		0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05

7.90	8.00
7.40	7.40
7.35	7.60
7.55	7.80
8.30	8.70
7.60	8.20
8.1	8.1
8.0	8.0
7.8	7.8
1.10	1.40
0.80	0.80
0.90	1.20
1.05	1.40
2.85	3.40
1.50	3.00
2.2	2.2
2.7	3.2
.6	1.2
0.25	0.28
0.14	0.14
0.21	0.26
0.17	0.17
0.14	0.16
0.35	0.54
0.19	0.19
0.20	0.20
0.25	0.35
0.14	0.18
0.14	0.14
0.14	0.15
0.15	0.16
0.13	0.14
0.17	0.17
0.18	0.18
0.23	0.23
0.34	0.38
0.17	0.17

0.05	<	0.05
0.05		0.09
0.05	<	0.05
0.05		0.10
0.06		0.11
0.05	<	0.05
0.04		0.07
0.07		0.13
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.03		0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05
0.05	<	0.05

8.10	8.40
8.10	8.70
7.85	8.30
7.70	8.00
8.30	8.60
8.10	8.30
8.4	8.5
8.3	8.3
8.3	8.3
1.10	1.10
1.10	1.20
1.40	1.80
0.90	1.20
2.50	3.00
1.40	2.80
2.1	2.1
2.1	2.7
.6 <	.6
0.28	0.32

0.14		0.15
0.16		0.17
0.17		0.17
0.14		0.15
0.33		0.45
0.18		0.18
0.33		0.51
0.11		0.12
0.09		0.10
0.12		0.13
0.08		0.15
0.13		0.13
0.10		0.10
0.11		0.11
0.10		0.10
0.10		0.10
0.08		0.09
0.21		0.22
0.06		0.07
0.16		0.24
0.05	<	0.05
0.04		0.08
0.06		0.12
0.05		0.09
0.03		0.05
0.05	<	0.05
0.05	<	0.05
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0.05	<	0.05
0.03		0.05
0.05	<	0.05
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0.05	<	0.05
0.05	<	0.05

7.45	7.90

7.80		8.30
7.55		7.90
7.80		7.80
7.65		8.00
8.10		8.10
8.2		8.3
7.9		7.9
7.3		7.6
3.90		5.70
3.75		4.30
5.20		5.70
5.50		6.80
5.20		5.20
9.70		11.00
9.5		12.7
10.1		13.4
6.3		6.4
0.60		0.85
0.42		0.45
0.52		0.61
0.51		0.64
0.45		0.46
0.52		0.53
0.51		0.76
0.35		0.37
0.39		0.42
0.06		0.07
0.04		0.04
0.05		0.05
0.07		0.08
0.05		0.05
0.08		0.09
0.07		0.07
0.08		0.09
0.16		0.20
0.58		0.86
0.38		0.42
0.43		0.54
0.59		0.90
0.36		0.38
0.24		0.26
0.28		0.37
0.18		0.20
0.14		0.14
0.05	<	0.05

0.05	<	0.05
0.03		0.06
0.04		0.07
0.04		0.05
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0.03		0.06
0.03		0.05
0.05	<	0.05

8.15		8.30
8.20		8.40
7.90		8.40
7.40		7.90
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7.85		8.00
8.1		8.1
8.0		8.2
7.4		8.2
0.60	<	0.60
0.60	<	0.60
0.30		0.60
0.80		0.90
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7.85	8.70
8.00	8.40
7.95	8.10
7.95	8.10
7.75	8.00
8.05	8.10
8.0	8.2
7.9	7.9
7.2	7.3
4.45	6.70

4.20		4.80
3.10		6.20
10.60		14.00
5.75		6.00
9.85		11.30
6.5		12.9
10.9		15.1
7.1		7.4
0.46		0.58
0.52		0.57
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0.68		0.69
0.58		0.86
0.42		0.47
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3.04		6.08
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Julia McCarthy/R8/USEPA/US	To	Marcel Tchaou, Matthew Klasen
01/12/2011 10:12 AM	cc	
	bcc	
	Subject	Re: Fw: Instructions and attachments for reviews 30 questions at a time

Marcel and Matt,
There are two missing references, one that may be referenced incorrectly and two references to add to Appendix 7:
1) Two missing references: Serne (2007) Napier and Snyder (2002)

Second, **Serne (2007)** provided a comparison of recommended Kd values from his research to past tabulations for non-groundwater scenarios. Serne's research focused on Kd values for agricultural and surface soils for use in Hanford site farm, residential, and river shoreline scenarios. Serne's report showed that the Kd values for Se can range from 3-30 L/Kg. The author compared this data to previous work by **Napier and Snyder (2002)** that reported Se Kd range of -3.4 to 0.78.

2) I think this one is referenced incorrectly, because there is a similar reference (Vesper et al. 2008) in Appendix 7. If it's referenced correctly, we need to add the reference... (Vesper & Rhoads, 2008)

Also, extraction data indicates that both organic and sulfide principal component analysis (PCA) show no single trend for Se **(Vesper & Rhoads, 2008)**.

Here's the ref from Appendix 7:
Vesper, D.J., Roy, M., & Rhoads, C. L. (2008). Selenium distribution and mode of occurrence in the Kanawha Formation, southern West Virginia, U.S.A. *International Journal of Coal Geology, 73*, 237-249.

3) The following references need to be added to Appendix 7:

U.S. EPA. (1991). Technical Support Document for Water Quality-based Toxics Control. *EPA/505/2-90-001. Washington, D.C.*

National Drought Mitigation Center. US Drought Monitor. *http://www.drought.unl.edu/dm/*

Cheers,
Julia

Julia McCarthy
on detail to USEPA Headquarters
Office of Wetlands, Oceans and Watersheds
(202) 566-1660
mccarthy.julia@epa.gov

A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a connection of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity. ~Aldo Leopold

Christopher Hunter	Spruce Team, here are the batches of respons...	01/12/2011 09:36:59 AM

From: Christopher Hunter/DC/USEPA/US
To: Ross Geredien/DC/USEPA/US@EPA, Julia McCarthy/R8/USEPA/US@EPA, Palmer Hough/DC/USEPA/US@EPA
Cc: Marcel Tchaou/DC/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/12/2011 09:36 AM
Subject: Fw: Instructions and attachments for reviews 30 questions at a time

Spruce Team,
here are the batches of responses to comments that need to be checked for references, instructions, and the latest draft of the Reference Appendix. Focus on the references first, then circle back for the cross-references if you have time.

Thanks!

Ross - please take 1-30
Julia - 31-60
Palmer - 61-90

[attachment "Appendix 7 FD Marcel version 1-11-2011Harmonized.doc" deleted by Julia McCarthy/R8/USEPA/US]

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov
----- Forwarded by Christopher Hunter/DC/USEPA/US on 01/12/2011 09:32 AM -----

From: Matthew Klasen/DC/USEPA/US
To: Christopher Hunter/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Cc: Marcel Tchaou/DC/USEPA/US@EPA
Date: 01/12/2011 09:30 AM
Subject: Instructions and attachments for reviews 30 questions at a time

Chris / Stef:

Here are instructions and responses, broken up in 30-question increments. Chris: Why don't you assign the first couple groups of these, and let Stef know; she can then farm out the next batch to R3.

Thanks,
Matt

Instructions: Go through and do the following:

- **Go through the document once and check for citations.** Verify that each citation included in the response is included in the reference list. If it isn't, make a note of the reference (e.g., Silva 2010) and a sentence for context (e.g., Silva (2010) found that birds are important).
- **Send citations that are missing and context (in groups of five, or once you're done going through the whole document, to Marcel, and copy Matt.** Make sure you include the questions # so Matt can make a note in the master document.
- **Once you're done going through citations, then go back through and check to make sure references to FD/RD/PD or Appendices or Figures/Tables are correct. If not, keep a running list and email Matt all of the changes (just note in an email, not in Track Changes).**

Call Matt (202-566-0780) or Chris (202-566-1454) with any questions.

For Distributing to Volunteers
[attachment "121A-150A.docx" deleted by Julia McCarthy/R8/USEPA/US] [attachment "1A-30A.docx" deleted by Julia McCarthy/R8/USEPA/US] [attachment "31A-60A.docx" deleted by Julia McCarthy/R8/USEPA/US] [attachment "61A-90A.docx" deleted by Julia McCarthy/R8/USEPA/US] [attachment "91A-120A.docx" deleted by Julia McCarthy/R8/USEPA/US]

Background Material (Chris: Also send folks the FD and appendices, especially the reference list. Probably too big for one email.

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Julia McCarthy/R8/USEPA/US

01/12/2011 11:44 AM

To Matthew Klasen, Marcel Tchaou

cc

bcc

Subject Re: Fw: Instructions and attachments for reviews 30 questions at a time

Matt and Marcel,
Here are my references issues for 151A-180A:
1) The following citations need to be edited:
151: Remove full references for (Clarke et al. 2008) and (Nakano and Murakami 2001).

154:Cite ORD Conductivity Benchmark Report as (USEPA 2010a) and the recent SAB draft report on the ORD study as (SAB 2010).

176:Cite ORD Conductivity Benchmark Report as (USEPA 2010a)

2) The following reference needs to be added to Appendix 7:

Nakano and Murakami 2001: Reciprocal subsidies: dynamic interdependence between terrestrial and aquatic food webs. *Proceedings of the National Academy of Science* , 98:166-170; Fukui et al. 2006. *Journal of Animal Ecology* 75:1252-1258.

3) The following references are missing:
154: Bernhardt (2010)

WVDEP's recent Valley Fill Study (WVDEP unpublished data 2010a) provides support for many of the conclusions drawn in Pond et al. (2008), as does **Bernhardt (2010).**

156, 178, 180: Timpano et al. 2010

The CH2M Hill report cites **Timpano et al. 2010** that shows conductivity is strongly correlated to component ions, TDS, and biological metrics that VADEQ uses to determine impairment downstream of mined sites that have good physical habitat.

163: Unknown WVDEP Comment response document

In its **response to comments on its 2008 Integrated Report submitted to EPA pursuant to 33 U.S.C. 1313(d)**, WVDEP stated that a shift in the macroinvertebrate population may represent impairment of the waterbody.

4) The following reference needs to be clarified
178: Hawkins 2006 – is it 2006a or 2006b?

In addition, EPA applied an accepted and peer reviewed approach, called an Observed/Expected index (O/E) (**Hawkins 2006**, Van Sickle et al. 2005) to estimate and quantify the taxonomic

changes in streams impacted from mining activities in the Spruce Fork watershed.

Cheers,

Julia

Julia McCarthy
on detail to USEPA Headquarters
Office of Wetlands, Oceans and Watersheds
(202) 566-1660
mccarthy.julia@epa.gov

A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a connection of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity. ~Aldo Leopold

Matthew Klasen/DC/USEPA/US	To	Gregory Peck
01/12/2011 12:25 PM	cc	
	bcc	
	Subject	Fw: NMA Comments on April 1 Guidance

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
cell (202) 380-7229
----- Forwarded by Matthew Klasen/DC/USEPA/US on 01/12/2011 12:25 PM -----

From:	Gregory Peck/DC/USEPA/US
To:	"Matt Klasen" <klasen.matthew@epa.gov>
Cc:	"Kevin Minoli" <minoli.kevin@epa.gov>, "sussman bob" <sussman.bob@epa.gov>
Date:	12/01/2010 06:22 PM
Subject:	Fw: NMA Comments on April 1 Guidance

Gregory E. Peck
Chief of Staff
Office of Water
U.S. E.P.A.

From: "Bennett,Karen" [KBennett@nma.org]
Sent: 12/01/2010 06:20 PM EST
To: OW-Docket
Cc: Gregory Peck
Subject: NMA Comments on April 1 Guidance

Please find attached, comments of the National Mining Association re: EPA-HQ-OW-2010-0315

EPA Detailed Guidance Comments 2010 Final Submitted.pdf

December 1, 2010

Peter S. Silva
Assistant Administrator for Water
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW.,
Washington, DC 20460

Docket ID No. EPA-HQ-OW-2010-0315

RE: Detailed Guidance: Improving EPA Review of Appalachian Surface Coal Mining Operations under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order

Dear Mr. Silva:

On April 1, 2010, Peter S. Silva, Assistant Administrator for the Office of Water, and Cynthia Giles, Assistant Administrator for the Office of Enforcement and Compliance Assistance, released Summary and Detailed Guidance on "Improving EPA Review of Appalachian Surface Coal Mining Operations under the Clean Water Act (CWA), National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898)." These documents intend to "clarify EPA's roles and expectations, in coordinating with our federal and state partners, to assure more consistent, effective, and timely compliance of Appalachian surface coal mining operations with the provisions of the CWA, NEPA, and the E.O. 12898." (Detailed Guidance). However, the Guidance goes far beyond clarification and coordination and arrogates to EPA new powers to supersede the authority of States under the CWA and the Surface Mining Control and Reclamation Act of 1977 (SMCRA), the authority of the U.S. Army Corps of Engineers (Corps) under the CWA and NEPA, the authority of the Office of Surface Mining (OSM) under SMCRA. EPA cannot, through guidance, change the meaning of these statutes or their implementing regulations. Yet, as noted by Randy Huffman, Director of West Virginia's Department of Environmental Protection, in a December 2, 2009, letter to Senator Inhofe, EPA's recent actions on surface mining permits "represent a stark change in regulatory direction," which "has been undertaken in the absence of any change in statute, regulation or formal policy which would necessarily require transparency in

the process." *See* United States Senate Report, *The Mingo Logan Spruce No. 1 Mine*, U.S. Senate Environment and Public Works Committee, Minority Staff Report, January 14, 2010 available at: www.epw.senate.gov/inhofe.

If EPA wishes for statutory changes, it must go to the Office of Management and Budget, develop an Administration legislative proposal, and submit that proposal to Congress. If EPA wishes for regulatory changes, it must go through notice and comment rulemaking. EPA cannot simply declare itself to be the master agency whose decisions trump all others.

The National Mining Association (NMA) submits the following comments on the above-referenced document that was made available for public comment and immediately effective on April 1, 2010. *See* 75 Fed. Reg. 18,500. In addition to these comments, NMA incorporates by reference comments filed with both the EPA and EPA's Science Advisory Panel on Mountaintop Mining regarding EPA's two draft reports, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (EPA 2010); *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields* (EPA 2009). NMA is a national trade association that includes the producers of most of the nation's coal, metals, industrial and agricultural minerals; the manufacturers of mining and mineral processing machinery, equipment and supplies; and the engineers and consulting firms, financial institutions and other firms serving the mining industry. NMA's members have a wide variety of surface coal mining operations, including operations in Central Appalachia, and thus are currently suffering direct and significant harm by EPA's implementation of the Detailed Guidance and associated studies. EPA's actions, immediate application of the Detailed Guidance along with the agency's reliance on hastily done and legally and scientifically flawed studies, has led to irreparable harm to NMA members and resulted in an NMA led industry challenge to the Detailed Guidance and associated studies, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (EPA 2010); *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields* (EPA 2009). *See NMA v. Jackson,* No. 10-cv-1220 (D.D.C. July 20, 2010).

I. EPA's "Detailed Guidance" is a Legislative Rule Requiring Notice and Comment

In announcing the April 1 Guidance, Administrator Jackson said: "this is a sweeping regulatory action" and "you're talking about no, or very few, valley fills that are going to meet this [new] standard." http://www.washingtonpost.com/wpdyn/content/articl/2010/04/01/AR2010040102312.html. According to Jackson, "EPA will now instruct its local offices not to approve new CWA valley-fill permits that are likely to produce a certain level of pollution in waters downstream." *Id.* Jackson's statements have proven correct as very few permits have been issued since. *See* U.S. GOV'T ACCOUNTABILITY

OFFICE GAO-11-101R, EPA AND THE CORPS' REVIEW OF SECTION 404 PERMITS (2010) (reporting 6 permits were issued, 36 were withdrawn and 36 are awaiting EPA's newly created enhanced review). EPA's Guidance amounts to a moratorium on the issuance of coal-related permits accomplished by rewriting the underlying statutory and regulatory permitting framework for coal mining. The Guidance dramatically alters regulatory timelines, imposes new requirements and creates legal presumptions in complete disregard of existing federal law and procedure. In addition, through implementing the Guidance, EPA has interfered with the statutory delegation of regulatory authority over coal mining placing the U.S. army Corps of Engineers (Corps), the Office of Surface Mining Reclamation and Enforcement (OSM), and states as permitting authorities and regulators of the environmental impacts of coal mining. Such substantial changes to these governing regulations and statutory authorities cannot be accomplished without adhering with the notice and comment rulemaking requirements under the Administrative Procedures Act (APA).

II. The Detailed Guidance Exceeds EPA's Authority under the CWA

Under the framework of the CWA, some authorities are granted to the Federal government and others are reserved to the States. And, some authorities may be exercised by the Federal government only if certain predicates are met. This framework provides an appropriate balance between the authority of the States to determine the appropriate level of protection for State resources and the Federal interest in environmental protection generally. EPA's Guidance and EPA's recent actions regarding surface coal mining fail to respect that balance. According to Mr. Huffman, in his December 2, 2009 letter, "EPA has manipulated the Federal CWA 404 permitting process so as to intrude on the State's primacy under SMCRA and its delegated authority under the CWA. I am deeply concerned that the April 1st Guidances represent further intrusion into State authority, again without any change in statue or regulation."

A. Section 101

Under section 101(g) of the CWA, Congress stated that: "It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act." The CWA only regulates the discharge of pollutants from point sources. It does not regulate the flow of water. Notwithstanding this limitation, in the Detailed Guidance, EPA asserts the authority over environmental impacts resulting from reduced water flows. Specifically, EPA appears to be asserting authority over "physical modification and elimination of headwater streams" due to reduced flow. "For example, elimination of all or even part of a headwater stream may remove from the overall watershed system an important source of freshwater dilution that contributes to water quality. Accordingly, even where a National Pollutant Discharge Elimination System (NPDES) permit has been issued, the Section 404

permit must independently ensure that water quality is protected." Detailed Guidance at 20. The Detailed Guidance says "the project" cannot cause a violation of water quality standards. However, the CWA gives Federal agencies the authority to regulate discharges of pollutants into waters of the United States, not projects.

B. Section 401

Section 401(a)(1) of the CWA gives States the authority to determine if an activity that is the subject of a Federal license or permit will meet water quality requirements in that State. EPA has the authority to issue this certification only if no State or interstate agency has the authority to do so. Water pollution control agencies in Kentucky, West Virginia, Virginia, Ohio, Tennessee, and Pennsylvania each have the authority to issue water quality certifications for their States. Under section 401(a)(2), downstream States also may request a public hearing on a Federal license or permit and EPA may make recommendations at that hearing. However, the agency that issues the Federal license or permit is the agency that decides what conditions in the license or permit are appropriate to protect the quality of water in downstream States. Notwithstanding the limits of EPA's authority under section 401(a) of the CWA, the Detailed Guidance States that "EPA retains its responsibility for ensuring that neither numeric nor narrative water quality standards are exceeded due to discharges of fill material even if a State has issued a water quality certification under Section 401 of the CWA." Detailed Guidance, at 18. EPA simply does not have the authority to second guess a State water quality certification and to suggest otherwise as EPA has in its Detailed Guidance is to completely disregard the holding of the Fourth Circuit Court of Appeals in *OVEC v. Aracoma Coal Company*, 556 F.3d 177 (4th Cir. 2009), reh'g & reh'g en banc denied, 567 F.3d 130 (4th Cir. 2009). In *OVEC*, the environmental plaintiffs argued that the Corps has an independent obligation to review claims that mines might violate water quality standards despite the state issued 401 certification. The Fourth Circuit quickly rejected the argument ruling that "A § 401 certification is considered conclusive, and no independent analysis of the certification is required."

C. Section 402

Under section 402(b) of the CWA, Congress established the NPDES permitting program. 33 U.S.C. § 1342. Conforming to the statute's goal of allocating the "primary responsibilities" for water pollution control to the states, the CWA establishes a system whereby a state may assume primary administration and enforcement of the NPDES permitting program. 33 U.S.C. 1342(b). Once EPA approves a proposed state permitting program, EPA must suspend its own program. 33 U.S.C. 1342(c)(1). Under such delegated permitting programs, states have exclusive authority to implement the NPDES program within their boundaries, and EPA has only limited authority to review state action. Once States are authorized to implement the CWA in that State, States develop water quality standards that are approved by EPA and issue permits that implement those standards and its

decisions, particularly its decisions about compliance with State water quality standards are given deference. However, in the Guidance, EPA creates a presumption that "EPA expects that in many, if not most, cases the available science will demonstrate that there is a reasonable potential for these discharges to cause or contribute to an excursion above numeric or narrative water quality standards, thus making water quality-based effluent limits necessary." Detailed Guidance at 8. Such a blanket statement about the need for water quality-based limits ignores the role of the delegated states under Section 402 and the existing protections under the CWA and its implementing regulations prohibiting states from approving any such discharge. Since all of the states subject to EPA's Guidance have delegated authority, the states, not EPA have the duty to determine whether any proposed discharges will cause, or have the reasonable potential to cause, or contribute to an in-stream excursion above a numeric or narrative criteria within an applicable water quality standard. 40 C.F.R. Section 122.44(d).

By asserting the authority to interpret the State narrative water quality standards as requiring conductivity levels between 300 and 500 uS/cm EPA substitutes an authorized State's interpretation of its narrative water quality standards with numeric standards without following the procedures required under CWA Section 303(c). EPA has not taken the steps necessary to make a determination that numeric conductivity standards are necessary in the Appalachian region and EPA has not gone through notice and comment rulemaking to establish numeric Federal standards for conductivity for the Appalachian States. EPA has not followed the required procedures and is therefore acting *ultra vires*.

EPA's conductivity levels of between 300 and 500 uS/cm. These conductivity levels rely heavily on one study of West Virginia streams by EPA Region III (the Pond-Passmore study) and a draft study by EPA's Office of Research and Development (ORD) that has not yet undergone independent, external, peer review. The Guidance requires regulatory agencies and states use these criteria when evaluating whether a discharge has a reasonable potential to violate water quality standards. Detailed Guidance, at 12. EPA Regions are being told to object to permits that do not incorporate these criteria as limits. Detailed Guidance, at 15. EPA also plans to use these criteria when evaluating the potential for a discharge to result in significant degradation of water quality. Detailed Guidance, at 22. EPA calls these criteria "new numeric water quality values for conductivity." Detailed Guidance, at 7. In the public announcement of the April 1st Guidance, Administrator Jackson called the criteria "standards." However, 300 and 500 uS/cm have not been adopted by any Appalachian state as numeric water quality standards.

Even if it were true, and it is not, that EPA could impose on states the agency's interpretation of the states' narrative water quality standards, EPA has not followed its own procedures for developing a chronic aquatic life criteria for conductivity. EPA's newly derived study "*A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*", which forms the basis for establishing a

conductivity range of 300-500 uS/cm, represents a departure from EPA's 1985 *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* ("Guidelines") Charles E. Stephan, et al., USEPA, Office of Research and Development, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049 (1985) and therefore, the benchmark should be set aside until such time as EPA adheres to its own guidelines.

These national guidelines with "appropriate modifications" may be applied to derive criteria for any specific geographic area, "if adequate information is available concerning the effects of the material of concern on appropriate species and their uses." *Id*. at 5. According to the national guidelines, "protection of aquatic organisms and their uses should be defined as prevention of unacceptable long-term and short-term effects on (1) commercially, recreationally, and other important species and (2) (a) fish and benthic invertebrate assemblages in rivers and streams, and (b) fish, benthic invertebrate, and zooplankton assemblages in lakes, reservoirs, estuaries, and oceans." *Id*. at 3.

The national guidelines require certain data to be available "to derive a criterion for freshwater aquatic organisms and their uses," including:

1. **Results of acceptable acute tests** (see Section IV) **with at least one species of freshwater animal in at least eight different families such that all of the following are included**:

    a. the family Salmonidae in the class Osteichthyes

    b. a second family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species (e.g., bluegill, channel catfish, etc.)

    c. a third family in the phylum Chordata (may be in the class Osteichthyes or may be an amphibian, etc.)

    d. a planktonic crustacean (e.g. cladoceran, copepod, etc.)

    e. a benthic crustacean (e.g., ostracod, isopod, amhipod, crayfish, etc.)

    f. an insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge, etc.)

    g. a family in a phylum other than Arthropoda or Chordata (e.g., Rotifiers, Annelida, Mollusca, etc.)

h. a family in any order of insect or any phylum not already represented.

2. **Acute-chronic ratios (see Section VI) with species of aquatic animals in at least three different families provided that of the three species**:

   - at least one is a fish
   - at least one is an invertebrate
   - at least one is an acutely sensitive freshwater species (the other two may be saltwater species).

3. **Results of at least one acceptable test with a freshwater alga or vascular plant** (see Section VIII). If plants are among the aquatic organisms that are most sensitive to the material, results of a test with a plant in another phylum (division) should also be available.

4. **At least one acceptable bioconcentration factor determined with an appropriate freshwater species**, if a maximum permissible tissue concentration is available (see Section IX). *Id.* at 23.

In addition, "if a criterion is to be related to a water quality characteristic … more data will be necessary. Similarly, if all required data are not available, a numerical criterion should not be derived except in special cases." *Id.* at 26. Thus in order to comply with the national guidelines the report should include all necessary data identified in Section IIIB to include data from at least eight different families of aquatic life. *Id*. at 23.

Deviation from U.S. EPA Guidance

A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams ("report") claims, "[t]his benchmark is intended to protect the aquatic life in the region. It is derived by a method modeled on the USEPA's standard methodology for deriving water quality criteria." USEPA, Office of Research and Development, National Center for Environmental Assessment, Washington, DC., *A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*, EPA/600/R-10/023A, (2010). However, this report deviates from the national guidelines in several ways, including,

1. it uses field-based data as opposed to laboratory tests;

2. the methodology for data analysis for the species sensitivity distribution (SSDs) is "extirpation concentrations (XCs) rather than median lethal concentrations (LC_{50}s);" *Id.* at xii.

3. the report only considers the effects of conductivity on certain invertebrate species and then limits its consideration of the confounding factors to only one genera of mayfly, Ephemeroptera. It fails to consider other taxa and does not include the minimum of eight different families of aquatic organisms as required by the national guidelines (such as, fish, mussels, or aquatic plants).

Field data vs. Laboratory data

The national guidelines suggest the use of laboratory data because, "it is not feasible to determine national criteria by conducting such field tests [on a wide variety of unpolluted bodies of fresh (or salt) water]," Charles E. Stephan, et al., USEPA, Office of Research and Development, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049 (1985) at 1. By contrast, the report uses field-based data because, "SSDs based on laboratory studies cannot replicate the full range of effects or species interactions that could reasonably be expected to occur in the environment (Suter et al., 2002)." *Id.* at 3.

Methodology

According to the report, its method for data analysis includes a three step process:

1. Derivation of benchmark values (XCs) for the invertebrate genera;
2. "XC_{95} values were used to generate an SSD and the 5th percentile of the distribution, the 5th percentile hazardous concentration (HC_{05})." *Id.* at 8; and
3. These results were compared to estimated regional background values.

The methodology deviates from the national guidelines in the second step in the data analysis because, "the HC_x terminology for concentrations derived from SSDs is not in the 1985 method." *Id.* at 8. Instead the report uses more recent methodology, which has not been officially incorporated into the national guidelines.

Mayflies and the Failure to Consider Other Taxa

The most striking example of how the report deviates from the national guidelines is its failure to consider taxa (other than certain invertebrate species) such as, fish, plants, amphibians, or mussels. According to the report:

> Fish were not included because their occurrence is affected by stream size making it difficult to determine XC_{95} values. Some of the affected streams naturally have no fish. In addition, the WABbase data set used to derive the benchmark does not contain data for fish. Other data sets that do contain fish are not as large and do not contain as great a range of conductivity values. A separate SSD might be developed for fish, once these technical issues are resolved. Data for plants and amphibians are not available. Additional findings regarding mussels could change this analysis if they are found to be more sensitive to conductivity than the invertebrates used here. Mussels were not represented because genera did not occur in a minimum of 30 samples. Additional analyses may be necessary to ensure protection of federally or state listed rare, threatened, or endangered species of fish, amphibians, and mussels. *Id.* at 17.

The failure to consider fish or other taxa when determining aquatic life criteria deviates substantially from the data that is required "to be available to derive a criterion for freshwater aquatic organisms and their uses" that specifically requires acute tests for at least eight different families to represent aquatic life, including vertebrate species. Regardless of the fact that this report was based on field-data, as opposed to the national guideline's assumption that the criterion would be based on laboratory testing, the conductivity benchmark does not evaluate data from at least eight different families of aquatic life; instead, it *only* considers invertebrate species.

Even among the invertebrate species data considered by the report, when evaluating the potentially confounding variables (resulting from the use of field-data as opposed to laboratory data), the report limited its evaluation of these confounding variables to the confounder's effect on ephemeropteran genera (mayflies). Ephemeroptera were selected allegedly "because they are among the most sensitive genera." USEPA, Office of Research and Development, National Center for Environmental Assessment, Washington, DC., *A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*, EPA/600/R-10/023A, (2010). The use of data from only invertebrate species and then considering the effects of potentially confounding variables on only one genera of mayfly does not correspond with the national guidelines data requirement to have data collected from eight different families of aquatic organisms.

On December 18, 2008, the Science Advisory Board (SAB) issued its *Advisory on Aquatic Life Water Quality Criteria for Contaminants of Emerging Concern* in response to its review of USEPA's White Paper *Aquatic Life Criteria for Contaminant of Emerging Concern* that proposes to interpret and/or adapt the principles found in the 1985 National Guidelines for deriving aquatic life criteria while focusing on contaminants of emerging concern. Science Advisory Board, *Advisory on Aquatic Life Water Quality Criteria for Contaminants of Emerging Concern*, EPA-SAB-09-007, (Dec. 18, 2008). The following section describes the SAB's concerns over USEPA's proposal to narrow the requirement to obtain data from eight different families of aquatic organisms:

> The Committee finds that the White Paper contains a comprehensive discussion of the issue of taxonomic coverage for developing aquatic life criteria. [US]EPA's 1985 Guidelines require that data be available for the following organisms: a salmonoid in the class Osteichthyes, a second family in the class Osteichthyes, a third family in the phylum Chordata, a planktonic crustacean, a benthic crustacean, an insect, a family in a phylum other than Arthropoda or Chordata, and a family in any order of insect or other phylum not already represented…In the White Paper, [US]EPA notes these taxonomic coverage requirements but recommends movement to a more "expert judgment" approach that is logical and should address some of the unique properties of [contaminants of emerging concern]. **The Committee understands and appreciates the desirability of avoiding the extra work required to develop chronic data for species that are unlikely to be sensitive to certain [contaminants of emerging concern]. On the other hand, we emphasize that it is equally important to perform adequate testing to ensure protection of aquatic life.** Therefore it is important to define what constitutes a sufficiently robust set of chronic data for criteria derivation and also to provide additional guidance concerning the data needed to infer that various taxa are insensitive to chemicals with specific modes of action…**Moreover, because goals for aquatic life criteria should extend to the protection of ecosystems and their services rather than individual targeted organisms or specific subsystems, there it's a need to assure that biological assessments adequately address a broad range of taxa and environmental contexts**. *Id.* at 9.

SAB specifically notes "[t]here is a need to maintain broad taxonomic coverage for the development of aquatic life criteria." *Id.* at 10. The use of data from only invertebrate species and then considering the effects of potentially confounding variables on only one genera of mayfly does not correspond with the SAB's specific recommendation to "maintain broad taxonomic coverage."

In addition to the national guidelines, USEPA has published literature related to the similar issue of the appropriate development of biological criteria. In the USEPA pamphlet "States and Tribes Embrace Bioassessment and Biocriteria for Protecting Streams and Small Rivers" USEPA explains "[t]he presence, condition, numbers and types of fish, insects, algae, plants, and other organisms provide direct, accurate information about the health of water bodies" while the "[a]ssessment of only one type of animal or plant life leads to only 80-85% effectiveness in identifying aquatic life use attainment or non-attainment. Assessment of a water body's biology can include the analysis of macroinvertebrates (insects), periphyton (algae), or fish life. [US]EPA recommends the use of two or more of these groups of biological assessments." USEPA, Office of Water, *States and Tribes Embrace Bioassessment and Biocriteria for Protecting Streams and Small Rivers*, EPA-822-F-03-005, (2003). This too suggests the collection of data from only one genera of mayflies is insufficient to make a conclusion about appropriate aquatic life criteria. So it is clear that while the guidelines provide for appropriate modifications in the development of criteria for a specific geographic area this report substantially deviates from USEPA's own guidance for the development of aquatic life criteria.

D. Section 404

Consistent with the above discussion on CWA section 401 and 402, EPA's Detailed Guidance makes similar presumptions and imposes similar restrictions on the Corps in the CWA 404 permitting context. "Projects projected to increase conductivity levels above 300 uS/cm should include permit conditions requiring adaptive remedial action to prevent conductivity levels from rising to levels that may contribute to water quality degradation." Detailed Guidance at 22. EPA has provided no basis to conclude that these conductivity levels will harm the uses protected by the various narrative water quality standards promulgated by the states. In some instances, natural background is higher than these levels. In other cases, because of the chemistry of a particular stream, the data accumulated in EPA's draft conductivity report would have no application. EPA also ignores the fact that water quality standards have no place in a Section 404 permit for coal mining where the ultimate discharge from any fill area is regulated by a Section 402 permit.

The Detailed Guidance also imposes several de facto changes to the 404(b)(1) guidelines, contrary to the agency's own regulations requiring that any substantive changes to the guidelines must be done by notice and comment rulemaking. 40 C.F.R. 230.2(c). Such changes include (a) requiring watershed scale (HUC 12) cumulative impact analysis "as an element of the factual determinations required

by the 404(b)(1) Guidelines"; and (b) denying Section 404 mitigation credit for sediment, groin, or other water control ditches required for mining projects under SMCRA and CWA Section 402 despite the Fourth Circuit's ruling affirming the Corps' reliance on these measures to satisfy both its CWA and NEPA obligations. 567 F.3d at 46.

The section 404(b)(1) guidelines are promulgated jointly by EPA and the Corps, but, under the statute, are implemented solely by the Corps. The Memorandum of Understanding Among the Corps, OSM, EPA, and the U.S. Fish and Wildlife Service for the Purpose of Providing Concurrent and Coordinated Review and Processing of Surface Coal Mining Applications Proposing Placement of Dredged and/or Fill Material in Waters of the United States (Feb. 2005), makes it clear that: "The Corps is solely responsible for making final permit decisions pursuant to section 404(a) of the CWA, including final determinations of compliance with Corps permit regulations, the Section 404(b)(1) Guidelines, and Section 7(a)(2) of the Endangered Species Act." EPA has the authority under section 404(c) of the Clean Water Act to veto a permit only if EPA determines the release will have unacceptable adverse effects on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. Yet, according to EPA: "EPA has the critical authority under CWA Section 404(b)(1) to make independent judgments about threats to water quality." Detailed Guidance, at 16. When did EPA change its interpretation of the 404(b)(1) guidelines to assume the authority to second-guess decisions made by the Corps regarding compliance with the 404(b)(1) guidelines?

EPA is creating new requirements for minimizing adverse impacts. Detailed Guidance, at 26. EPA's new approach would require, among other things, disposal of excess spoil "as far up the valley as is feasible from an engineering perspective." Detailed Guidance, at 26. Is EPA claiming the authority to regulate the disposal of spoil in uplands? If so, under what authority is EPA operating? Also, the 404(b)(1) guidelines require "all appropriate and practicable measures to minimize potential harm." Practicable means "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purposes." 40 CFR 230.91(c)(2). Is EPA now taking the position that it can require measures to avoid and minimize adverse effects that are not practicable? If so, would EPA agree that this is a substantive change to the 404(b)(1) guidelines as well as 40 CFR Part 230, Subpart J, requiring rulemaking.

Under the 404(b)(1) guidelines, the Corp employs sequencing when evaluating permit applications, looking at avoidance and minimization of harm before looking at compensatory mitigation. Upon conclusion of the review and issuance of a permit, a permittee then may make an economic investment in a project with the assurance that its project has received the needed regulatory approvals. In the Detailed Guidance, EPA has adopted a new definition of sequencing to permit the construction of only one valley fill at a time. Detailed Guidelines, at 25. EPA's new definition of sequencing removes any regulatory certainty that would support making an economic investment. Even after a permit is issued EPA may decide to

ban any future valley fills. Such a change to the regulatory definition requires rulemaking.

As noted above, EPA's Detailed Guidance prohibits mitigation credit for drainage ways (sediment, groin, or other water control ditches). Detailed Guidance, at 23-24. Is EPA taking the position that it can veto a permit just because it disagrees with the mitigation plan, even if the mitigation is consistent with the mitigation regulations promulgated jointly by the Corps and EPA, as well as SMCRA regulations promulgated by OSM? EPA apparently believes it has authority to prohibit the use of drainage ways to develop perennial streams for mitigation of the loss of headwaters streams, yet, EPA has not provided the public with any data that show that such mitigation will result in "unacceptable adverse effects on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas" and thus be a basis for a permit veto under section 404(c) of the CWA.

EPA is apparently taking the position that only headwater streams can mitigate for loss of headwater streams. Is EPA applying this new policy to all industries? This unique new position is completely inconsistent with the watershed approach to compensatory mitigation required by the Corps and EPA mitigation regulations and is not defensible, particularly when applied only to the coal industry. How does EPA plan to reconcile this new position with existing regulations? It would appear that a rulemaking would be required to make the changes EPA is imposing on the Corps through implementation of the Detailed Guidance.

III. EPA is Usurping State Authority Under SMCRA

Congress passed SMCRA in 1977 to "establish a nationwide program to protect society and the environment from the adverse effects of surface coal mining operations." 30 U.S.C. § 1202(a). Congress also recognized a need to "strike a balance between protection of the environment and agricultural productivity and the Nation's need for coal as an essential source of energy." 30 U.S.C. § 1202(f).

Under SMCRA, States have "exclusive jurisdiction over the regulation of surface coal mining and reclamation operations" on non-Federal lands, so long as their regulatory program has been approved by the Secretary of the Interior as satisfying the Act's minimum requirements. 30 U.S.C. § 1253. Once a State's SMCRA program has been approved, anyone wishing to engage in surface coal mining operations within the State must first obtain a permit from the State's regulatory authority. 30 U.S.C. § 1256(a).

In all Appalachian States except Tennessee, SMCRA authority has been assumed by the States. In Tennessee, OSM implements SMCRA.

Regulation of the disposal of excess spoil material from surface coal mining operations is within SMCRA's purview. As part of its environmental protection performance standards, SMCRA requires that all excess spoil material from surface

mining operations be disposed of "in a controlled manner . . . and in such a way to assure mass stability and to prevent mass movement." 30 U.S.C. § 1265(b)(22)(A). The Act clearly contemplates that valley fills will be used in the disposal process. 30 U.S.C. § 1265(b)(22)(D) (requiring that, where the disposal area contains "springs, natural water courses, or wet weather seeps . . . lateral drains [must be] constructed from the wet areas to the main underdrains in such a manner that filtration of the water into the spoil pile will be prevented.").

Thus, it is clear that SMCRA contemplates that excess spoil material will be placed into waters of the United States. Notwithstanding Congressional approval of this activity, EPA is attempting to ban it. In fact, in announcing the Guidance, EPA has asserted that the Guidance is "tantamount to banning valley fills."

The Corps' authority (and thereby EPA's) under Section 404 is limited to the narrow issue of regulating the discharge of fill material in waters of the United States. SMCRA, by contrast, confers exclusive jurisdiction over the regulation of surface coal mining and reclamation. According to the Fourth Circuit Court of Appeals in *OVEC*, it is proper for Federal agencies to harmonize the two statutes' goals: ensuring that mining operations can proceed while maintaining the highest level of water quality possible outside of the mining area. How can banning valley fills be considered to be "harmonizing" SMCRA and the CWA? EPA has no authority under section 404 of the CWA to regulate the entire valley fill project. Instead, that authority rests with the State (or in Tennessee, OSM) under SMCRA. In *OVEC*, the Fourth Circuit ruled that the scope of the Corps' CWA jurisdiction (and by extension EPA's) is limited to the material actually discharged into navigable waters and does not extend even to the portions of the valley fill that rest on the discharged fill material. 567 F.3d at 27 (rejecting OVEC's contention that the 404 permit is a permit for the entire valley fill). Therefore, EPA concerns expressed in the Guidance with upland impacts from proposed mining projects such as "forest fragmentation" and "habitat loss" are completely outside the scope of its authority and instead are issues within the purview of the states to regulate under SMCRA.

By disregarding State authority under SMCRA, EPA is attempting to federalize every aspect of a surface mining project under NEPA and trammeling a State's authority over land use. Again, the Fourth Circuit has rejected such extensive federal interference. *Id*. Indeed, the Court suggested that any other position would violate NEPA regulations and SMCRA provisions requiring inter-agency cooperation to avoid duplicative reviews. *Id*. at29. ("if the Corps, by issuing a 404 permit, can turn a valley fill project 'into a Federal action,' … the WVDEP's regulation of the fill process becomes at best duplicative"; and citing SMCRA as prohibiting construction of NEPA by which the Corps federalizes a review that has been delegated to federally-approved state [SMCRA] programs. *Id*.

Accordingly, the Fourth Circuit, at the urging of the United States, has expressly limited the scope of the United States' CWA authority to the valley fill underdrain

areas and likewise affirmed a similarly narrow application of NEPA. EPA's Guidance seeks to unwind these decisions.

As part of its exclusive regulatory authority over surface coal mining and reclamation, SMCRA regulations address cumulative impact through a "Cumulative Hydrologic Impact Assessment" (CHIA). However, in the Detailed Guidance EPA is now saying that CHIAs are not sufficient for determining cumulative impacts under the 404(b)(1) guidelines or NEPA. Detailed Guidance, at 23, 29. Instead, EPA is requiring a "watershed scale" analysis. Here again, EPA seeks to avoid the Fourth Circuit ruling on this issue. In *OVEC*, the Fourth Circuit affirmed that the Corps' use of the SMCRA-mandated "cumulative hydrologic impact assessment" as providing a rational basis for concluding there would be no impermissible cumulative aquatic impacts.

IV. EPA is Usurping the Corps' Authority under NEPA

NEPA requires federal agencies to prepare an Environmental Impact Statement (EIS) for "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. Section 4332(2)(C). Where it is not readily determined that an EIS is required, an agency may prepare an Environmental Assessment (EA) that documents the findings and analysis of environmental impacts. The agency may choose either to proceed with the preparation of an EIS or, alternatively to make a Finding of No Significant Impact (FONSI). 40 C.F.R. Sections 1501.4, 1508.9. The Corps is the lead Federal agency for 404 permits under NEPA. The Corps has promulgated regulations for implementing NEPA. In addition, the Corps has announced that it plans to begin a rulemaking to amend its NEPA regulations. Notwithstanding the existing regulatory framework for implementing NEPA, EPA's Guidance states that "it is EPA's experience that projects that involve more than one mile of stream loss or more than one valley fill are likely to result in significant adverse impacts." EPA also suggests that upland impacts such as forest fragmentation and habitat loss are within the scope of the Corps' analysis under NEPA. The Fourth Circuit has ruled that these impacts are outside the scope of the Corps' CWA and NEPA authority and thereby also outside EPA's 404(c) authority.

V. Underlying Science is Seriously Flawed

EPA cites emerging science as a basis for adopting its newly fashioned approach to reviewing coal mining permits, including immediate implementation of the conductivity limits. EPA has issued these significant new policies prior to submitting its newly emerging science to outside scientific peer review or making it available for public comment. NMA is not aware of another time when the agency has taken such an action, particularly action that brings to bear such drastic regulatory implications prior to completing these important reviews. With respect to the overall benchmark development effort, it is remarkable that it is taking the agency more than a decade to revise the water quality criteria for selenium and in a matter of months the agency was able to produce a benchmark criteria for conductivity

and with the confidence to make it immediately effective. EPA likes to distinguish between a benchmark and a water quality criterion to justify its failure to adhere to its own policies and legally required procedure, however, NMA and the companies it represents sees a distinction without a difference. In the real world, EPA's "benchmark" is having the effect of a de factor water quality standard and is now forming the basis for third party permit appeals.

NMA has expressed repeatedly its grave concerns with EPA's studies underlying and forming the basis for new policies, presumptions and de facto water quality standards. See *Final Report, Technical Review: A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*, GEI Consultants, Submitted to EPA September 2010 (GEI 2010). At bottom, NMA's primary concerns, as outlined in GEI (2010), is EPA's use of species sensitivity distribution (SSD)-based methods to develop a conductivity benchmark, similar to those used with laboratory-derived toxicity data, to derive numeric ambient water quality criteria for protection of aquatic life and their uses. The underlying principle governing the use of a species-sensitivity distribution (SSD) is that all of the organisms in the distribution exhibit a consistent response to the stressor. Specifically, each of the taxa should respond negatively to the stressor – only differing in their degree of sensitivity. However, EPA's benchmark study (EPA 2010) which drives all of these regulatory and policy changes, shows five fundamentally different types of stressor-response profiles. These five stressor-response profiles provide substantially different answers to the question "what conductivity concentration is necessary to provide the level of protection used by EPA?" See *Primary Technical Concerns with Proposed EPA Conductivity Benchmark*, GEI Consultants, attached. Accordingly, there is no way to reconcile these widely conflicting stressor-responses into a single benchmark protective of the entire macroinvertebrate community.

These issues along with a number of additional concerns with EPA's science and field data methodology have been largely ignored by EPA and its Science Advisory Panel. NMA has participated at every step of the SAB review process, submitting written and oral comments with every opportunity to do so but its comments have not been addressed in that forum. Even where our comments were presented in the context of the agency's charge questions they were ignored. For these reasons, NMA finds the SAB review woefully inadequate in terms of constituting fair and open external peer review of EPA's work. If EPA is so confident that the science the agency relies on is scientifically sound, the agency should welcome additional scientific review. NMA strongly encourages the agency to submit these studies for meaningful, independent, external peer review.

Conclusion

NMA appreciates the opportunity to provide comments on the Detailed Guidance. As stated in NMA's lawsuit, the coal mining industry is under an incredible regulatory burden caused by implementation of these new policies and guidances –

actions that are indefinitely delaying and obstructing the issuance of much needed permits critical to new and continuing operations and threatening the future of coal mining in the Appalachian region.

Sincerely,

Karen C. Bennett
Vice President, Environmental Affairs
National Mining Association

Gregory Peck/DC/USEPA/US
01/12/2011 12:26 PM

To Denis Borum
cc
bcc
Subject Re: Did industry ever formally respond to the April 2010 Appalachian Surface Mining Guidance?

EPA Detailed Guidance Comments 2010 Final Submitted.pdf

Denis Borum | Greg, Following-up: You were going to get me c... | 01/12/2011 12:17:01 PM

From: Denis Borum/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA
Date: 01/12/2011 12:17 PM
Subject: Re: Did industry ever formally respond to the April 2010 Appalachian Surface Mining Guidance?

Greg,

Following-up: You were going to get me copies of NMA comments in the docket? Or an electronic link to them? I need to get these to Ryan (ideally before I call him about Spruce). Thanks

Denis

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Gregory Peck | Industry sued us over the guidance - but we also... | 01/06/2011 05:39:28 PM

From: Gregory Peck/DC/USEPA/US
To: Denis Borum/DC/USEPA/US@EPA
Date: 01/06/2011 05:39 PM
Subject: Re: Did industry ever formally respond to the April 2010 Appalachian Surface Mining Guidance?

Industry sued us over the guidance - but we also received extensive comments from the National Mining Association to our FR notice.

Denis Borum | Greg, I think this one fell through the cracks; I do... | 01/06/2011 05:33:20 PM

From: Denis Borum/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA
Date: 01/06/2011 05:33 PM
Subject: Re: Did industry ever formally respond to the April 2010 Appalachian Surface Mining Guidance?

Greg,

I think this one fell through the cracks; I don't see a reply back from you. The inquiry was from Ryan

Seiger (now packing up to move into the closet next door). At any rate, he has just asked again. He wants to know if industry put in writing, or otherwise iterated, any counter-arguments to our planned improvements in reviewing the permits. Thanks

Denis

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Denis Borum	Denis R. Borum Congressional Liaison Specialist	11/16/2010 04:35:58 PM

From: Denis Borum/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA
Date: 11/16/2010 04:35 PM
Subject: Did industry ever formally respond to the April 2010 Appalachian Surface Mining Guidance?

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December 1, 2010

Peter S. Silva
Assistant Administrator for Water
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW.,
Washington, DC 20460

Docket ID No. EPA-HQ-OW-2010-0315

RE: Detailed Guidance: Improving EPA Review of Appalachian Surface Coal Mining Operations under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order

Dear Mr. Silva:

On April 1, 2010, Peter S. Silva, Assistant Administrator for the Office of Water, and Cynthia Giles, Assistant Administrator for the Office of Enforcement and Compliance Assistance, released Summary and Detailed Guidance on "Improving EPA Review of Appalachian Surface Coal Mining Operations under the Clean Water Act (CWA), National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898)." These documents intend to "clarify EPA's roles and expectations, in coordinating with our federal and state partners, to assure more consistent, effective, and timely compliance of Appalachian surface coal mining operations with the provisions of the CWA, NEPA, and the E.O. 12898." (Detailed Guidance). However, the Guidance goes far beyond clarification and coordination and arrogates to EPA new powers to supersede the authority of States under the CWA and the Surface Mining Control and Reclamation Act of 1977 (SMCRA), the authority of the U.S. Army Corps of Engineers (Corps) under the CWA and NEPA, the authority of the Office of Surface Mining (OSM) under SMCRA. EPA cannot, through guidance, change the meaning of these statutes or their implementing regulations. Yet, as noted by Randy Huffman, Director of West Virginia's Department of Environmental Protection, in a December 2, 2009, letter to Senator Inhofe, EPA's recent actions on surface mining permits "represent a stark change in regulatory direction," which "has been undertaken in the absence of any change in statute, regulation or formal policy which would necessarily require transparency in

the process." *See* United States Senate Report, *The Mingo Logan Spruce No. 1 Mine*, U.S. Senate Environment and Public Works Committee, Minority Staff Report, January 14, 2010 available at: www.epw.senate.gov/inhofe.

If EPA wishes for statutory changes, it must go to the Office of Management and Budget, develop an Administration legislative proposal, and submit that proposal to Congress. If EPA wishes for regulatory changes, it must go through notice and comment rulemaking. EPA cannot simply declare itself to be the master agency whose decisions trump all others.

The National Mining Association (NMA) submits the following comments on the above-referenced document that was made available for public comment and immediately effective on April 1, 2010. *See* 75 Fed. Reg. 18,500. In addition to these comments, NMA incorporates by reference comments filed with both the EPA and EPA's Science Advisory Panel on Mountaintop Mining regarding EPA's two draft reports, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (EPA 2010); *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields* (EPA 2009). NMA is a national trade association that includes the producers of most of the nation's coal, metals, industrial and agricultural minerals; the manufacturers of mining and mineral processing machinery, equipment and supplies; and the engineers and consulting firms, financial institutions and other firms serving the mining industry. NMA's members have a wide variety of surface coal mining operations, including operations in Central Appalachia, and thus are currently suffering direct and significant harm by EPA's implementation of the Detailed Guidance and associated studies. EPA's actions, immediate application of the Detailed Guidance along with the agency's reliance on hastily done and legally and scientifically flawed studies, has led to irreparable harm to NMA members and resulted in an NMA led industry challenge to the Detailed Guidance and associated studies, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (EPA 2010); *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields* (EPA 2009). *See NMA v. Jackson,* No. 10-cv-1220 (D.D.C. July 20, 2010).

I. EPA's "Detailed Guidance" is a Legislative Rule Requiring Notice and Comment

In announcing the April 1 Guidance, Administrator Jackson said: "this is a sweeping regulatory action" and "you're talking about no, or very few, valley fills that are going to meet this [new] standard." http://www.washingtonpost.com/wpdyn/content/articl/2010/04/01/AR2010040102312.html. According to Jackson, "EPA will now instruct its local offices not to approve new CWA valley-fill permits that are likely to produce a certain level of pollution in waters downstream." *Id.* Jackson's statements have proven correct as very few permits have been issued since. *See* U.S. GOV'T ACCOUNTABILITY

OFFICE GAO-11-101R, EPA AND THE CORPS' REVIEW OF SECTION 404 PERMITS (2010) (reporting 6 permits were issued, 36 were withdrawn and 36 are awaiting EPA's newly created enhanced review). EPA's Guidance amounts to a moratorium on the issuance of coal-related permits accomplished by rewriting the underlying statutory and regulatory permitting framework for coal mining. The Guidance dramatically alters regulatory timelines, imposes new requirements and creates legal presumptions in complete disregard of existing federal law and procedure. In addition, through implementing the Guidance, EPA has interfered with the statutory delegation of regulatory authority over coal mining placing the U.S. army Corps of Engineers (Corps), the Office of Surface Mining Reclamation and Enforcement (OSM), and states as permitting authorities and regulators of the environmental impacts of coal mining. Such substantial changes to these governing regulations and statutory authorities cannot be accomplished without adhering with the notice and comment rulemaking requirements under the Administrative Procedures Act (APA).

II. The Detailed Guidance Exceeds EPA's Authority under the CWA

Under the framework of the CWA, some authorities are granted to the Federal government and others are reserved to the States. And, some authorities may be exercised by the Federal government only if certain predicates are met. This framework provides an appropriate balance between the authority of the States to determine the appropriate level of protection for State resources and the Federal interest in environmental protection generally. EPA's Guidance and EPA's recent actions regarding surface coal mining fail to respect that balance. According to Mr. Huffman, in his December 2, 2009 letter, "EPA has manipulated the Federal CWA 404 permitting process so as to intrude on the State's primacy under SMCRA and its delegated authority under the CWA. I am deeply concerned that the April 1st Guidances represent further intrusion into State authority, again without any change in statue or regulation."

A. Section 101

Under section 101(g) of the CWA, Congress stated that: "It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act." The CWA only regulates the discharge of pollutants from point sources. It does not regulate the flow of water. Notwithstanding this limitation, in the Detailed Guidance, EPA asserts the authority over environmental impacts resulting from reduced water flows. Specifically, EPA appears to be asserting authority over "physical modification and elimination of headwater streams" due to reduced flow. "For example, elimination of all or even part of a headwater stream may remove from the overall watershed system an important source of freshwater dilution that contributes to water quality. Accordingly, even where a National Pollutant Discharge Elimination System (NPDES) permit has been issued, the Section 404

permit must independently ensure that water quality is protected." Detailed Guidance at 20. The Detailed Guidance says "the project" cannot cause a violation of water quality standards. However, the CWA gives Federal agencies the authority to regulate discharges of pollutants into waters of the United States, not projects.

B. Section 401

Section 401(a)(1) of the CWA gives States the authority to determine if an activity that is the subject of a Federal license or permit will meet water quality requirements in that State. EPA has the authority to issue this certification only if no State or interstate agency has the authority to do so. Water pollution control agencies in Kentucky, West Virginia, Virginia, Ohio, Tennessee, and Pennsylvania each have the authority to issue water quality certifications for their States. Under section 401(a)(2), downstream States also may request a public hearing on a Federal license or permit and EPA may make recommendations at that hearing. However, the agency that issues the Federal license or permit is the agency that decides what conditions in the license or permit are appropriate to protect the quality of water in downstream States. Notwithstanding the limits of EPA's authority under section 401(a) of the CWA, the Detailed Guidance States that "EPA retains its responsibility for ensuring that neither numeric nor narrative water quality standards are exceeded due to discharges of fill material even if a State has issued a water quality certification under Section 401 of the CWA." Detailed Guidance, at 18. EPA simply does not have the authority to second guess a State water quality certification and to suggest otherwise as EPA has in its Detailed Guidance is to completely disregard the holding of the Fourth Circuit Court of Appeals in *OVEC v. Aracoma Coal Company*, 556 F.3d 177 (4th Cir. 2009), reh'g & reh'g en banc denied, 567 F.3d 130 (4th Cir. 2009). In *OVEC*, the environmental plaintiffs argued that the Corps has an independent obligation to review claims that mines might violate water quality standards despite the state issued 401 certification. The Fourth Circuit quickly rejected the argument ruling that "A § 401 certification is considered conclusive, and no independent analysis of the certification is required."

C. Section 402

Under section 402(b) of the CWA, Congress established the NPDES permitting program. 33 U.S.C. § 1342. Conforming to the statute's goal of allocating the "primary responsibilities" for water pollution control to the states, the CWA establishes a system whereby a state may assume primary administration and enforcement of the NPDES permitting program. 33 U.S.C. 1342(b). Once EPA approves a proposed state permitting program, EPA must suspend its own program. 33 U.S.C. 1342(c)(1). Under such delegated permitting programs, states have exclusive authority to implement the NPDES program within their boundaries, and EPA has only limited authority to review state action. Once States are authorized to implement the CWA in that State, States develop water quality standards that are approved by EPA and issue permits that implement those standards and its

decisions, particularly its decisions about compliance with State water quality standards are given deference. However, in the Guidance, EPA creates a presumption that "EPA expects that in many, if not most, cases the available science will demonstrate that there is a reasonable potential for these discharges to cause or contribute to an excursion above numeric or narrative water quality standards, thus making water quality-based effluent limits necessary." Detailed Guidance at 8. Such a blanket statement about the need for water quality-based limits ignores the role of the delegated states under Section 402 and the existing protections under the CWA and its implementing regulations prohibiting states from approving any such discharge. Since all of the states subject to EPA's Guidance have delegated authority, the states, not EPA have the duty to determine whether any proposed discharges will cause, or have the reasonable potential to cause, or contribute to an in-stream excursion above a numeric or narrative criteria within an applicable water quality standard. 40 C.F.R. Section 122.44(d).

By asserting the authority to interpret the State narrative water quality standards as requiring conductivity levels between 300 and 500 uS/cm EPA substitutes an authorized State's interpretation of its narrative water quality standards with numeric standards without following the procedures required under CWA Section 303(c). EPA has not taken the steps necessary to make a determination that numeric conductivity standards are necessary in the Appalachian region and EPA has not gone through notice and comment rulemaking to establish numeric Federal standards for conductivity for the Appalachian States. EPA has not followed the required procedures and is therefore acting *ultra vires*.

EPA's conductivity levels of between 300 and 500 uS/cm. These conductivity levels rely heavily on one study of West Virginia streams by EPA Region III (the Pond-Passmore study) and a draft study by EPA's Office of Research and Development (ORD) that has not yet undergone independent, external, peer review. The Guidance requires regulatory agencies and states use these criteria when evaluating whether a discharge has a reasonable potential to violate water quality standards. Detailed Guidance, at 12. EPA Regions are being told to object to permits that do not incorporate these criteria as limits. Detailed Guidance, at 15. EPA also plans to use these criteria when evaluating the potential for a discharge to result in significant degradation of water quality. Detailed Guidance, at 22. EPA calls these criteria "new numeric water quality values for conductivity." Detailed Guidance, at 7. In the public announcement of the April 1st Guidance, Administrator Jackson called the criteria "standards." However, 300 and 500 uS/cm have not been adopted by any Appalachian state as numeric water quality standards.

Even if it were true, and it is not, that EPA could impose on states the agency's interpretation of the states' narrative water quality standards, EPA has not followed its own procedures for developing a chronic aquatic life criteria for conductivity. EPA's newly derived study "*A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*", which forms the basis for establishing a

conductivity range of 300-500 uS/cm, represents a departure from EPA's 1985 *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* ("Guidelines") Charles E. Stephan, et al., USEPA, Office of Research and Development, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049 (1985) and therefore, the benchmark should be set aside until such time as EPA adheres to its own guidelines.

These national guidelines with "appropriate modifications" may be applied to derive criteria for any specific geographic area, "if adequate information is available concerning the effects of the material of concern on appropriate species and their uses." *Id*. at 5. According to the national guidelines, "protection of aquatic organisms and their uses should be defined as prevention of unacceptable long-term and short-term effects on (1) commercially, recreationally, and other important species and (2) (a) fish and benthic invertebrate assemblages in rivers and streams, and (b) fish, benthic invertebrate, and zooplankton assemblages in lakes, reservoirs, estuaries, and oceans." *Id*. at 3.

The national guidelines require certain data to be available "to derive a criterion for freshwater aquatic organisms and their uses," including:

1. **Results of acceptable acute tests** (see Section IV) **with at least one species of freshwater animal in at least eight different families such that all of the following are included**:

    a. the family Salmonidae in the class Osteichthyes

    b. a second family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species (e.g., bluegill, channel catfish, etc.)

    c. a third family in the phylum Chordata (may be in the class Osteichthyes or may be an amphibian, etc.)

    d. a planktonic crustacean (e.g. cladoceran, copepod, etc.)

    e. a benthic crustacean (e.g., ostracod, isopod, amhipod, crayfish, etc.)

    f. an insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge, etc.)

    g. a family in a phylum other than Arthropoda or Chordata (e.g., Rotifiers, Annelida, Mollusca, etc.)

h. a family in any order of insect or any phylum not already represented.

2. **Acute-chronic ratios (see Section VI) with species of aquatic animals in at least three different families provided that of the three species**:

   - at least one is a fish
   - at least one is an invertebrate
   - at least one is an acutely sensitive freshwater species (the other two may be saltwater species).

3. **Results of at least one acceptable test with a freshwater alga or vascular plant** (see Section VIII). If plants are among the aquatic organisms that are most sensitive to the material, results of a test with a plant in another phylum (division) should also be available.

4. **At least one acceptable bioconcentration factor determined with an appropriate freshwater species**, if a maximum permissible tissue concentration is available (see Section IX). *Id.* at 23.

In addition, "if a criterion is to be related to a water quality characteristic … more data will be necessary. Similarly, if all required data are not available, a numerical criterion should not be derived except in special cases." *Id.* at 26. Thus in order to comply with the national guidelines the report should include all necessary data identified in Section IIIB to include data from at least eight different families of aquatic life. *Id*. at 23.

Deviation from U.S. EPA Guidance

A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams ("report") claims, "[t]his benchmark is intended to protect the aquatic life in the region. It is derived by a method modeled on the USEPA's standard methodology for deriving water quality criteria." USEPA, Office of Research and Development, National Center for Environmental Assessment, Washington, DC., *A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*, EPA/600/R-10/023A, (2010). However, this report deviates from the national guidelines in several ways, including,

1. it uses field-based data as opposed to laboratory tests;

2. the methodology for data analysis for the species sensitivity distribution (SSDs) is "extirpation concentrations (XCs) rather than median lethal concentrations (LC_{50}s);" *Id.* at xii.

3. the report only considers the effects of conductivity on certain invertebrate species and then limits its consideration of the confounding factors to only one genera of mayfly, Ephemeroptera. It fails to consider other taxa and does not include the minimum of eight different families of aquatic organisms as required by the national guidelines (such as, fish, mussels, or aquatic plants).

Field data vs. Laboratory data

The national guidelines suggest the use of laboratory data because, "it is not feasible to determine national criteria by conducting such field tests [on a wide variety of unpolluted bodies of fresh (or salt) water]," Charles E. Stephan, et al., USEPA, Office of Research and Development, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049 (1985) at 1. By contrast, the report uses field-based data because, "SSDs based on laboratory studies cannot replicate the full range of effects or species interactions that could reasonably be expected to occur in the environment (Suter et al., 2002)." *Id.* at 3.

Methodology

According to the report, its method for data analysis includes a three step process:

1. Derivation of benchmark values (XCs) for the invertebrate genera;
2. "XC_{95} values were used to generate an SSD and the 5th percentile of the distribution, the 5th percentile hazardous concentration (HC_{05})." *Id.* at 8; and
3. These results were compared to estimated regional background values.

The methodology deviates from the national guidelines in the second step in the data analysis because, "the HC_x terminology for concentrations derived from SSDs is not in the 1985 method." *Id.* at 8. Instead the report uses more recent methodology, which has not been officially incorporated into the national guidelines.

Mayflies and the Failure to Consider Other Taxa

The most striking example of how the report deviates from the national guidelines is its failure to consider taxa (other than certain invertebrate species) such as, fish, plants, amphibians, or mussels. According to the report:

> Fish were not included because their occurrence is affected by stream size making it difficult to determine XC_{95} values. Some of the affected streams naturally have no fish. In addition, the WABbase data set used to derive the benchmark does not contain data for fish. Other data sets that do contain fish are not as large and do not contain as great a range of conductivity values. A separate SSD might be developed for fish, once these technical issues are resolved. Data for plants and amphibians are not available. Additional findings regarding mussels could change this analysis if they are found to be more sensitive to conductivity than the invertebrates used here. Mussels were not represented because genera did not occur in a minimum of 30 samples. Additional analyses may be necessary to ensure protection of federally or state listed rare, threatened, or endangered species of fish, amphibians, and mussels. *Id.* at 17.

The failure to consider fish or other taxa when determining aquatic life criteria deviates substantially from the data that is required "to be available to derive a criterion for freshwater aquatic organisms and their uses" that specifically requires acute tests for at least eight different families to represent aquatic life, including vertebrate species. Regardless of the fact that this report was based on field-data, as opposed to the national guideline's assumption that the criterion would be based on laboratory testing, the conductivity benchmark does not evaluate data from at least eight different families of aquatic life; instead, it *only* considers invertebrate species.

Even among the invertebrate species data considered by the report, when evaluating the potentially confounding variables (resulting from the use of field-data as opposed to laboratory data), the report limited its evaluation of these confounding variables to the confounder's effect on ephemeropteran genera (mayflies). Ephemeroptera were selected allegedly "because they are among the most sensitive genera." USEPA, Office of Research and Development, National Center for Environmental Assessment, Washington, DC., *A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*, EPA/600/R-10/023A, (2010). The use of data from only invertebrate species and then considering the effects of potentially confounding variables on only one genera of mayfly does not correspond with the national guidelines data requirement to have data collected from eight different families of aquatic organisms.

On December 18, 2008, the Science Advisory Board (SAB) issued its *Advisory on Aquatic Life Water Quality Criteria for Contaminants of Emerging Concern* in response to its review of USEPA's White Paper *Aquatic Life Criteria for Contaminant of Emerging Concern* that proposes to interpret and/or adapt the principles found in the 1985 National Guidelines for deriving aquatic life criteria while focusing on contaminants of emerging concern. Science Advisory Board, *Advisory on Aquatic Life Water Quality Criteria for Contaminants of Emerging Concern*, EPA-SAB-09-007, (Dec. 18, 2008). The following section describes the SAB's concerns over USEPA's proposal to narrow the requirement to obtain data from eight different families of aquatic organisms:

> The Committee finds that the White Paper contains a comprehensive discussion of the issue of taxonomic coverage for developing aquatic life criteria. [US]EPA's 1985 Guidelines require that data be available for the following organisms: a salmonoid in the class Osteichthyes, a second family in the class Osteichthyes, a third family in the phylum Chordata, a planktonic crustacean, a benthic crustacean, an insect, a family in a phylum other than Arthropoda or Chordata, and a family in any order of insect or other phylum not already represented…In the White Paper, [US]EPA notes these taxonomic coverage requirements but recommends movement to a more "expert judgment" approach that is logical and should address some of the unique properties of [contaminants of emerging concern]. **The Committee understands and appreciates the desirability of avoiding the extra work required to develop chronic data for species that are unlikely to be sensitive to certain [contaminants of emerging concern]. On the other hand, we emphasize that it is equally important to perform adequate testing to ensure protection of aquatic life.** Therefore it is important to define what constitutes a sufficiently robust set of chronic data for criteria derivation and also to provide additional guidance concerning the data needed to infer that various taxa are insensitive to chemicals with specific modes of action…**Moreover, because goals for aquatic life criteria should extend to the protection of ecosystems and their services rather than individual targeted organisms or specific subsystems, there it's a need to assure that biological assessments adequately address a broad range of taxa and environmental contexts**. *Id.* at 9.

SAB specifically notes "[t]here is a need to maintain broad taxonomic coverage for the development of aquatic life criteria." *Id.* at 10. The use of data from only invertebrate species and then considering the effects of potentially confounding variables on only one genera of mayfly does not correspond with the SAB's specific recommendation to "maintain broad taxonomic coverage."

In addition to the national guidelines, USEPA has published literature related to the similar issue of the appropriate development of biological criteria. In the USEPA pamphlet "States and Tribes Embrace Bioassessment and Biocriteria for Protecting Streams and Small Rivers" USEPA explains "[t]he presence, condition, numbers and types of fish, insects, algae, plants, and other organisms provide direct, accurate information about the health of water bodies" while the "[a]ssessment of only one type of animal or plant life leads to only 80-85% effectiveness in identifying aquatic life use attainment or non-attainment. Assessment of a water body's biology can include the analysis of macroinvertebrates (insects), periphyton (algae), or fish life. [US]EPA recommends the use of two or more of these groups of biological assessments." USEPA, Office of Water, *States and Tribes Embrace Bioassessment and Biocriteria for Protecting Streams and Small Rivers*, EPA-822-F-03-005, (2003). This too suggests the collection of data from only one genera of mayflies is insufficient to make a conclusion about appropriate aquatic life criteria. So it is clear that while the guidelines provide for appropriate modifications in the development of criteria for a specific geographic area this report substantially deviates from USEPA's own guidance for the development of aquatic life criteria.

D. Section 404

Consistent with the above discussion on CWA section 401 and 402, EPA's Detailed Guidance makes similar presumptions and imposes similar restrictions on the Corps in the CWA 404 permitting context. "Projects projected to increase conductivity levels above 300 uS/cm should include permit conditions requiring adaptive remedial action to prevent conductivity levels from rising to levels that may contribute to water quality degradation." Detailed Guidance at 22. EPA has provided no basis to conclude that these conductivity levels will harm the uses protected by the various narrative water quality standards promulgated by the states. In some instances, natural background is higher than these levels. In other cases, because of the chemistry of a particular stream, the data accumulated in EPA's draft conductivity report would have no application. EPA also ignores the fact that water quality standards have no place in a Section 404 permit for coal mining where the ultimate discharge from any fill area is regulated by a Section 402 permit.

The Detailed Guidance also imposes several de facto changes to the 404(b)(1) guidelines, contrary to the agency's own regulations requiring that any substantive changes to the guidelines must be done by notice and comment rulemaking. 40 C.F.R. 230.2(c). Such changes include (a) requiring watershed scale (HUC 12) cumulative impact analysis "as an element of the factual determinations required

by the 404(b)(1) Guidelines"; and (b) denying Section 404 mitigation credit for sediment, groin, or other water control ditches required for mining projects under SMCRA and CWA Section 402 despite the Fourth Circuit's ruling affirming the Corps' reliance on these measures to satisfy both its CWA and NEPA obligations. 567 F.3d at 46.

The section 404(b)(1) guidelines are promulgated jointly by EPA and the Corps, but, under the statute, are implemented solely by the Corps. The Memorandum of Understanding Among the Corps, OSM, EPA, and the U.S. Fish and Wildlife Service for the Purpose of Providing Concurrent and Coordinated Review and Processing of Surface Coal Mining Applications Proposing Placement of Dredged and/or Fill Material in Waters of the United States (Feb. 2005), makes it clear that: "The Corps is solely responsible for making final permit decisions pursuant to section 404(a) of the CWA, including final determinations of compliance with Corps permit regulations, the Section 404(b)(1) Guidelines, and Section 7(a)(2) of the Endangered Species Act." EPA has the authority under section 404(c) of the Clean Water Act to veto a permit only if EPA determines the release will have unacceptable adverse effects on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. Yet, according to EPA: "EPA has the critical authority under CWA Section 404(b)(1) to make independent judgments about threats to water quality." Detailed Guidance, at 16. When did EPA change its interpretation of the 404(b)(1) guidelines to assume the authority to second-guess decisions made by the Corps regarding compliance with the 404(b)(1) guidelines?

EPA is creating new requirements for minimizing adverse impacts. Detailed Guidance, at 26. EPA's new approach would require, among other things, disposal of excess spoil "as far up the valley as is feasible from an engineering perspective." Detailed Guidance, at 26. Is EPA claiming the authority to regulate the disposal of spoil in uplands? If so, under what authority is EPA operating? Also, the 404(b)(1) guidelines require "all appropriate and practicable measures to minimize potential harm." Practicable means "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purposes." 40 CFR 230.91(c)(2). Is EPA now taking the position that it can require measures to avoid and minimize adverse effects that are not practicable? If so, would EPA agree that this is a substantive change to the 404(b)(1) guidelines as well as 40 CFR Part 230, Subpart J, requiring rulemaking.

Under the 404(b)(1) guidelines, the Corp employs sequencing when evaluating permit applications, looking at avoidance and minimization of harm before looking at compensatory mitigation. Upon conclusion of the review and issuance of a permit, a permittee then may make an economic investment in a project with the assurance that its project has received the needed regulatory approvals. In the Detailed Guidance, EPA has adopted a new definition of sequencing to permit the construction of only one valley fill at a time. Detailed Guidelines, at 25. EPA's new definition of sequencing removes any regulatory certainty that would support making an economic investment. Even after a permit is issued EPA may decide to

ban any future valley fills. Such a change to the regulatory definition requires rulemaking.

As noted above, EPA's Detailed Guidance prohibits mitigation credit for drainage ways (sediment, groin, or other water control ditches). Detailed Guidance, at 23-24. Is EPA taking the position that it can veto a permit just because it disagrees with the mitigation plan, even if the mitigation is consistent with the mitigation regulations promulgated jointly by the Corps and EPA, as well as SMCRA regulations promulgated by OSM? EPA apparently believes it has authority to prohibit the use of drainage ways to develop perennial streams for mitigation of the loss of headwaters streams, yet, EPA has not provided the public with any data that show that such mitigation will result in "unacceptable adverse effects on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas" and thus be a basis for a permit veto under section 404(c) of the CWA.

EPA is apparently taking the position that only headwater streams can mitigate for loss of headwater streams. Is EPA applying this new policy to all industries? This unique new position is completely inconsistent with the watershed approach to compensatory mitigation required by the Corps and EPA mitigation regulations and is not defensible, particularly when applied only to the coal industry. How does EPA plan to reconcile this new position with existing regulations? It would appear that a rulemaking would be required to make the changes EPA is imposing on the Corps through implementation of the Detailed Guidance.

III. EPA is Usurping State Authority Under SMCRA

Congress passed SMCRA in 1977 to "establish a nationwide program to protect society and the environment from the adverse effects of surface coal mining operations." 30 U.S.C. § 1202(a). Congress also recognized a need to "strike a balance between protection of the environment and agricultural productivity and the Nation's need for coal as an essential source of energy." 30 U.S.C. § 1202(f).

Under SMCRA, States have "exclusive jurisdiction over the regulation of surface coal mining and reclamation operations" on non-Federal lands, so long as their regulatory program has been approved by the Secretary of the Interior as satisfying the Act's minimum requirements. 30 U.S.C. § 1253. Once a State's SMCRA program has been approved, anyone wishing to engage in surface coal mining operations within the State must first obtain a permit from the State's regulatory authority. 30 U.S.C. § 1256(a).

In all Appalachian States except Tennessee, SMCRA authority has been assumed by the States. In Tennessee, OSM implements SMCRA.

Regulation of the disposal of excess spoil material from surface coal mining operations is within SMCRA's purview. As part of its environmental protection performance standards, SMCRA requires that all excess spoil material from surface

mining operations be disposed of "in a controlled manner . . . and in such a way to assure mass stability and to prevent mass movement." 30 U.S.C. § 1265(b)(22)(A). The Act clearly contemplates that valley fills will be used in the disposal process. 30 U.S.C. § 1265(b)(22)(D) (requiring that, where the disposal area contains "springs, natural water courses, or wet weather seeps . . . lateral drains [must be] constructed from the wet areas to the main underdrains in such a manner that filtration of the water into the spoil pile will be prevented.").

Thus, it is clear that SMCRA contemplates that excess spoil material will be placed into waters of the United States. Notwithstanding Congressional approval of this activity, EPA is attempting to ban it. In fact, in announcing the Guidance, EPA has asserted that the Guidance is "tantamount to banning valley fills."

The Corps' authority (and thereby EPA's) under Section 404 is limited to the narrow issue of regulating the discharge of fill material in waters of the United States. SMCRA, by contrast, confers exclusive jurisdiction over the regulation of surface coal mining and reclamation. According to the Fourth Circuit Court of Appeals in *OVEC*, it is proper for Federal agencies to harmonize the two statutes' goals: ensuring that mining operations can proceed while maintaining the highest level of water quality possible outside of the mining area. How can banning valley fills be considered to be "harmonizing" SMCRA and the CWA? EPA has no authority under section 404 of the CWA to regulate the entire valley fill project. Instead, that authority rests with the State (or in Tennessee, OSM) under SMCRA. In *OVEC*, the Fourth Circuit ruled that the scope of the Corps' CWA jurisdiction (and by extension EPA's) is limited to the material actually discharged into navigable waters and does not extend even to the portions of the valley fill that rest on the discharged fill material. 567 F.3d at 27 (rejecting OVEC's contention that the 404 permit is a permit for the entire valley fill). Therefore, EPA concerns expressed in the Guidance with upland impacts from proposed mining projects such as "forest fragmentation" and "habitat loss" are completely outside the scope of its authority and instead are issues within the purview of the states to regulate under SMCRA.

By disregarding State authority under SMCRA, EPA is attempting to federalize every aspect of a surface mining project under NEPA and trammeling a State's authority over land use. Again, the Fourth Circuit has rejected such extensive federal interference. *Id*. Indeed, the Court suggested that any other position would violate NEPA regulations and SMCRA provisions requiring inter-agency cooperation to avoid duplicative reviews. *Id*. at29. ("if the Corps, by issuing a 404 permit, can turn a valley fill project 'into a Federal action,' … the WVDEP's regulation of the fill process becomes at best duplicative"; and citing SMCRA as prohibiting construction of NEPA by which the Corps federalizes a review that has been delegated to federally-approved state [SMCRA] programs. *Id*.

Accordingly, the Fourth Circuit, at the urging of the United States, has expressly limited the scope of the United States' CWA authority to the valley fill underdrain

areas and likewise affirmed a similarly narrow application of NEPA. EPA's Guidance seeks to unwind these decisions.

As part of its exclusive regulatory authority over surface coal mining and reclamation, SMCRA regulations address cumulative impact through a "Cumulative Hydrologic Impact Assessment" (CHIA). However, in the Detailed Guidance EPA is now saying that CHIAs are not sufficient for determining cumulative impacts under the 404(b)(1) guidelines or NEPA. Detailed Guidance, at 23, 29. Instead, EPA is requiring a "watershed scale" analysis. Here again, EPA seeks to avoid the Fourth Circuit ruling on this issue. In *OVEC*, the Fourth Circuit affirmed that the Corps' use of the SMCRA-mandated "cumulative hydrologic impact assessment" as providing a rational basis for concluding there would be no impermissible cumulative aquatic impacts.

IV. EPA is Usurping the Corps' Authority under NEPA

NEPA requires federal agencies to prepare an Environmental Impact Statement (EIS) for "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. Section 4332(2)(C). Where it is not readily determined that an EIS is required, an agency may prepare an Environmental Assessment (EA) that documents the findings and analysis of environmental impacts. The agency may choose either to proceed with the preparation of an EIS or, alternatively to make a Finding of No Significant Impact (FONSI). 40 C.F.R. Sections 1501.4, 1508.9. The Corps is the lead Federal agency for 404 permits under NEPA. The Corps has promulgated regulations for implementing NEPA. In addition, the Corps has announced that it plans to begin a rulemaking to amend its NEPA regulations. Notwithstanding the existing regulatory framework for implementing NEPA, EPA's Guidance states that "it is EPA's experience that projects that involve more than one mile of stream loss or more than one valley fill are likely to result in significant adverse impacts." EPA also suggests that upland impacts such as forest fragmentation and habitat loss are within the scope of the Corps' analysis under NEPA. The Fourth Circuit has ruled that these impacts are outside the scope of the Corps' CWA and NEPA authority and thereby also outside EPA's 404(c) authority.

V. Underlying Science is Seriously Flawed

EPA cites emerging science as a basis for adopting its newly fashioned approach to reviewing coal mining permits, including immediate implementation of the conductivity limits. EPA has issued these significant new policies prior to submitting its newly emerging science to outside scientific peer review or making it available for public comment. NMA is not aware of another time when the agency has taken such an action, particularly action that brings to bear such drastic regulatory implications prior to completing these important reviews. With respect to the overall benchmark development effort, it is remarkable that it is taking the agency more than a decade to revise the water quality criteria for selenium and in a matter of months the agency was able to produce a benchmark criteria for conductivity

and with the confidence to make it immediately effective. EPA likes to distinguish between a benchmark and a water quality criterion to justify its failure to adhere to its own policies and legally required procedure, however, NMA and the companies it represents sees a distinction without a difference. In the real world, EPA's "benchmark" is having the effect of a de factor water quality standard and is now forming the basis for third party permit appeals.

NMA has expressed repeatedly its grave concerns with EPA's studies underlying and forming the basis for new policies, presumptions and de facto water quality standards. See *Final Report, Technical Review: A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*, GEI Consultants, Submitted to EPA September 2010 (GEI 2010). At bottom, NMA's primary concerns, as outlined in GEI (2010), is EPA's use of species sensitivity distribution (SSD)-based methods to develop a conductivity benchmark, similar to those used with laboratory-derived toxicity data, to derive numeric ambient water quality criteria for protection of aquatic life and their uses. The underlying principle governing the use of a species-sensitivity distribution (SSD) is that all of the organisms in the distribution exhibit a consistent response to the stressor. Specifically, each of the taxa should respond negatively to the stressor – only differing in their degree of sensitivity. However, EPA's benchmark study (EPA 2010) which drives all of these regulatory and policy changes, shows five fundamentally different types of stressor-response profiles. These five stressor-response profiles provide substantially different answers to the question "what conductivity concentration is necessary to provide the level of protection used by EPA?" See *Primary Technical Concerns with Proposed EPA Conductivity Benchmark*, GEI Consultants, attached. Accordingly, there is no way to reconcile these widely conflicting stressor-responses into a single benchmark protective of the entire macroinvertebrate community.

These issues along with a number of additional concerns with EPA's science and field data methodology have been largely ignored by EPA and its Science Advisory Panel. NMA has participated at every step of the SAB review process, submitting written and oral comments with every opportunity to do so but its comments have not been addressed in that forum. Even where our comments were presented in the context of the agency's charge questions they were ignored. For these reasons, NMA finds the SAB review woefully inadequate in terms of constituting fair and open external peer review of EPA's work. If EPA is so confident that the science the agency relies on is scientifically sound, the agency should welcome additional scientific review. NMA strongly encourages the agency to submit these studies for meaningful, independent, external peer review.

Conclusion

NMA appreciates the opportunity to provide comments on the Detailed Guidance. As stated in NMA's lawsuit, the coal mining industry is under an incredible regulatory burden caused by implementation of these new policies and guidances –

actions that are indefinitely delaying and obstructing the issuance of much needed permits critical to new and continuing operations and threatening the future of coal mining in the Appalachian region.

Sincerely,

Karen C. Bennett
Vice President, Environmental Affairs
National Mining Association

Julia McCarthy/R8/USEPA/US	To	Matthew Klasen, Marcel Tchaou
01/12/2011 12:38 PM	cc	
	bcc	
	Subject	Re: Fw: Instructions and attachments for reviews 30 questions at a time

Matt and Marcel,
Here are the reference issues for comment responses 211A-240A:
1) This reference needs to be added to Appendix 7:

> Wiley, J.B., R.D. Evaldi, J.H. Eychaner and D.B. Chambers. 2001. Reconnaissance of stream geomorphology, low streamflow, and stream temperature in the mountaintop coal-mining region, southern West Virginia, 1999-2000. Water-Resources Investigations Report 01-4092. U.S. Department of the Interior, U.S. Geological Survey, Charleston, WV.

2) This is an unknown reference:
218A: unpublished EPA MTM database

In many of the high conductivity streams that EPA has studied (e.g., Green et al. 2000; Pond et al. 2008; Pond 2010; **unpublished EPA MTM database**), "preferred habitat" (as suitable substratum, velocity, depth, shade, etc.) is indeed present, but the naturally occurring organisms are absent.

3) These references may need to be cited differently:
236A:
WVDEP study of selenium concentrations downstream of recently constructed valley fills is (WVDEP unpublished data, 2010a)

WVDEP studies of selenium effects on fish are (WVDEP 2010, WVDEP 2009a)

See Responses #14A (**WVDEP study of selenium concentrations downstream of recently constructed valley fills**), 47A (discussing Discharge Monitoring Report results exceeding 5 ug/L downstream of the Spruce No. 1 mine in Seng Camp Creek), and 24A and 63A (**WVDEP studies of selenium effects on fish**).

Cheers,
Julia

Julia McCarthy
on detail to USEPA Headquarters
Office of Wetlands, Oceans and Watersheds
(202) 566-1660
mccarthy.julia@epa.gov

A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a connection of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity. ~Aldo Leopold

Gregory Peck/DC/USEPA/US
01/12/2011 12:45 PM

To Kevin Minoli
cc Christopher Hunter, Karyn Wendelowski, Matthew Klasen, Stefania Shamet
bcc
Subject Re: Clean Final Draft

Great - thanks.

Kevin Minoli	I have not connected with Sam, but why don't I s...	01/12/2011 12:43:50 PM

From: Kevin Minoli/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA
Cc: Christopher Hunter/DC/USEPA/US@EPA, Karyn Wendelowski/DC/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/12/2011 12:43 PM
Subject: Re: Clean Final Draft

I have not connected with Sam, but why don't I send it to the three of them and see if any of them have two hours right now to read it.

Gregory Peck	Would be helpful to send this now to Phil and/or...	01/12/2011 12:35:16 PM

From: Gregory Peck/DC/USEPA/US
To: Christopher Hunter/DC/USEPA/US@EPA
Cc: Karyn Wendelowski/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/12/2011 12:35 PM
Subject: Re: Clean Final Draft

Would be helpful to send this now to Phil and/or Ann for a fresh perspective. Should I ask them to review or was Kevin just sending to Sam?

Christopher Hunter	Should incorporate all comments I've received....	01/12/2011 12:32:19 PM

From: Christopher Hunter/DC/USEPA/US
To: Karyn Wendelowski/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA, Gregory Peck/DC/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
Date: 01/12/2011 12:32 PM
Subject: Clean Final Draft

Should incorporate all comments I've received. (b) (5) [redacted] Appendices will be coming momentarily.
[attachment "Spruce FD 011211 clean.doc" deleted by Gregory Peck/DC/USEPA/US]

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Kevin Minoli/DC/USEPA/US
01/12/2011 12:59 PM

To Gregory Peck
cc Christopher Hunter, Karyn Wendelowski, Matthew Klasen, Stefania Shamet
bcc
Subject Re: Clean Final Draft

Phil and Ann are both going to give it a quick read.

Gregory Peck | Would be helpful to send this now to Phil and/or... | 01/12/2011 12:35:16 PM

From: Gregory Peck/DC/USEPA/US
To: Christopher Hunter/DC/USEPA/US@EPA
Cc: Karyn Wendelowski/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Stefania Shamet/R3/USEPA/US@EPA
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Stefania Shamet/R3/USEPA/US
01/12/2011 03:31 PM

To Marcel Tchaou, Matthew Klasen
cc
bcc
Subject Another one found -- Fw: QUICK TURNAROUND -- NEED Fw: reference citations

----- Forwarded by Stefania Shamet/R3/USEPA/US on 01/12/2011 03:31 PM -----

From: Margaret Passmore/R3/USEPA/US
To: Stefania Shamet/R3/USEPA/US@EPA
Cc: Frank Borsuk/R3/USEPA/US@EPA
Date: 01/12/2011 03:28 PM
Subject: Re: QUICK TURNAROUND -- NEED Fw: reference citations

REidel et al. 1991

could not get the pdf for free. Heres the link

http://www.springerlink.com/content/l775762461134540/

and full citation

Riedel GF, Ferrier DP, Sanders JG (1991) Uptake of selenium by freshwater phytoplankton. Water Air Soil Pollut 57/58: 23–30

Margaret Passmore
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Visit our website at http://epa.gov/reg3esd1/3ea50.htm

Stefania Shamet | Frank -- are these yours??? can you get us the... | 01/12/2011 03:13:56 PM

From: Stefania Shamet/R3/USEPA/US
To: Frank Borsuk/R3/USEPA/US@EPA
Cc: Margaret Passmore/R3/USEPA/US@EPA
Date: 01/12/2011 03:13 PM
Subject: QUICK TURNAROUND -- NEED Fw: reference citations

Frank -- are these yours??? can you get us the cites v. quickly?? thanks.

----- Forwarded by Stefania Shamet/R3/USEPA/US on 01/12/2011 03:12 PM -----

From: David Kargbo/R3/USEPA/US
To: Stefania Shamet/R3/USEPA/US@EPA
Cc: Matthew Klasen/DC/USEPA/US@EPA
Date: 01/12/2011 03:09 PM
Subject: Re: reference citations

These are not my references.

David M. Kargbo, PhD
Office of Environmental Innovation
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1650 Arch Street
Philadelphia, PA 19103
Tel: 215 814-3319 / E-mail: kargbo.david@epa.gov

Stefania Shamet | Dave --- a few of your references didn't make it i... | 01/12/2011 02:18:36 PM

From: Stefania Shamet/R3/USEPA/US
To: David Kargbo/R3/USEPA/US@EPA
Cc: Matthew Klasen/DC/USEPA/US@EPA
Date: 01/12/2011 02:18 PM
Subject: reference citations

Dave --- a few of your references didn't make it into the appendix -- probably my bad. Would you mind giving me the full citations for thefollowing:

92 Selenium typically enters a stream or river as selenate (Cutter and Bruland 1984;

92 Reidel et al 1991; Hu et al 1997;

Thanks!;

Frank Borsuk/R3/USEPA/US
01/12/2011 04:18 PM

To Stefania Shamet
cc Marcel Tchaou, Margaret Passmore, Matthew Klasen
bcc
Subject Riedel et al 1991 - Re: Hu et al 1997 pdf ---Re: QUICK TURNAROUND -- NEED Fw: reference citations

Riedel et al 1991.pdf

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Please visit our website at http://epa.gov/reg3esd1/3ea50.htm

Stefania Shamet	Another one found. Thanks, Frank	01/12/2011 03:48:01 PM

From: Stefania Shamet/R3/USEPA/US
To: Frank Borsuk/R3/USEPA/US@EPA, Marcel Tchaou/DC/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA
Cc: Margaret Passmore/R3/USEPA/US@EPA
Date: 01/12/2011 03:48 PM
Subject: Re: Hu et al 1997 pdf ---Re: QUICK TURNAROUND -- NEED Fw: reference citations

Another one found.

Thanks, Frank

Frank Borsuk	Frank Borsuk, Ph.D. Aquatic/Fisheries Biologist	01/12/2011 03:44:32 PM

From: Frank Borsuk/R3/USEPA/US
To: Margaret Passmore/R3/USEPA/US@EPA
Cc: Stefania Shamet/R3/USEPA/US@EPA
Date: 01/12/2011 03:44 PM
Subject: Hu et al 1997 pdf ---Re: QUICK TURNAROUND -- NEED Fw: reference citations

[attachment "Hu et al 1997.pdf" deleted by Stefania Shamet/R3/USEPA/US]

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Margaret Passmore	REidel et al. 1991 could not get the pdf for free....	01/12/2011 03:28:20 PM

From: Margaret Passmore/R3/USEPA/US
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92 Selenium typically enters a stream or river as selenate (Cutter and Bruland 1984;

92 Reidel et al 1991; Hu et al 1997;

Thanks!;

UPTAKE OF SELENIUM BY FRESHWATER PHYTOPLANKTON

GERHARDT F. RIEDEL, DOROTHEA P. FERRIER,
and JAMES G. SANDERS
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Benedict Estuarine Research Laboratory
Benedict, Maryland 20612
USA

ABSTRACT. The uptake of three forms of Se, selenate, selenite and selenomethionine, was examined in three species of freshwater algae, Anabaena flos-aquae (Cyanophyceae), Chlamydomonas reinhardtii (Chlorophyceae), and Cyclotella meneghiania (Bacillariophyceae) in a defined medium using radiotracers at Se concentrations representative of contaminated systems. Based on the relative accumulation by live vs. heat-killed cells, and linear accumulation through time, selenate accumulation by all three species appears to be a physiological process. However, selenite accumulation at these concentrations appears to be due largely to sorption rather than active uptake, as shown by rapid initial accumulation and the fact that accumulation by heat-killed cells was nearly equal to that of dead cells. Both selenate and selenite uptake rates increased linearly with concentration over the range of 1 to 50 $\mu g\ L^{-1}$. Selenomethionine uptake is a biological process with saturable uptake kinetics (K_s ranging from about 2 to 30 $\mu g\ L^{-1}$ Se), with much greater uptake rates than the other two forms, and little inactive sorbtion to heat-killed cells.

1. Introduction

Selenium is known to be both an essential and a toxic trace element for a wide variety of organisms, ranging from microorganisms (including many phytoplankton) to man. Selenium is distributed unevenly in the environment, with organisms in some ecosystems showing evidence of Se deficiency, and others showing evidence of Se toxicity. In addition, Se is a by-product of certain industrial and agricultural processes (Gissel-Nielsen and Gissel-Nielsen, 1973; Andren et al., 1975; Furr et al., 1977; Parekh and Husain, 1981; Marshall, 1985) and there are cases where Se from such sources has caused environmental damage (Cumbie and Van Horn, 1978; Sorenson et al., 1982; Marshall, 1985).

Among phytoplankton, Se has been established as a necessary micronutrient for several species from diverse taxa including dinoflagellates (Lindstrom, 1980, 1983; Lindstrom and Rodhe, 1978, Ishimaru et al., 1989), diatoms (Price et al., 1987) and chrysophytes (Pintner and Provasoli, 1968; Wehr and Brown, 1985). In a study with Chrysochromulina breviturrita, Wehr and Brown (1985) found that selenate, selenite, selenomethionine, selenocystamine, and dimethylselenide could fulfill the Se requirement.

Selenium is not known to be highly toxic to phytoplankton. For example, Wheeler et al. (1982) examined selenate and selenite toxicity to 6 species of marine algae and found that approximately 10 mg L^{-1} selenate was toxic, while the same species were not inhibited by as much as 100 mg L^{-1} selenite. Moreover, selenate toxicity was decreased by increased sulfate concentrations, while selenite toxicity was not. Foe and Knight (1986) found that 125 $\mu g\ L^{-1}$ Se as selenite inhibited the freshwater green alga Selenastrum capricornutum and Kiffney and Knight (1990) found 5 mg L^{-1} Se as selenate, 5 mg L^{-1} Se as selenite and 0.3 mg L^{-1} Se as selenomethionine inhibited the growth of Anabaena flos-aquae.

Water, Air, and Soil Pollution **57–58**: 23–30, 1991.
© 1991 *Kluwer Academic Publishers. Printed in the Netherlands.*

In this study we have examined the rates and kinetics of Se uptake at levels found in contaminated freshwater systems as part of a larger project to model the fate and effects of Se released into lakes as a result of power generation (Porcella et al., 1990). Selenium in these lakes has at times exceeded 15 $\mu g\ L^{-1}$ (Cutter, 1989), predominantly as selenite, and as a result some larger fish species have been virtually eliminated from the lakes (Cumbie and Van Horn, 1978; Sorenson et al., 1982). It is believed that Se bioaccumulation through the food chain is at least partially responsible for these effects. In other areas, such as the central valley of California, agricultural waste waters in areas of high soil Se have had up to 300 $\mu g\ L^{-1}$ of Se as selenate (Cooke and Bruland, 1987). These systems contrast with pristine freshwaters which generally contain much less than 1 $\mu g\ L^{-1}$ Se, in which algae may be Se deficient (Lindstrom, 1983; Wehr and Brown, 1985).

Our overall objective is to understand the role of phytoplankton in the biogeochemistry of Se in contaminated freshwaters. In particular our objectives are 1) provide information on the accumulation of various forms of Se by algae in order to make predictions about Se accumulations into higher trophic levels, and 2) to examine the role of phytoplankton in the biogeochemical transformations of Se forms. This paper reports on some of our results from experiments concerning the time course and substrate dependence of uptake of three forms of Se by a taxonomically diverse group of freshwater phytoplankton.

2. Methods and Materials

2.1. CULTURING AND GENERAL METHODS

Three species of algae chosen to represent a wide taxonomic range were obtained from the University of Texas culture collection. These were Anabaena flos-aquae (UTEX 1444), a blue-green alga, Chlamydomonas reinhardtii (UTEX 89), a green alga, and Cyclotella meneghiania (UTEX 2455), a diatom. Cultures were not axenic.

Maintenance and experimental culturing were carried out in a modified WC medium (Guillard and Lorenzen, 1972), the modifications being additional $NaHCO_3$ (300 μM total), KBr (1 μM) and NaF (10 μM). These modifications were made to more completely simulate the ion composition of Hyco Lake, NC, one of the sites selected for modeling purposes. One other modification to the medium has been made. Because Anabaena is a N-fixing, blue-green alga, and because such algae tend to be dominants during times of N-depletion, owing to the competitive advantage of N-fixation, we have performed physiological experiments on Anabaena in medium with no added nitrate. Individual components of the media were autoclave sterilized and added to sterile deionized water to minimize precipitate formation. Glassware and plasticware for maintenance and experimental cultures were acid-washed with 10% (V/V) HCl and autoclaved partially filled with deionized water, which was discarded. Background levels of selenite, selenate, and total Se were measured in this medium using hydride generation and atomic absorption detection (Cutter and Bruland, 1984), and were found to be negligible compared to our addition levels ($<0.02\ \mu g$ Se L^{-1}). Cultures were grown and maintained in medium with no added Se.

Algae for experiments were grown from inocula of 1 x 10^3 cells mL^{-1} in modified WC medium in 4 L glass carboys in a temperature-controlled incubator at a temperature of 25 $\pm$ 1 °C, with light levels of approximately 100 $\mu Ein\ m^{-2}\ s^{-1}$, on a 14/10 hr light/dark cycle. The pH of the culture was then adjusted to 7.0 with 10% HCl, and a sample preserved for the initial cell count (Guillard, 1973). In the Chlamydomonas time course the pH of the selenite and selenate cultures increased to pH 8.0 over the 24 hr incubation, while the selenomethionine culture remained at pH 7.0. In the Cyclotella experiment, no pH shifts were observed. In subsequent substrate experiments, shorter incubations and less dense cultures resulted in pH shifts of 0.1 to 0.2 pH units.

Selenium-75 as sodium selenate, sodium selenite and selenomethionine was obtained from Amersham in 1 mCi lots and diluted with deionized water into high density polyethylene bottles. Specific activities of the isotope stock solutions were 2.07, 2.04 and 4.84 Ci g^{-1}, respectively. Selenate and selenite stock solutions were stored in the dark at room temperature, while selenomethionine was kept refrigerated (4 °C). Counting was carried out on a Tennelec NaI(Tl) gamma counting system equipped with a 7.6 cm well detector and a multichannel analyzer. Uptake was calibrated by comparing counts of the experimental samples to aliquots of the ^{75}Se stock solutions. Substrate additions were made using ^{75}Se stock isotope solutions, and were based on the Se concentration of isotope stocks supplied by the manufacturer and their subsequent dilution.

2.2. TIME COURSE SELENIUM ACCUMULATION EXPERIMENTS

Log-phase culture of each species were placed into six 250 ml polycarbonate incubation bottles. Cell densities of the experimental cultures were 2.3 x 10^6 cells mL^{-1} for Anabaena 1.7 x 10^5 cells mL^{-1} for Chlamydomonas and 2.0 x 10^4 cells mL^{-1} for Cyclotella. Three of these bottles were heated in a microwave oven until the water temperature reached 70 °C for 5 minutes, to kill the cells and stop metabolic processes, but to allow physical uptake (e.g., absorption, adsorption and occlusion on the filter) to continue. After this treatment cells remain intact to microscopic examination, with pigments, but do not grow. One bottle of live and one bottle of dead cells were used for each form of Se. ^{75}Se additions were rather high in these experiments in order to facilitate examining uptake during short incubations, (1 μCi mL^{-1} for all forms for Anabaena, 0.2 μCi mL^{-1} for Chlamydomonas and 0.25 μCi mL^{-1} for Cyclotella), however, preliminary experiments had shown that these levels of Se had no effect on the growth rate of the algae. ^{75}Se stock solution was added to each bottle, and filtrations performed through 2.5 cm diameter, 0.4 μm Nuclepore filters using 35 kPa suction at intervals of 0, 10, 30 min, 1, 2, 3, 4, 6, 12 and 24 hr. Filtered phytoplankton were then rinsed twice with fresh medium to remove non-incorporated Se. The filters were placed in disposable 15 mL test tubes for gamma counting. Time course uptake curves were analyzed by polynomial regression for evidence of significant curvature.

2.3 SUBSTRATE CONCENTRATION UPTAKE EXPERIMENTS

Log-phase culture of each species was placed into 50 mL Pyrex test tubes. Cell densities of the experimental culture were 3.6 x 10^5 cells mL^{-1} for Anabaena, 4.9 x 10^4 cells mL^{-1} for Chlamydomonas and 5.3 x 10^4 cells mL^{-1} for Cyclotella. Samples were also taken for bacterial enumeration by acridine orange direct counts (Hobbie et al., 1977). Bacterial densities at the beginning of uptake experiments were 6.1 x 10^5 cells mL^{-1} for Anabaena, 1.2 x 10^5 for Chlamydomonas and 6.97 x 10^5 for Cyclotella. Using a value of 100 fg C $cell^{-1}$ for bacteria (Atlas and Bartha, 1981), bacteria represented $< 1\%$ of the total biomass. For the Anabaena experiment, 50 mL of culture were used for each treatment, while for Chlamydomonas and Cyclotella 25 mL were used. For each form of Se (selenate, selenite and selenomethionine), six substrate concentrations were tested: 1, 2, 5, 10, 20 and 50 $\mu g\ L^{-1}$. Two live cultures and one dead culture were tested at each concentration. Cultures were incubated for 6 hr in a 25 °C incubator at approximately 100 μEin $m^{-2}\ s^{-1}$. The cultures were filtered onto 2.5 cm diameter 0.4 μm Nuclepore filters at 35 kPa. Filters were rinsed twice with clean medium and placed in 15 mL disposable test tubes for gamma counting. Substrate concentration curves were tested with an F-test for lack of fit. The curves which showed significant lack of fit ($p < 0.05$) were further analyzed by fitting a Michelis-Menten function to them using a nonlinear fitting routine (Marquadt algorithm).

3. Results and Discussion

For all three algal species, selenate accumulation by live algae was basically linear up to 24 hr, and uptake by dead algae was constant and much less than live uptake (Figure 1 a-c). For all three species, the rate of selenate accumulation was the least of the three forms tested (at least in the early time period, before selenite accumulation leveled off). The fact that accumulation by live algae was much greater than that of dead algae is strong evidence that selenate uptake by these algae is a physiologically-mediated process. The continued accumulation of selenate over 24 hr indicated that internal concentrations of selenate had not yet reached levels at which significant excretion occurs.

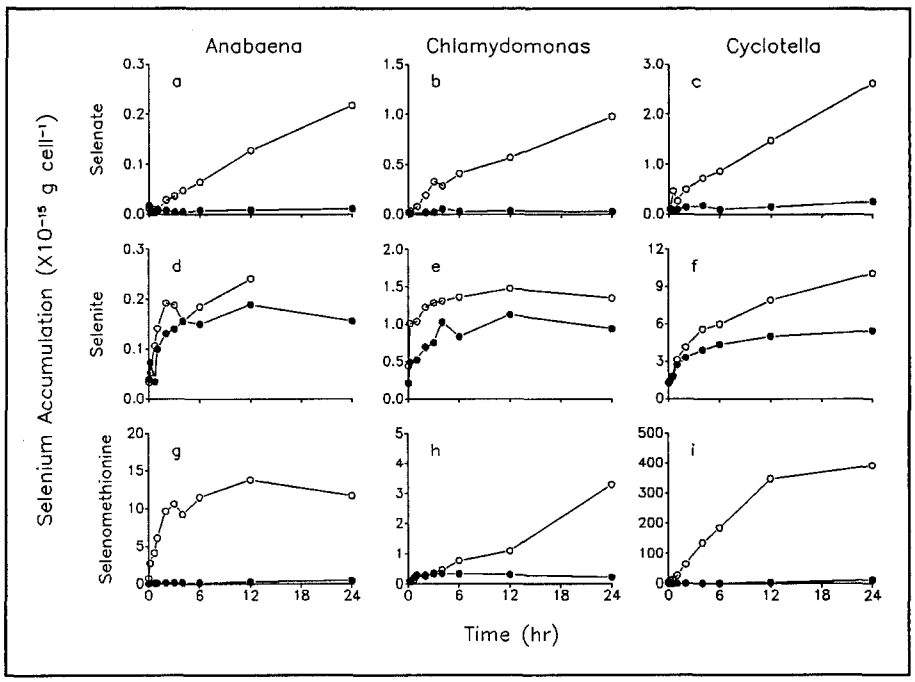

Fig. 1. Uptake of selenate, selenite and selenomethionine by Anabaena flos-aquae, Chlamydomonas reinhardtii, and Cyclotella meneghiania through time. Open circles are live cells, closed circles are heat-killed cells.

For both Anabaena and Chlamydomonas, selenate uptake rate increased linearly with external selenate concentration to 50 $\mu g\ L^{-1}$ (Figure 2 a,b). In Cyclotella, however, selenate exhibited saturation uptake kinetics, with a K_s of 3.6 $\mu g\ L^{-1}$ (0.05 μM) (Figure 2 c). If one tentatively assumes that selenate is transported into the cell by the same enzyme that normally transports sulfate, it is likely that selenate is a competitive inhibitor of sulfate transport (and vice versa). Sulfate uptake has been studied in a variety of algae, and some algae have two systems for sulfate uptake, a high affinity system with a K_s of between 0.75 and 32 μM, and a second, low affinity system responsible for uptake at much higher concentrations (Raven, 1980). If such systems are responsible for selenate uptake in the algae in this study it is not surprising that two species show

almost no sign of saturation of selenate uptake at sulfate to selenate ratios of 450:1 or less. Rather it is surprising that Cyclotella shows saturation at such low concentrations in the presence of 150 μM sulfate. Perhaps a high affinity, low velocity system present in Cyclotella is involved in the uptake of selenate.

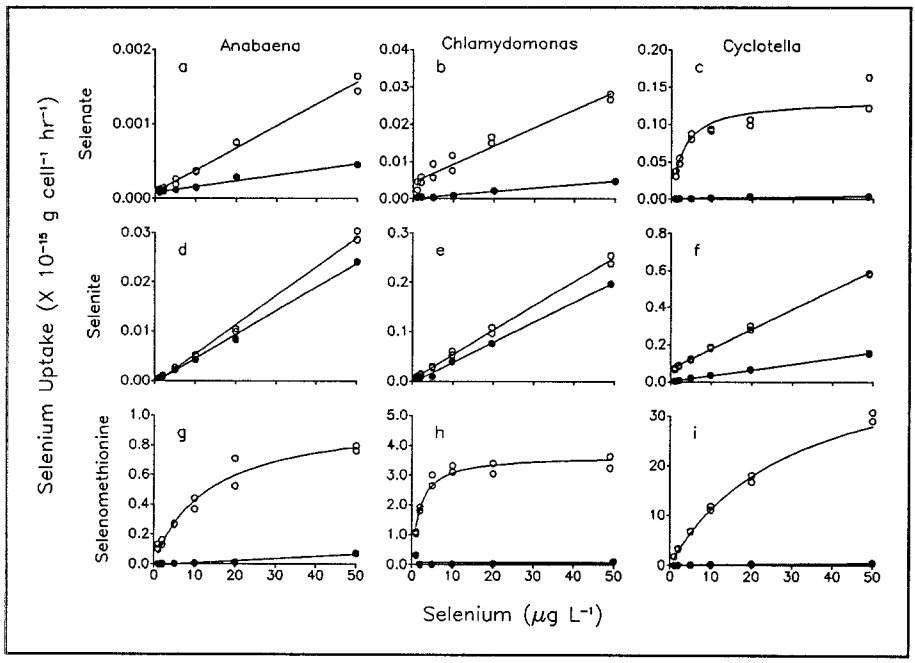

Fig. 2. Uptake of selenate, selenite and selenomethionine by Anabaena flos-aquae, Chlamydomonas reinhardtii, and Cyclotella meneghiania as a function of substrate concentration. Open circles are live cells, closed circles are heat-killed cells.

For all three species of algae, selenite uptake occurred rapidly, reaching near maximum values by about 6 hr (Figure 1 d-f). Moreover, uptake by heat-killed cells was a significant fraction of the uptake by live cells for all three species (78% for Anabaena, 76% for Chlamydomonas, and 63% for Cyclotella, at 12 hr). This suggests that selenite uptake, although it may have a biological component, also has a non-biological, relatively rapid adsorptive component. Generally speaking, the uptake of selenite was more rapid than selenate in the early period before it declined, but slower than uptake of selenomethionine. Further experimentation is needed to determine if the adsorbed selenite can be removed chemically so that underlying biological uptake can be determined.

For all three algae, selenite uptake was linear with concentration up to 50 μg L^{-1}, and similar in magnitude for both live and dead cells (Figure 2 d-f), except for Cyclotella where uptake by live cells was approximately 3 times uptake by dead cells. Overall, this strongly suggests that much of the selenite "uptake" we observed is non-biological adsorption of selenite to cell surfaces, cell debris, or precipitates in the medium. Because selenous acid is a weak acid (pKa = 8.09), selenite adsorption is expected to be high compared to selenate over the pH range

encountered in natural waters, and should increase as pH declines. This is not meant to suggest that biological selenite uptake by algae does not occur; other studies have shown that selenite fulfills the Se requirements of algae at lower concentrations than selenate. However, methods must be tested to separate biological uptake from the large abiotic component. Such methods have been successfully employed in the study of Fe uptake by phytoplankton, which presents similar adsorption problems (Hudson and Morel, 1989).

Selenomethionine uptake in all three algae appears to be a biologically-mediated process; for all three algae the living cells took up much more than the heat-killed cells (Figure 1 g-i, Figure 2 g-i). Selenomethionine also showed the most variable time course of uptake of the three forms of Se. For Anabaena, uptake was rapid through the first 4 hr, after which it leveled off. With Chlamydomonas, uptake was approximately linear over 24 hr. With Cyclotella, uptake was linear over the first 12 hr. We do not know the reason for these variations in the uptake pattern of selenomethionine, but there is evidence that selenomethionine is rapidly (within 1 to 2 days) transformed into other substances, in small part a gaseous Se compound, possibly dimethylselenide (Karlson and Frankenberger, 1988), and largely a different organic Se compound, possibly a selenonium compound (Cooke and Bruland, 1987). We are continuing to investigate this transformation. For all three algae, selenomethionine was the most rapidly transported species of Se. For all three species of algae, selenomethionine displayed saturation uptake kinetics, with the K_s from 1.9 to 30 μg L^{-1} Se (0.03 to 0.4 μM). Amino acid uptake by phytoplankton has been extensively studied as an alternative source of N, and the K_s for uptake of amino acids ranges from 0.4 to 150 μM (Flynn and Butler, 1986).

Our work is in general agreement with other investigations that suggest that selenite is taken up by phytoplankton more rapidly than selenate. For example, Kiffney and Knight (1990) have examined the concentration of Se in Anabaena flos-aquae grown for several days in much higher concentrations of Se in all three forms we have examined (1 to 10 mg L^{-1} Se as selenate and selenite, 50 to 300 μg L^{-1} Se as selenomethionine). They found approximately constant bioconcentration factors (BCF) for selenate and selenite after the first 2 days of uptake; selenomethionine, however, showed decreasing BCF with increasing concentrations. This corresponds well with our findings of linear uptake with concentration of selenate and selenite, and saturated uptake of selenomethionine.

Vandermeulen and Foda (1988) examined cellular Se in several species of marine phytoplankton cultured with concentrations of selenite and selenate from 10^{-10} to 10^{-5} M in batch culture over several days. They report that selenite is taken from the medium in much greater amounts than selenate, much like our results. Unlike our results, they report little uptake of selenite by dead cells, from 0 to 10.6% of living cells. This may be due in part to differences in pH and ionic strength of the marine medium, with higher pH decreasing the adsorptive strength of selenite, and greater ionic strength increasing competition for available adsorptive sites.

Price and Harrison (1988) studied the uptake of 10^{-8} M selenite by the diatom Thalassiosira pseudonana in batch culture over five days. They observed approximately constant concentrations of Se per cell (1.6×10^{-18} mol Se $cell^{-1}$). They fractionated the cellular Se and found 51% in the TCA insoluble fraction which includes proteins (and possibly adsorbed selenite) and 36% in the TCA soluble fraction (polysaccharides and nucleic acids). The remainder was present in lipids and low molecular weight materials.

Our study suggests that while all three forms of Se tested are accumulated by phytoplankton, each form may be taken up by a biochemically different process. Selenate is transported into the cell by a biological process with low affinity, selenite appears to be largely physically adsorbed, and selenomethionine transported by a rapid, high affinity system.

While we have not addressed it in this paper, our results with selenate uptake are consistent with uptake of selenate by the sulfate transport system, as shown by Schrift (1954) for the green alga Chlorella vulgaris. Selenate is the dominant form of Se in some polluted areas, and an

examination of how sulfate and other variable constituents of freshwaters influence selenate uptake is vital to understanding how Se affects such ecosystems.

This study appears to be the first to demonstrate that apparent uptake of selenite by phytoplankton may contain a large fraction of nonbiological uptake, although the inorganic chemistry of selenite suggests that adsorption is likely in the low pH, low ionic strength medium. However, similar uptake of selenite by heat-killed cells has been observed with ovine rumen bacteria (Hudman and Glenn, 1984). More research into the role of adsorption in phytoplankton selenite uptake is necessary to understand the implications of this in biogeochemical models of Se transport, and the relative availability of adsorbed vs. assimilated selenite to higher trophic levels.

Although organic Se has been shown to be a significant, and in some cases dominant fraction of Se in freshwaters (Cutter, 1989) selenomethionine has not been found to be a major fraction of the dissolved organic Se. The results of our experiments, and those of others show (Sandholm et al., 1973; Besser et al., 1989; Kiffney and Knight, 1990) that selenomethionine is rapidly removed from water by algae and bacteria, and that even if there was a significant source of selenomethionine to the waters, little would accumulate.

Selenium is an unusual trace element in that it is commonly present in three valence forms, (IV, VI, and -II) which are at least kinetically stable in the aquatic environment. Different sources may selectively enrich environments with one or another of these forms. Our results demonstrate that phytoplankton process these forms by different mechanisms, that they will be concentrated within the cell to different degrees, and that concentration will be affected by various chemical and biological factors in the environment. Therefore, similar aquatic systems receiving loadings of different forms of Se can be expected to react dissimilarly, yielding distinct mixtures of speciation within the water column. Attempts to predict either the potential food chain transfer or toxicity of added Se to natural systems must take such differences into account.

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K_d Values for Agricultural and Surface Soils for Use in Hanford Site Farm, Residential, and River Shoreline Scenarios

Technical Report for Groundwater Protection Project -- Characterization of Systems Task

R. Jeff Serne

August 2007

Prepared for Fluor Hanford, Inc. and
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This report provides best estimate K_d values and a minimum and maximum range of K_d values to be used for agricultural soils and Columbia River bank sediments that exist today or would exist in the future when portions of the Hanford Site are released for farming, residential, and recreational use after the U.S. Department of Energy (DOE) completes clean up of defense waste on the site. The K_d values should be used to determine the fate and transport rates of contaminants and their availability for plant and animal uptake in selected non-groundwater scenarios included in Hanford Site environmental impact statements, risk assessments and specific facility performance assessments.

This report describes scenarios such as a small farm where drilling of a well inadvertently goes through buried waste and brings waste to the surface, allowing the tailings to become available for direct human exposure or incorporation into garden crops and farm animals used for food by the farm family. The K_d values recommended in this report can also be used to calculate sediment-water partitioning factors used to predict plant and animal uptake from interaction with the contaminated soil.

The values recommended herein should not be used to predict exposure to contaminants in drinking water or from water used for irrigation. For the waterborne scenarios, K_d values recommended in Last et al. (2004) and Krupka et al. (2004) should be used because they better predict the distribution and mobility of contaminants in water.

Other non-groundwater scenarios include (1) recreational or native American use of the Columbia River bank that exposes humans to contaminants adsorbed to the river bank sediments, (2) contaminants transferred from sediments to plants or animals that reside along the Columbia River bank, and (3) any other scenario that requires estimation of soil-to-plant or soil-to-animal transfer parameters that are often calculated based on soil K_d values.

For these non-groundwater exposure scenarios, choosing a larger K_d value from available values will be "conservative" in the sense that large K_d values keep the contaminant available longer (retains more contaminants in the soils) such that exposure to humans or incorporation into animals and plants is maximized. Therefore, the K_d values in this report are slightly biased to keep the contaminants near the ground surface for longer time periods. Upon exposure to water or by direct contact, the contaminated near-surface soils allow more opportunity for direct exposure and incorporation into plant matter and animals.

The following contaminants of concern were the focus of the search: americium, bismuth, carbon-14, carbon tetrachloride, cesium, chlorine-36, chromium, cobalt, iodine, lanthanides (especially europium), lead, neptunium, nickel, nitrate/nitrite, plutonium, polonium, protactinium, radium, selenium, strontium, technetium, tritium, and uranium.

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1.0 Introduction

This report tabulates K_d values for a selected list of contaminants of interest isolated within near-surface agricultural soils and Columbia River bank near-surface sediments that exist today or would exist in the future when portions of the Hanford Site are released for farming, residential, and recreational use after the U.S. Department of Energy (DOE) waste cleanup activities are completed. The soil and sediment types considered are surface soils that are capable of sustaining large agricultural farms or small family farms that produce typical food crops and surface soils typically found at rural/suburban residences. In addition, the K_d values tabulated in this report can be used to evaluate the risks of exposure to near-shore Columbia River bank sediments that may have been contaminated by Hanford activities and are currently found along the riverbank today and into the future. The K_d values can be used to determine the fate and transport rates and availability for plant and animal uptake of these contaminants in selected scenarios included in Hanford Site environmental impact statements, risk assessments, and specific facility performance assessments, such as:

1. Small farm development that includes inadvertently drilling a well through buried waste, bringing solid/sediment-bearing waste to the surface. These tailings then become available for direct human exposure or incorporation into garden crops and farm animals used for food by the farm family. The K_d values recommended in this report can be used to calculate direct human exposure to the sediments bearing small masses of tailings and to determine sediment-water partitioning factors used in predicting plant and animal uptake from interaction with the contaminated soil. The K_d values recommended herein should not be used to predict migration of contaminants to the groundwater or for direct exposure to contaminants in the drinking water. For such water-borne scenarios, K_d values recommended in Last et al. (2004) and Krupka et al. (2004) should be used because they better predict the distribution and mobility of contaminants in water. There is one scenario involving irrigation water that can use the K_d values from this report. The uptake of contaminants from contaminated irrigation water by the future agricultural and Columbia River bank sediments can use the tabulated K_d values because future soil and riverbank sediments have the potential to adsorb more contaminants than the current sediments based on the assumption that future soil will contain more organic matter and have a slightly lower overall mean particle size due to soil amendments and farming practices.
2. Recreational or Native American use of the Columbia River bank. In this scenario, humans may be exposed to contaminants adsorbed to the riverbank sediments or contaminants transferred from sediments to plants or animals that reside along the Columbia River bank.
3. Any other scenario that requires estimation of soil-to-plant or soil-to-animal transfer parameters that are often calculated based on near-surface soil K_d values.

To re-iterate, the K_d values reported herein should not be used for fate and transport modeling for water-borne contaminant scenarios except when the modeling is used to estimate accumulation of contaminants by future surface soils from irrigation practices. Scenarios for which the K_d values tabulated herein should not be used include transport of contaminants through the vadose zone to the groundwater or human exposure from well waters. For the groundwater/well water scenarios, K_d values have been extensively collated, reviewed, and documented in reports such as Cantrell et al. (2003), Last et al. (2004) and Krupka et al. (2004). The K_d values recommended in Last et al. (2004) are intended to provide best estimate values and a range in uncertainty for scenarios where liquid waste was disposed to

subsurface disposal facilities with emphasis on adsorption. Values tabulated in Krupka et al. (2004) are slightly biased toward values that promote contaminant mobility via water pathways.

For the non-groundwater exposure scenarios, choice of a larger K_d value will be conservative in the sense that large K_d values keep the contaminant available longer (retains more contaminants in the soils) so that incorporation or exposure to humans, animals, and plants is maximized for the non-groundwater scenarios. Therefore, the K_d values in this report are slightly biased to keep the contaminants near the ground surface for longer time periods than generally assumed for past liquid waste disposal operations. Upon exposure to water or by direct contact, the contaminated near-surface soils allow more opportunity for direct exposure and incorporation into plant matter and animals. On the other hand, for groundwater/ well water scenarios, choosing lower K_d values leads to more rapid transport of contaminants from the near surface to the groundwater and, thus, more exposure or risk to the receptor who imbibes the water or bathes in the contaminated water.

One goal of this study was to capture the fact that agricultural soils often contain more organic matter and silt- and clay-size particles than generally exists in the native Hanford formation sands and aeolian deposits that lie near ground surface today. Both the increased organic matter content and increased fine-particle content tend to increase the adsorption properties of most contaminants (see EPA 1999a for discussion on the impact of organic matter and particle surface area); this would lead to larger K_d values than one should use for modeling contaminant adsorption on typical Hanford sand sediments found today.

A recent screening survey of soil pH values at highly vegetated upland sites and along the Columbia River shoreline at locations designated informally as "Vernita Riparian," "100B/C Riparian," "Downstream Riparian," and "Upland Reference" show slightly acidic pH values (6.2 to 7.8) likely caused by decaying plant material.[1] These are the pH measurements and general soil descriptions used in this report for vegetated near-surface and Columbia River bank soils. The slightly acidic nature of these soils is an indication that future soils may have lower than ambient pH. This influenced the range of K_d values recommended in this report because pH is a key parameter that influences the adsorption properties of many of the contaminants and hydrous oxide coatings/adsorbents present in soils. It is not clear whether the lowered pH values signify the presence of any potential strong radionuclide chelating agents, such as fulvic and humic acids, or whether the slightly acidic pH values are caused by less strong complexing moieties, such as simple organic acids. In fact, the slightly acidic pH values measured on these few samples have not been shown to be caused by decay of organics, it is only a supposition at this time. The possibility that decaying organic matter has produced significant concentrations of strong chelators such as fulvic and humic acids should be considered if further measurements of pH and other parameters are made on soil along the Columbia River or upland at highly vegetated sites.

One might also assume that sediments along a river shoreline include more fine-grained sediments and organic matter than sediments/soils from inland areas based on the deposit of suspended fine sediments and organic debris from the river water and the higher potential for plant growth because of the high water content. However, at present there is no evidence that the sediments along the Columbia River banks within the Hanford Site show significantly smaller grain size or larger organic content than the

[1] Personal communication from JL Downs (Pacific Northwest National Laboratory, Richland, Washington) to RJ Serne (PNNL) via email, dated March 4, 2005.

native vegetated Hanford formation/aeolian sediments inland (Patton and Crecelius 2001).[2] The data in Patton and Crecelius (2001) show total organic carbon contents for sediments along the Columbia River banks at three sloughs range from <0.5 to 1.5% by weight and that the silt and clay content is generally <10% by weight. These particle-size values are similar to agricultural soils expected at the Hanford Site in the future and not much different from the existing sediments in burial grounds at present Serne et al. (1993) and Horton et al. (2003). The observed organic carbon content in the sloughs is somewhat greater than subsurface sediments near burial grounds that generally have organic carbon at or less than 0.1%.[3] However, values between 0.5 and 1.5% organic carbon are not high compared to highly productive agricultural soils, which typically reach values of several %wt (Tan 2000 and Tan 2003). Therefore, I recommend that the K_d values reported in this report be used for all Columbia River shoreline fate/risk calculations and for Hanford agricultural soil/Hanford family farm, recreational and residential land use scenarios that do not involve ingestion of contaminated well water by humans. The K_d values can also be used to estimate plants/animal uptake factors, which are generally related to concentrations of contaminants in the surface soils, for irrigation with contaminated well water.

The K_d values in this tabulation should also not be used to represent release of contaminants directly from solid waste tailings inadvertently brought to the surface. If large masses of waste reach the surface, release or leach values need to be measured or estimated on a case-by-case basis with keen attention to using appropriate conditions and test protocols. Rather, the K_d values tabulated herein represent adsorption and desorption from the near surface soils and river bank sediments themselves. One exception is found in the discussion of appropriate K_d values for uranium (see Section 3.23) where some consideration of waste-induced influence is assumed.

The source of contaminants in the scenarios of interest is assumed to be either:

1. residual adsorbed or precipitated contaminants in sediments deeper than those removed during clean up (often sediments from the near ground surface to a depth of 15 ft are removed from inactive disposal sites and clean fill is emplaced in the excavation to bring the contours back to grade) that are inadvertently brought to the surface and mixed with near-surface soils

   or

2. solidified waste (e.g., grout, glass, solid waste) that is inadvertently exhumed from depths below 15 ft during well drilling activities. The exhumed waste is assumed to be mixed with near surface soils around the well location or wherever the Hanford farmer would place the well drilling tailings. It should be noted that the volume of waste brought to the ground surface by well drilling should be rather limited. Because of the assumed small mass of waste, except for the contaminant uranium, this tabulation does not account for any significant changes in the solution composition or physical attributes of the soils/river bank sediments in the selection of K_d values.

   or

[2] Personal communication from GW Patton and RE Peterson (Pacific Northwest National Laboratory, Richland, Washington) with RJ Serne (PNNL), June 2005.
[3] Data taken from a Hanford Site database available at \\wd40960\AGGData\AGGPublic\COS Min Database\Database Project\Master Database.xls or available from GV Last (Pacific Northwest National Laboratory, Richland, Washington).

3. re-deposited waste solids that had been dispersed into the atmosphere by some activity or waste brought near the surface by burrowing animals and mixed with the surface soils. Again the assumption is that the mass or percentage of waste that gets mixed with the near-surface soils/ sediments is small and does not significantly alter the soil and pore water attributes, except for uranium.

These mixed waste/soils are contacted by natural precipitation and irrigation waters and also can impact humans by direct exposure and be transferred to plants (e.g., vegetables, grasses, fruit trees), farm animals (via forage and direct ingestion), and fish (via food chain dynamics and direct ingestion) taken from the Columbia River. The pore waters in the agricultural soils and Columbia River bank sediments are assumed to be similar to natural precipitation, irrigation water, or Columbia River water that exhibits near-neutral pH values (i.e., between 7 and 8) and low ionic strength as opposed to being highly saline and either caustic- or acidic-pH bearing chemical processing waste streams that were present during the re-processing activities needed to obtain plutonium. It also has been assumed that any solid waste tailings brought to the ground surface are of limited mass that does not cause wide excursions in pH or the dissolved solids content of waters that come in contact with the tailings, excepting for uranium, which is hyper-sensitive to carbonate/pH variations.

A final process that has not been considered in this study is the impact from addition of fertilizers and other possible soil amendments to increase agricultural productivity. The study assumed that fertilizers and other soil amendments would not dramatically alter the soil pore water chemical composition or soil adsorption properties aside from promoting increased organic matter build up and a slight lowering of the mean particle-size distribution, both of which generally increase adsorption tendencies for most contaminants.

Past K_d tabulations performed for Hanford uses did not focus on agricultural soils or river bank sediments because they are not located on the Hanford Site or proximal to the majority of past and current burial grounds. Therefore, K_d literature was reviewed to locate applicable studies for low ionic strength "natural" solutions, such as groundwater, river and lake water, and rainwater contacting agricultural soils and river bank sediments. Sorption data for chemical waste streams were used only if no other data were available. Hanford Site-specific data was relied on when it was available and other general literature data was factored in to a lesser extent. From the strategies used in other Hanford K_d tabulations, only K_d value used to describe far-field or waste un-impacted conditions were considered based on the assumption that any waste brought to the surface during drilling or burrowing animal scenarios are of limited mass. The one exception was uranium, which at Hanford appears to be quite sensitive to two key variables, pH and dissolved inorganic carbon content, that both are highly influenced by common solid waste to be left in shallow-land burial facilities once the Hanford Site is released for public use.

As a service to other K_d compilers, this study contains more recent literature and provides a brief synopses of the new literature in the hope that it will be easier to update the Hanford K_d compilations in the future.

1.1 Where Did the K_d Values Come From

This critical review and update of K_d values for non-groundwater scenarios (i.e., that do not involve direct ingestion of contaminated well water by humans or animals) uses some past data compilations

performed by PNNL staff and published compilations by Coughtrey and Thorne (1983a,b) and Coughtrey et al.(1983, 1984a, 1984b, 1985) and by Thibault et al. (1990) as the main source of information.

The list of contaminants to review was prepared by Bruce Napier (PNNL) and was based on his risk assessment experience for the Hanford Site over the last ~30 years. The contaminants that have been important risk drivers for past Hanford Site assessments are listed in Section 1.2. The list is somewhat reduced from the list originally used in Napier and Snyder (2002) based on preliminary exposure dose calculations performed in the cited report. That is, some contaminants were "de-listed" based on their low inventories and/or low dose impacts.

A previous effort to tabulate K_d values for agricultural soils for non-groundwater scenarios was provided to Bruce Napier in unpublished letter reports,[4] which are attached as Appendix A to this report, from geochemists at Hanford. The geochemists had performed a limited review of available literature that focused on finding K_d values to use for groundwater scenarios, where conservative values are those biased to low numbers. The geochemists took the ranges in the available literature, with emphasis on Hanford Site-specific data when available, and simply chose the high end of the range as appropriate for non-groundwater scenarios. For the non-groundwater scenarios, conservatism was achieved by choosing high K_d values. These past letter reports were summarized as a table in Napier and Snyder (2002, Table 2).

This report, recommends using K_d values that take into consideration the nature of projected Hanford agricultural soils and river bank sediments as described in the introduction as opposed to just recommending the highest value reported in the literature. The K_d values recommended in this report should be more realistic, but remain reasonably conservative for non-groundwater scenarios.

In addition, three electronic databases were searched: on-line documents at DOE-OSTI at http://www.osti.gov/bridge/search.easy.jsp , *Web of Science* for journal manuscripts from 1980 to 2004, and On-line Computer Library Center's *First Search (*http://www.oclc.org/firstsearch/). Each database was searched using a combination of key words such as the element of interest and K_d or adsorption. When the matches were large the search was further refined with adding soil(s) or sediment(s) as a qualifier. From these searches, approximately 50 published references were found with useful data since the past compilations by Coughtrey and Thorne (1983a, 1983b), Coughtrey et al. (1983, 1984a, 1984b, 1985), and Thibault et al. (1990). All the new materials were read and useful data extracted to aid in developing the database. Because no sorption literature was found for some of the contaminants of interest, some expert judgment was used to populate the database in this report. The nuclides for which relevant data were non-existent or too sparse to select actual Hanford Site-specific K_d values were bismuth, carbon tetrachloride, chlorine-36, nitrate/nitrite, polonium, protactinium, radium, and tritium.

1.2 List of Contaminants Reviewed

The following contaminants of concern were the focus of the search: americium, bismuth, carbon-14, carbon tetrachloride, cesium, chlorine-36, chromium, cobalt, iodine, lanthanides (especially europium), lead, neptunium, nickel, nitrate/nitrite, plutonium, polonium, protactinium, radium, selenium, strontium, technetium, tritium, and uranium. The review was limited to these contaminants, per Mr. Napier's

[4] On October 3, 1997 Dr. Dan Kaplan prepared a letter report, *Selected K_d Values for Agricultural Soils*. This letter report was revised/updated by R. Jeff Serne on May 17, 1999.

request that is based on his experience and other published Hanford risk and performance assessments (Mann et al. 2001; Kincaid et al. 1998, 2000; and DOE 2004), which have shown that these are potential key risk drivers for groundwater, Hanford farm, Native American or recreational scenarios. Contaminants included in Napier and Synder (2002) that were not reviewed further include actinium (Ac), curium (Cm), iron (Fe), manganese (Mn), potassium (K), rhenium (Re), radon (Rn), ruthenium (Ru), antimony (Sb), tin (Sn), thorium (Th), and yttrium (Y). In Napier and Snyder (2002, Table 2), maximum K_d values and ranges where available are listed for these contaminants. Also the same information is found in Appendix A of this report.

1.3 Additional Discussion

This report does not include much discussion on key geochemical characteristics of the contaminants of interest, soils and sediments and the low ionic strength waters that influence the myriad of reactions that control the magnitude of adsorption. Neither should it be considered a primer on the conceptual models that are commonly used to quantify the processes that sequester contaminants in soils and sediments or the processes that promote the mobility of contaminants by keeping them in the aqueous fluids that percolate through sediments. Adsorption-desorption processes, K_d tabulations, and what parameters control the degree of adsorption for each contaminant are discussed in detail elsewhere. For example, there is a recent three volume set published by the Environmental Protection Agency (EPA 1999a, 1999b, and 2004). Other compilations, such as Ames and Rai (1978), Krupka et al. (2002), and Krupka et al. (2004), discuss the geochemistry and solution speciation, using Eh-pH or Pourbaix diagrams, for many of the contaminants reviewed herein.

It is also assumed that the K_d values do not depend on the isotope number for a given element and that all isotopes of a given element have the same K_d value. That is, the K_d for ^{152}Eu, ^{154}Eu, and ^{155}Eu are the same for a given soil/water system and geochemical conditions; and K_ds for ^{234}U, ^{235}U, and ^{238}U are the same, etc. The assumed lack of sensitivity to isotope number for K_ds is not necessarily upheld for other parameters such as soil to plant, plant to animal or human uptake factors and toxicity, which sometimes do depend on the isotope number.

The last discussion point is adsorption-desorption hysteresis, which is a term used to describe a commonly observed phenomenon where measured K_d values differ depending on whether the measurement was made by putting the contaminant in solution and contacting “clean” solids or taking previously contaminated solids and contacting them with clean water. Quite often the K_d value measured by the former method yields a lower value than when the K_d value is measured by leaching or desorption off the solid. There has been significant discussion of this hysteresis phenomenon and several process level or mechanistic explanations have been offered. More discussion is found in EPA (1999a) but knowledge of the cause(s) is not complete. For this K_d value, it was assumed that the key scenarios of interest are biased toward desorption processes; this is yet another reason to favor higher K_d values than tabulations that are concerned mostly with how fast contaminants might reach the groundwater. Table 1.1 notes which elements seem to be more sensitive to adsorption-desorption hysteresis. But in general, most of the K_d values chosen in this tabulation and shown in the left hand columns in Tables 1.2 and 1.3 have been increased somewhat to account for some desorption hysteresis.

Table 1.1. Qualitative Ranking of Adsorption-Desorption Hysteresis

Qualitative Degree of Sorption Hysteresis				
	Non-Groundwater Scenarios			
Constituent	**High**	**Moderate**	**Low**	**Comment**
Americium	**X**			Precipitation rxn usually cause
Bismuth	**X**			Precipitation rxn usually cause
Carbon tetra chloride		**?**		"Aging" effects often discussed
^{14}Carbon as carbonate			?	Could be moderate when isotope exchange into crystal lattics sites is significant
^{36}Chlorine			X	
Cesium		**X**		Special case where clays with frayed edge sites dominate
Cr as chromate		x	X	Redox induced precipitation rxn can move to moderate
Cobalt		X		Sorption of ferric oxides not displaced by competitive common cations; requires drop in pH
Iodide		**X**		Common observation some suggest organic matter is key
Lanthanides	**X**			Precipitation rxn usually cause
Lead (Pb)	**X**			Precipitation rxn usually cause
Neptunium		**X**		Redox induced precipitation rxn usually cause
Nitrate/Nitrite			X	
Nickel		X		Sorption of ferric oxides not displaced by competitive common cations; requires drop in pH
Plutonium	**X**			Redox induced precipitation rxn usually cause
Polonium	**X**			Precipitation rxn usually cause
Protactinium	**?**			Precipitation rxn might be cause
Radium			X	
Selenium		**X**		Can be redox sensitive and selectively adsorbed by ferric oxides
Strontium			X	Isotope exchange into carbonate minerals can generate hysteresis
Technetium		**x**	X	Can be redox sensitive and reduced form high insoluble
Tritium (^{3}H)			X	
Uranium (VI) (short times)		**X**		Precipitation rxn usually cause
Uranium (VI) (long times)		**x**	X	Can be redox sensitive and reduced form high insoluble

Bold X = strong consensus amongst geochemists.
X= most geochemists favor this choice; most likely tendency.
Small x = also possible but less likely; hysteresis usually occurs with redox change to reducing conditions.
? = literature is not available or contradictory (experts in active debate) or placed in category that author favors.

Table 1.2. Comparison of Recommended K_d Values from this Activity to Past Tabulations for Non-Groundwater Scenarios

Constituent	K_d Values (mL/g)			
	Non-Groundwater Scenarios			
	This Work		Napier and Snyder (2002)	Napier and Snyder(2002)
	Best	**Range**	**Best**	**Range**
Americium	**500**	**60 to 5000**	1500	67 to >1200
Bismuth	**400**	**100 to 5000**	900	NA
Carbon tetra chloride	**1.0**	**0.1 to 5**	NA	NA
^{14}Carbon as carbonate	**7**	**0.5 to 100**	7	0.03 to 4.56
^{36}Chlorine	**0.5**	**0 to 2**	1	-0.008 to -0.13
Cesium	**2000**	**200 to 5000**	2000	>200 to 10,000
Cr as chromate	**3**	**0.3 to 10**	NA	NA
Cobalt	**50**	**10 to 1000**	NA	NA
Iodide	**3**	**0 to 15**	15	0.05 to 15
Lanthanides	**400**	**50 to 3000**	1500	1000 to >2000
Lead (Pb)	**600**	**270 to 10,000**	80,000	13,000 to 79,000
Neptunium	**25**	**2 to 50**	25	2.4 to 21.7
Nitrate/Nitrite	**0.5**	**0 to 2**	NA	NA
Nickel	**200**	**50 to 1500**	2400	50 to 2350
Plutonium	**600**	**200 to 5000**	5000	80 to 4300
Polonium	**400**	**150 to 1100**	1100	196 to 1063
Protactinium	**25**	**150 to 10,000**	3600	NA
Radium	**200**	**5 to 500**	500	214 to 467
Selenium	**15**	**3 to 30**	2	-3.4 to 0.78
Strontium	**50**	**5 to 200**	180	5 to 173
Technetium	**0.5**	**0 to 2**	2	-3.4 to 0.57
Tritium (^{3}H)	**0.2**	**0 to 1**	0.7	0 to 0.7
Uranium (VI) (short times)	**30**	**5 to 50**	7	0.08 to 3.5
Uranium (VI) (long times)	**5**	**0 to 20**	7	0.08 to 3.5
NA = Not available or not discussed.				

Table 1.3. Recommended K_d Values and Values for Waterborne Scenarios Used in Other Tabulations

Constituent	Non-Water Scenarios		K_d Values (mL/g)									
			Water Scenarios									
			Last et al. (2004)		Krupka et al. (2004)		Thibault et al. (1990)		Coughtrey and Thorne (1983a,b), Coughtrey et al. (1983, 1984a, 1984b, 1985)		Ames and Rai (1978)	Onishi et al. (1981)
	This Work		Last	Last	Krupka	Krupka	Thibault*	Thibault*	Coughtrey	Coughtrey	Ames & Rai	Onishi
	Best	Range	Best	Range	Best	Range	Sand	Loam	Best	Range	Range	Range
Am	**500**	**60 to 5000**	NA(1)	NA	300	60 to 1300	1900	9600	2000	1200 to 8700	125 to 800	85 to 900
Bi	**400**	**100 to 500**	NA	NA	NA	NA	100(2)	450	NA	NA	NA	NA
Carbon tetra chloride	**0.6**	**0.1 to 1**	0.2	0.1 to 0.6	NA	NA	NA	NA	NA	NA	NA	NA
^{14}C	**7**	**0.5 to 100**	unsuitable	unsuitable	5	0.5 to 1000	5	20	NA	NA	NA	NA
^{36}Cl	**0.5**	**0 to 1**	NA	NA	0	0 to 0.6	NA	NA	NA	NA	NA	NA
Cs	**2000**	**200 to 5000**	2000	200 to 10,000	2000	500 to 4000	280	4600	1000	100 to 10,000	>200 to 2000	50 to >1000
Cr	**3**	**0.3 to 10**	0	0 to 0.3	0	0 to 0.6	70	30	NA	NA	NA	NA
Co	**50**	**10 to 1000**	NA	NA	2000	1000 to 12,500	60	1300	10 to 15	NA	30 to 1000	
I	**3**	**0 to 15**	0.2	0 to 2	0.25	0 to 15	1	5	6	NA	NA	<5
Lanthanides	**400**	**50 to 3000**	200	10 to 1000	300	60 to 1300	400-500	800-1500	NA	NA	>1900	400 to 3000
Pb	**600**	**270 to 10,000**	NA	NA	10,000	8000 to 80,000	270	16,000	NA	NA	NA	NA
Np	**25**	**2 to 50**	10	2 to 30	15	2 to 25	5	25	50	0.2 to 929	2.4 to 30	2.4 to 35
Nitrate/Nitrite	**0.5**	**0 to 1**	NA	NA	0	0 to 0.6	NA	NA	NA	NA	NA	NA
Ni	**200**	**50 to 1500**	NA	NA	300	50 to 2500	400	300	20	NA	NA	NA
Pu	**600**	**200 to 5000**	600	200 to 2000	150	50 to 2000	550	1200	5000	18 to 10,000	>2000	>500
Po	**400**	**150 to 1100**	NA	NA	NA	NA	150	400	ND	ND	NA	NA
Pa	**25**	**150 to 10,000**	NA	NA	15	2 to 25	550	1800	NA	NA	NA	NA
Ra	**200**	**5 to 500**	NA	NA	14	5 to 200	500	36,000	NA	NA	NA	200 to 500
Se	**15**	**3 to 30**	5	3 to 10	7	3 to 15	150	500	>9	NA	NA	NA
Sr	**50**	**5 to 200**	22	10 to 50	14	5 to 200	15	20	NA	NA	12 to 70	15 to 30
Tc	**0.5**	**0 to 1**	0	0 to 0.1	0	0 to 0.6	0.1	0.1	0.11	ND	0	0
^{3}H	**0.2**	**0 to 1**	0	0	0	0	0.06	20	NA	NA	0	0
U (short times)	**30**	**5 to 50**	0.8	0.2 to 4	1	0.1 to 80	35	15	NA	NA	NA	NA
U (long times)	**5**	**0 to 20**	0.8	0.2 to 4	1	0.1 to 80	35	15	NA	NA	NA	NA

(1) NA = not available or not discussed.
(2) Values in red type were estimated from plant uptake factors.
(3) Unsuitable = Authors do not feel that carbon-14 sequestration in sediments can be quantified by K_d construct.

2.0 Recommended K_d Values

Table 1.2 presents the new recommended K_d values and ranges, which should replace those given in Napier and Snyder (2002, Table 2), that should be used for scenarios involving humans, animals and plants getting exposed in the future getting exposed to contaminants present in agricultural soil and river bank sediments. The table compares the new recommendations to K_d values listed in Napier and Snyder (2002, Table 2) that were generally biased high to assure conservatism.

In addition, Table 1.3 presents the data available in past compendiums that focused on tabulating K_d values for waterborne scenarios, where low K_d values assure conservatism in risk predictions of contaminant transport in water. More discussion on the past compendiums follows. To reiterate, the terms non-groundwater scenario and waterborne scenario are used to differentiate the scenarios being considered in this report from the traditional groundwater scenarios, which are most often the key risk driving scenarios. Non-groundwater scenarios are those described in the Section 1.0 and include the adsorption of contaminants in irrigation water by the near-surface agricultural soils and river bank sediments. Briefly, non-groundwater scenarios include human, animal, and plant exposure to contaminants attached to solids, such as soil or waste particles. The sources of contaminants found attached to the solids include liquid waste that once percolated through the solids and left contaminants via adsorption/precipitation processes, and particles of solidified waste/contaminated sediments brought to the ground surface via drilling, land contouring, animal burrowing, or wind erosion.

This report does not discuss probability distribution functions for K_d values for any elements except cesium and strontium. This is because there is an adequate data population of K_d values for other elements wherein enough laboratory or field measurements have been made in which all the parameters that affect the K_d value are kept similar enough to claim that the observed K_d values do in fact come from the same population. That is, one cannot take K_d values for a given element that represent measurements on many different adsorbents or many different water types and claim that the values are from the same statistical population and the main variation is caused by inherent natural heterogeneity. The numerical value measured is so dependent on the type of adsorbent, its available surface area, the type of solution bearing the contaminant and the concentrations of all the aqueous species in the solution that most K_d datum represent a distinct statistical population. Seldom is the same adsorbent and same solution studied with adequate replication to establish a true statistical population that can be used to develop probability distribution functions.

However, the Characterization of Systems Project has decided to use a mathematical protocol to take "best" K_d values and K_d value ranges and generate probability distribution functions. The details are presented in Last et al. (2006) and are repeated herein as a quote. Words in parentheses were added for clarity.

> 'Probability distribution functions for the K_d values were generated according to the following set of rules and derived from the minimum, maximum, and best estimate K_d values (provided by the expert geochemists for scenarios of interest).
>
> Case 1: Where the minimum estimate, best estimate, and maximum estimate were all greater than zero, a lognormal distribution was assumed. The best estimate was assigned

to the median value. The minimum estimate was assigned to the lower 1% tail of the distribution, and the maximum estimate was not used in defining the distribution.

Case 2: Where the minimum estimate was zero, but the best estimate and maximum estimate were greater than zero. A lognormal distribution was used, with the best estimate assigned to the median value, the lower 1% tail of the distribution assigned to the value 0.001, and the maximum estimate used to define a probability truncation limit for the upper tail of the distribution (if less than 0.99 probability, otherwise truncation was set to 0.99).

Case 3: Where the minimum and best estimates were zero, but the maximum estimate was greater than zero. A composite distribution was used. The value zero was assigned a 50% probability. The other portion of the distribution was assigned a triangular distribution where the minimum and mode were both zero and the maximum was assigned to the upper tail estimate.

Case 4: Where the best estimate is "unsuitable" or not provided, a uniform distribution is assumed between the minimum and maximum values.

In those cases where a lognormal distribution was assumed, the lognormal distributions were truncated at the 1% and 99% levels, thereby preventing the generation of values that could fall below the minimum estimate.'

This paradigm allows for stochastic risk predictions to be performed and, if stochastic risk predictions are required for scenarios addressed in this report, the same paradigm is acceptable. For cesium and strontium K_d values, Case 1 would be used if one follows Last et al. (2006), which relies on a log normal distribution.

2.1 K_d Values Available in Other Compendiums Germane to This Activity

Thibault et al. (1990) and Sheppard and Thibault (1990) generated a compendium of K_d values for four types of soils: clay-dominated, loam, sand-dominated, and organic-dominated. Based on their generic descriptions, a future Hanford Site "agricultural soil" would remain in the sand-dominated category. The clay dominated category contains >35% clay and the organic-dominated category contains >30% organic matter such as bog and peat materials. To allow some perspective of the variation in K_d in the general literature for adsorption of radionuclides to different soil types, I provide the values for both the sand-dominated and loam categories used by Thibault et al. (1990) in Table 1.3. Their definition of a loam is equal distributions of sand-silt-clay or greater than 80% silt and clay (by default <20% sand). Some of the contaminants' K_d values from Thibault et al. (1990) as listed in Table 1.3 were derived from soil-plant transfer factors because no data were found in the literature when they performed their review. The values that were estimated from plant uptake factors are italicized and in red type. Besides the contaminants of interest herein, Thibault et al. (1990) provide values for antimony (Sb), arsenic (As), barium (Ba), cadmium (Cd), calcium (Ca), copper (Cu), curium (Cm), iron (Fe), lithium (Li), manganese (Mn), molybdenum (Mo), tellurium (Te), terbium (Tb), thorium (Th), tin (Sn), zinc (Zn), and zirconium (Zr).

Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1984b, 1985) published a six volume compendium of K_d, plant-soil transfer factors, animal-food transfer factors and information on human assimilation of radionuclides from plants and animals in both terrestrial and aquatic environments. Parameters to quantify these transfer or uptake factors between soils, waters, plants and animals for the following elements are tabulated in the Coughtrey et al.'s six volume compendium: americium (Am), antimony (Sb), bromine (Br), cadmium (Cd), cesium (Cs), cerium (Ce), chloride (Cl), chromium (Cr), cobalt (Co), curium (Cm), iodine (I) iron (Fe), lanthanides, manganese (Mn), molybdenum (Mo), neptunium (Np), nickel (Ni), niobium (Nb), plutonium (Pu), rubidium (Rb), ruthenium (Ru), selenium (Se), silver (Ag), sodium (Na), strontium (Sr), sulfur (S), technetium (Tc), tellurium (Te), tin (Sn), zinc (Zn), and zirconium (Zr). The K_d values listed for terrestrial soils in the six volume compendium are shown in Table 1.3.

The Hanford Site-specific K_d recommended values and ranges from Last et al. (2004), which emanates from the tabulations and discussions found in Cantrell et al. (2003), and from the Hanford Site integrated disposal facility (IDF) geochemical data package, Krupka et al. (2004) are also shown in Table 1.3. Cantrell et al. (2003) tabulate K_d values for most of the contaminants of interest to this report. Krupka et al. (2004) also tabulate K_d values for the following elements/constituents not discussed in this report: actinium (Ac), niobium (Nb), ruthenium (Ru), tin (Sn), thorium (Th), and zirconium (Zr).

2.2 Recommended Best K_d and Range for Agricultural Soils and Columbia River Bank Sediments

The second and third columns from the left in Table 1.2 list the recommended best K_d value and range to use for risk and performance assessment scenarios (excluding the "water-borne" scenarios) mentioned in Section 1.0. Table 1.2 also includes values recommended in the past (Napier and Synder 2002) for the same non-groundwater scenarios of interest herein.

Table 1.3 lists the K_d values tabulated for water-borne scenarios or pathways that are being or have been used to perform risk and performance assessments at the Hanford Site and other nuclear waste disposal sites. A brief rationale for the choice of the best range for each contaminant is provided in Section 3 along with some discussion on literature recently obtained and not used in past Hanford K_d tabulations such as Last et al. (2004) and Krupka et al. (2004).

As mentioned in the Section 1, adsorption-desorption hysteresis is a commonly observed phenomenon in laboratory batch K_d studies. Table 1.1 ranks the degree, which is a qualitative measure of both frequency and magnitude of the difference (K_d desorption value > K_d adsorption value), to which each contaminant appears to be effected. The qualitative ranking categories are high, moderate, and low degrees of impact. These qualitative rankings are based on geochemical literature discussions and expert opinion/experience of the author. For those contaminants with a high degree of impact some further discussion is often found in the individual element discussions in Section 3.

3.0 Description of Literature Reviewed to Update Non-Groundwater Scenario K_d Values for Agricultural Soils and River Bank Sediments

This section contains details on literature reviewed to augment past Hanford K_d tabulations, which in general have ignored agricultural soil and Columbia River bank sediments, and justification for the K_d values chosen in Table 1.2 columns two and three from the left.

3.1 Americium

Americium is found predominately in solution in the +3 valence state and in low ionic strength groundwater or vadose-zone pore waters with circum-neutral pH (see EPA 2004). At pH values between 6 and 8 americium aqueous complexes with hydroxide and carbonate dominate and these complexes have cationic charges (see Figure 5.1 in EPA (2004). Americium is also only moderately soluble at circum-neutral pH. There is adequate Hanford Site-specific adsorption data (see Cantrell et al. 2003 and Krupka et al. 2004 for primary references) that are consistent with the general literature that indicates americium adsorbs fairly strongly adsorption to soils and sediments. Some of the generic literature that shows K_d values larger than several thousand mL/g may reflect that precipitation/co-precipitation occurred during the adsorption measurements. The reader is referred to Cantrell et al. (2003) and Krupka et al. (2004) for details on the Hanford Site-specific information.

Roussel-Debe (2005) determined the K_d for six agricultural soils near French nuclear reactors. The soil closest in physical and chemical properties to Hanford sands yielded a K_d value of 2000 mL/g. Using statistical correlations such as particle size and slurry pH, Roussel-Debe (2005) recommends an average K_d for a sandy soil with alkaline pH of 2800 mL/g. In general, the French soils contained significantly more silt and clay than Hanford sands so I recommend the value be set at 500 mL/g for Hanford-relevant agricultural soils and river bank sediments.

Tanaka and Muraoka (1999) measured the adsorption of americium onto <1 mm-size particles of several sand sediments, soils and crushed tuff and sandstone rocks that surround the proposed Shimokita low-level waste disposal site in Japan. Trace concentrations of Am(III) were placed in distilled water and contacted with the sorbents for 7 days. The adsorbed americium was desorbed using a sequence of ever more aggressive chemical reagents to ascertain how strong the adsorption was. The pH of the sand slurries, which most closely resemble Hanford sands varied from 6.4 to 7.5 whereas Hanford soil pH currently vary between 7.5 to 8.5 but with increased organic content might lower to the values in this study. The americium K_d values for the sands that most closely resemble Hanford sands varied between 1000 and 7000 mL/g and the desorption K_d values into 0.5 M salt solutions were greater than 10,000 mL/g, thus showing significant irreversibility. Based on the selective chemical reagent extractions, Tanaka and Muraoka suggested that americium was associated with hydrous iron and manganese phases in the sands. The adsorption K_d values in Tanaka and Muraoka (1999) are a factor of two to fourteen times greater than the value I recommend, but my range covers most of the range in this study. I also believe that desorption of sorbed americium often shows hysterisis (desorption can be more difficult to effect than adsorption) as found in this study but I set the upper range K_d value at 5000 mL/g to account for the fact that Hanford sands contain a high percentage of particles >1 mm.

Livens et al. (1994) measured the K_d value of americium in three fine-grained river estuary sediments proximate to Sellafield reprocessing plant. The americium K_d value was determined from extracting the pore fluids from the saturated sediments and measuring the activity in each phase. The K_d values were 3360, 3450, and 3480 mL/g for the three sediments. Because the Columbia River bank sediments are not as fine-grained, a lower K_d value of 500 mL/g was chosen, but the range was extended to values even larger than Livens et al. (1994) found.

Emery et al. (1974) and Emery and Garland (1974) studied pond sediments and pond water at U Pond on the Hanford Site in 200 West Area. On average, the pond sediments contained 53.9 pCi/g Am-241 and the overlying waters contained 1.1 pCi/L. It was assumed that the pond sediments and water represent an equilibrium condition; the in-situ K_d for americium is 49,000 mL/g. Emery and Garland (1974) and Emery et al. (1974) also extracted the pond sediments with several chemical reagents in a sequential fashion wherein each extract used became more vigorous in reaction. Over 90% of the americium was not extractable from the pond sediments even with strong reagents. These authors also subjected the pond water to filtration through a serial reactive resin bed and found that the dissolved americium was 30% cationic and 70% anionic in nature. The source of the americium reaching the U Pond was likely from plutonium purification and finishing processes, and it is possible that some of the americium reached the pond sediments as suspended particulates. Thus, the observed in-situ K_d value may be inflated over situations where the source is dissolved contaminants in waste waters. Emery and McShane (1978) describe detailed limnological and ecological studies at several Hanford ponds and ditches however only data on gross alpha and gross beta are presented for concentrations in sediments and waters. Thus, no specific element K_d values could be calculated. Emery et al. (1974) and Emery and Garland (1974) found no evidence that radiation dose at these facilities were limiting the algal, plant, or animal communities present even though calculated maximum dose rates reached 1 R per week and maximum gross beta levels reach 10^4 pCi/L in the water.

A value of 500 mL/g was chosen as a representative best K_d value based on the discussion in the following paragraphs. The recommended range of 60 to 5000 mL/g excludes the extremely high values >5000 mL/g reported in the literature because these data may be biased by precipitation reactions. Americium desorption is often hysteretic such that K_d desorption is greater than K_d adsorption e.g., see Tanaka and Muraoka (1999) and Topcuoglu et al. (2002). A value of 500 mL/g was used for the best or most probable K_d, which is larger that the value 300 mL/g recommended in Krupka et al. (2004) for water-borne pathways, but smaller than the values chosen by Thibault et al. (1990) and Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1984b, and 1985). The value of 500 mL/g is near the mid point of ranges recommended in the two early Hanford tabulations by Ames and Rai (1978) and Onishi et al. (1981). Note that Last et al. (2004) do not list K_d data for americium. The recommended value of 500 mL/g is lower than the value (1500 mL/g) chosen in Napier and Snyder (2002), which was based on less critical analysis of past tabulations and general literature.

Thus, because the source of americium in the Hanford farm, native American, and recreational land use scenarios will be solids containing americium that must desorb to migrate, the "best" K_d value should be greater than values chosen to represent the adsorption of americium from contaminated waters (i.e., groundwater scenario data). Because desorption is slower and more difficult than adsorption processes, a higher K_d value is recommended for the non-groundwater scenarios. If K_d sensitivity predictions are performed, they should weight values higher than 500 mL/g more strongly than K_d values lower than 500 mL/g. If using an americium K_d value of 500 mL/g does not generate significant risks in any non-groundwater scenario of interest, it is likely that this contaminant will not be an important risk driver for

future Hanford conditions. The available data, however, is too sparse to select quantitative probability distribution functions but as mentioned weighting values above 500 mL/g up to the upper range value of 5000 mL/g is supportable because of the desorption hysteresis.

3.2 Bismuth

Bismuth is generally assumed to exist in natural environments in the +3 valence state and when in solution at circum-neutral pH would be present as hydroxide complexes; predominately cationic and neutrally charged (Ames and Rai 1978). Bismuth is slightly soluble at circum-neutral pH. There is no available sorption-desorption data for bismuth adsorbing to Hanford Site-specific sediments under Hanford geochemical conditions, and little general literature exists. Bismuth is a daughter product of uranium decay and is generally found to associate with sediments in comparison with uranium when slurries of bottom sediments from the ocean or lakes are analyzed (see references listed in Onishi et al. 1981).

Ulrich and Degueldre (1993) determined the influence of the ionic strength and of pH on the adsorption/desorption processes of lead, bismuth, and polonium on montmorillonite clay. The solution composition had no influence on the sorption/desorption of both bismuth and polonium. The K_d values for ^{210}Bi and ^{210}Po ranged from 10^4 to 10^7 mL/g (note that the values on the high end might reflect precipitation). When adsorption and desorption coefficients are compared, the K_d values for bismuth and polonium adsorption were several orders of magnitude lower than those obtained for desorption. The concentrations of these two elements in the liquid phase are limited by the formation of bismuth- and polonium-colloids prior to the sorption step. This fact could explain the differences in the K_d values between the adsorption and desorption processes and the extremely high adsorption K_d values. Only very small amounts of bismuth and polonium could be desorbed from the montmorillonite suggesting quasi-irreversible adsorption is occurring. The difference in the K_d values between adsorption and desorption is approximately two orders of magnitude in the case of bismuth, which would classify bismuth as highly impacted by sorption hysteresis.

Based on these measurements on montmorillonite clay, bismuth is either removed from solution by strong adsorption and/or precipitation processes. The value of 400 mL/g was chosen arbitrarily as the best K_d value and a range of 100 to 5000 mL/g was chosen based mainly on expert judgment. As shown in Table 1.3 no other tabulations are available for bismuth K_d values. The value of 400 mL/g was chosen to reflect that bismuth may be slightly more soluble than americium and thus might have a lower effective K_d. The recommended bismuth K_d value is less than the value of 900 mL/g tabulated in Napier and Snyder (2002) in order to use a bit less conservatism. The range was increased from 100 to 5000 to better reflect the lack of measured data. If predicted doses from bismuth contamination in Hanford scenarios ever rise large enough to merit concern, some Hanford Site-specific adsorption-desorption testing using appropriate soils/sediments and pore waters would be needed to validate the K_d values recommended herein.

3.3 Carbon-14

As discussed in Cantrell et al. (2003), carbon-14 released at Hanford is not well understood and how to describe its fate is problematical. Carbon-14 when in soil and sediment pore waters of interest to this report is assumed to be present predominately as the bicarbonate anion. Bicarbonate in Hanford waters

will react with calcium carbonate minerals that are ubiquitous in the Hanford sediments. Through isotope exchange reactions, any $H^{14}CO_3^-$ ions in solution will react with stable carbonate ions bound in carbonate-bearing minerals in the soil such that the $^{14}CO_3$ species will be incorporated into the solids until equilibrium is reached. At equilibrium, the ratios of ^{14}C to ^{12}C in the solids, in the surrounding pore water, and in the vadose zone air present in the pores will all be the same. Further, there is a constant supply of ^{14}C being formed by cosmic ray bombardment of nitrogen in the atmosphere such that a global supply is present that will mingle with any ^{14}C that was generated during fuel irradiation at Hanford and directly released or released during fuel reprocessing. Plants also utilize carbon during photosynthesis and do discriminate between the various isotopes; ^{12}C, ^{13}C, and ^{14}C such that the isotopic dynamics are quite complicated. Isotope exchange can be considered as a specialized form of adsorption-desorption that is not readily described by the K_d construct.

The author recommends a K_d value of 7 mL/g and a range of 0.5 to 100 mL/g for carbon-14 based on very limited Hanford specific data (see Krupka et al. 2004) and general literature that is hard to formulate directly as K_d values. The K_d value was increased from 5 to 7 mL/g to reflect the fact that non-groundwater scenario K_d values should be larger than values chosen for groundwater scenarios. The recommended value is the same as Napier and Synder (2002) and slightly larger than the value recommended by Thibault et al. (1990). No other tabulations offered carbon-14 K_d values. Last et al. (2004) specifically avoid offering K_d values based on the isotopic exchange conundrum. The range shown in Table 1.2 was chosen to be larger than Thibault et al. (1990) but smaller than the range discussed in Krupka et al. (2004), which considered carbon-14 sequestration in large masses of cement waste forms and concrete structures.

Should scoping risk assessments suggest that carbon-14 is a significant risk driver and if actual measurements of the amount of carbon-14 present in Hanford waste, sediments, and waters become available some of the more mechanistic isotope exchange reactions between air, soil, water, and plant material might be used for specific scenarios to improve risk predictions. More discussion of these ideas can be found in Martin (1996) and references therein.

3.4 Carbon Tetrachloride

Very little literature was found that describes the interactions of carbon tetrachloride with soils and sediments in a quantitative fashion. Most of the literature describes the interaction only in qualitative terms and shows that carbon tetrachloride does not interact strongly with soils and sediments.

Harmon et al. (1992) determined the K_d for trichloroethylene, carbon tetrachloride and vinyl chloride using a gravelly sand aquifer sediment taken from Moffet Field, California. Batch K_d tests were performed at 1:1 sediment to solution ratios in glass ampoules. Radiotraced (^{14}C-organic species) were added to simulated groundwater and tests performed for 1, 3, 5, 10, and 30 days of contact. The K_d value for carbon tetrachloride was found to be 1.1 ± 0.2 mL/g.

Other quantitative data relevant to the Hanford Site is reviewed in Cantrell et al. (2003). There are some traditional laboratory batch K_d test results specific to Hanford, and it is common knowledge, based on the large plume of carbon tetrachloride in the upper unconfined aquifer at Hanford (see Hartman et al. 2004) that carbon tetrachloride is quite mobile in the Hanford subsurface. The range of carbon tetrachloride K_d values reported by Cantrell et al. (2003) was expanded slightly to 0.1 to 5 mL/g and the best

value was raised to 1 mL/g to keep carbon tetrachloride from being rapidly removed from the near surface environment. This increased K_d value should be appropriately conservative for the non-water scenarios.

The amount and concentration of carbon tetrachloride that would be found along the Columbia River shoreline or in areas outside the 200 Area exclusion zone are likely very small. Also the mass of carbon tetrachloride that has been solidified in solid waste forms and destined to be buried at near-surface Hanford burial grounds that might be inadvertently drilled into after Hanford lands are released is also likely very minute.

A best K_d value of 0.6 mL/g carbon tetrachloride was chosen based on the high-end range selected by Last et al. (2004) for groundwater scenarios. However, non-groundwater scenarios should be assigned larger K_d values. The lower value in Last et al. (2004) tabulation was maintained for the lower range and the upper range was increased to 1 mL/g. Napier and Synder (2002) did not tabulate K_d values for carbon tetrachloride.

3.5 Cesium

There is a wealth of Hanford Site-specific as well as general literature on cesium adsorption-desorption interactions, but not much on projected Hanford agricultural soils and river bank sediments. Cesium exhibits fairly simple aqueous speciation in natural waters where it is predominately found as the free monovalent cation, Cs^+ (see EPA 1999b). It reacts with soils and sediments by ion exchange and some unique specific-adsorption reactions with certain types of clay minerals, which are found in good abundance in Hanford soils and sediments. Illite, biotite, and vermiculite minerals are highly selective to adsorbing cesium and once adsorbed, the cesium is only partially released with difficulty from the aforementioned clay minerals

Shimada et al. (1996) determined K_d values, transfer coefficient by direct foliar absorption (K), and transfer coefficients for root uptake for strontium-90 and cesium-137 for several Japanese soils. The K_d values were found to be 10 to ~300 for strontium-90 and 10 to 2000 mL/g for cesium-137.

Chang and Hsu (1993) determined the adsorption of trace amounts of cesium-137 onto bentonite clay (<75-micron-size fraction) and reagent grade sand (silica 250-micron-size fraction) using distilled water with contact times of three days in batch tests. The sand slurry pH was 4.9 and the bentonite slurry pH was 6.1, which are both lower than Hanford Site conditions although in general the sorption of cesium is not strongly sensitive to pH. The cesium K_d for the bentonite was 6200 mL/g and for the silica sand was 29 mL/g.

Lima and Mazzilli (1994) measured the adsorption of cesium onto oven-dried river sediments from the Pinheiros River in Brazil using actual river water with pH 5.5 to 6.0. The river sediments were quite fine grained; 49% fine sand, 10% coarse sand, and 40% silt/clay with a total cation exchange capacity of 11 meq/100 g, which is ~2.5 to 3 times larger than the total cation exchange capacity of typical Hanford sand sediments. Batch adsorption tests as a function of pH, solid to solution ratio, and contact time were performed. Lima and Mazzilli (1994) found quite low K_d values for cesium (21 to 33 mL/g) and no sensitivity to pH (between 4 and 8) and that equilibrium was reached within a few days. They felt that oven drying the sediment had collapsed the clays and lowered the true adsorption capabilities of the sediments.

Pulford et al. (1998) studied the geochemical associations of Sellafield waste radionuclides in saltmarsh sediments from south-west Scotland. The radionuclides are transported to this environment in association with particulate material and cesium-137 was found to be predominantly (80 to 98%) non-extractable with saline waters. The relatively aggressive nature of the chemical extractants required to remove the radionuclides from the sediments suggests that they were in a form that was unlikely to result in their being released into the aquatic environment or taken up by plants. Plutonium had a greater potential mobility or bioavailability than cesium. The K_d values for desorption of cesium-137 from the sediment by freshwater, groundwater, and seawater were all approximately 10^5 mL/g, confirming its immobility in this environment. The desorption K_d values for stable cesium-133 were all approximately 10^6 mL/g, so the stable cesium did not have a significant influence on the radiocesium in this sediment.

The low ionic strength circum-neutral fluids expected in the near surface sediments at Hanford promote strong adsorption of cesium. Therefore, the recommended K_d value was chosen as 2000 mL/g in agreement with the two recent Hanford tabulations (Cantrell et al. 2003; Krupka et al. 2004) and the Napier and Synder (2002) tabulation. The cesium K_d range is 200 to 5000 mL/g based on averaging the ranges cited in the two recent Hanford tabulations for water-borne scenarios. There is enough cesium adsorption data for Hanford sediments and in general literature to suggest that a probability distribution function that is log normal around the best value and which incorporates the low and high range as limits is reasonable.

3.6 Chlorine-36

The atmospheric nuclear bomb testing in the 1950s to 1960s spread chlorine-36 around the world. It is often used as a tracer to estimate water recharge in near-surface sediment (Lo Russo 2003; Prych 1998; Gee et al. 2005 and references therein) and has been used to infer fracture flow geometry at the Yucca Mountain proposed repository (Campbell et al. 2003). Chlorine-36 is a long-lived radionuclide (half life of 301,000 years) and exhibits high mobility in the vadose zone and groundwater. It is also produced in reactor operations as an activation product of chlorine-35 and also results from a small amount of natural atmospheric and subsurface production. Although chlorine-36 in the vadose zone and groundwater may be present due to atmospheric fallout and a small subsurface production rate, the bulk of chlorine-36 in groundwater at several DOE sites has been shown to result from reactor operations (Beasley et al. 1992, 1993).

The fate of chlorine-36 from the Hanford fuel re-processing is unknown. Chlorine chemistry is similar to iodine, so it is likely that a fraction of the chlorine-36 was released to the atmosphere with the iodine-129 and -131 radionuclides. Beasley et al. (1993) postulate that chlorine-36 is released as chlorine gas and as NOCl gas during fuel decladding and fuel dissolution. Because of the long half-life of chlorine-36, it is likely that breakthrough occurred on the silver scrubbers used at Hanford to remove iodine-131 from the gases released through stacks. If this is the case, then chlorine-36 would have been released to the atmosphere through the entire period of Hanford fuel reprocessing operations. Chlorine-36 is expected mainly to stay in the aqueous waste streams and, thus, much chlorine-36 may have remained with the high activity fission products in the Hanford tank waste streams and a smaller fraction should be present in other aqueous waste streams that went to cribs, ponds and trenches. Pre-bomb pulse chlorine-36:chloride ratios[1] in the atmosphere at Hanford are estimated to be 735 to 876 x 10^{-15}

[1] Chlorine-36 to chloride ratios are atoms of chlorine-36 divided by atoms of total chloride in a given medium such as air, suspended particles, water samples or sediments/rocks.

atoms/atoms with atmospheric bomb pulse levels increasing to approximately 4000 to 8000 x 10^{-15}. Deep groundwater in the Columbia River Basalts has reported ratios of 7 to 1130 x 10^{-15} (Gifford et al. 1985). Some chlorine-36 measurements in groundwater samples from the Hanford Site were measured in 1995 [see Dresel et al. (2002) for details]. The 1995 sampling confirms the presence of measurable amounts of chlorine-36 in 17 out of 18 water samples studied. The maximum chlorine-36 concentration detected, 94.3 pCi/L in well 199-F8-1 at the 100-F Area, corresponds to a potential ingestion dose of less than 0.2 mrem/yr. The variability in chlorine-36 concentrations and in chlorine-36:chloride ratios in these 17 groundwater samples suggests that further sampling and analysis for chlorine-36 would be productive to evaluate origins. The chlorine-36:chloride ratios for the 17 groundwater samples ranged from 604 to 216,000,000 x 10^{-15}. These shallow groundwater samples range from low levels consistent with pre-bomb pulse background to levels over 4 orders of magnitude greater than the bomb-pulse ratios. The higher ratios clearly show a large Hanford Site contribution. By contrast, the ratios reported at the Savannah River Site ranged from 61 to 4452 x 10^{-15} (Beasley et al. 1992). Ratios reported at Idaho National Environmental Engineering Laboratory ranged from 539 to 1,560,000 x 10^{-15} (Beasley et al. 1993). The Hanford production and release of chlorine-36 appears to have been significantly greater than at these other two DOE sites.

The limited Hanford groundwater data suggest that chlorine-36 is found in the large-volume liquid releases to cribs during Hanford fuel re-processing. The chlorine-36 activity in the 17 groundwater samples correlates poorly with tritium, indicating that these two mobile species provide complementary information on groundwater contamination.

There is very little data available on the interactions of chloride with sediments at the Hanford Site or in general literature. Most scientists consider chloride and other halides, such as bromide, to be conservative tracers that do not adsorb to soils/sediments. In fact, some studies have observed (from chloride breakthrough curves for pulse inputs of chloride into packed soil/sediment columns) that chloride actually migrates faster than tritium. The explanation is that anions such as chloride exhibit anion exclusion properties whilst percolating through sediments that contain a negative net surface charge. The anions are repulsed by the sediment surfaces and remain in the middle of the pores in the packed columns and travel slightly faster than the some of the water molecules that interact slightly with the sediment surfaces. Gee and Campbell (1980) compared chloride and tritium breakthrough curves from typical Hanford sand sediments and found anion exclusion that could be quantified as a negative K_d with values varying between -0.008 and -0.13 mL/g. A detailed discussion of anion exclusion is found in Jurinak et al. (1987).

Seaman et al. (1995, 1996) ran bromide breakthrough curves on four sandy soils from the Upper Coastal Plain (Georgia) and found that bromide breakthrough was retarded in comparison to tritium. Bromide retardation was sensitive to whether the companion cation was sodium (NaBr) or magnesium ($MgBr_2$). At low ionic strength (0.001 N), the bromide retardation factor varied from 0.95 to 2.51, where a value less than 1 signifies anion exclusion and a value greater than 1 signifies adsorption. For the one soil studied at three ionic strengths, the bromide retardation factor dropped from 2 to 1.35 to 1.08, respectively as ionic strength was increased from 0.001 to 0.01 and 0.1 N. Because the pH of these coastal sediments was buffered by the solids to 3.9 to 5.0, they contained more positively charged sites on hydrous oxides present in the soils than would be found in Hanford Site soils. Because of the net positive charge on the hydrous oxide surfaces, the anion bromide should show some interaction, however at higher pH values more relevant to Hanford Site conditions the net charge on hydrous oxides should be more

negative and anion repulsion could occur. For Hanford sediments the pH is never as low as in the studies of Seaman et al. (1995, 1996) so the phenomenon of anion sorption is not as accentuated at Hanford as for acidic soils.

Thus, the author recommends a conservative K_d value for chlorine of 0.5 mL/g for use in the agricultural, river bank, and Native American scenarios germane to this report to reflect that chloride may interact somewhat with sediments in these non-groundwater scenarios. An appropriate range would be 0 to 2 mL/g. The recommended values for chloride are the same values chosen for technetium-99, another highly mobile, predominately anionic species in Hanford near-surface sediments and soils.

A second option for chlorine-36 would be to use the values chosen for iodine-129 where the "best" value of 3 mL/g was chosen and a range of 0 to 15 mL/g. However, trace concentrations of iodide react with Hanford formation sediments in more complicated and as yet unexplained ways, such that it is not the most appropriate analog for chloride. The recommended K_d value for chlorine-36 of 0.5 mL/g is one-half the value tabulated in Napier and Snyder (2002) and the range, 0 to 2 mL/g, used in this report is more consistent than theirs. Napier and Snyder (2002) used a range of -0.008 to -0.13 mL/g, which is not compatible with choosing a best value of 1 mL/g. Last et al. (2004) did not discuss chlorine-36 and Krupka et al. (2004) chose a best value of 0 mL/g and a range of 0 to 0.6 mL/g for groundwater scenarios.

3.7 Chromium

Chromium is found in two valence states in the natural environment, as a rather immobile Cr(III) form and as a mobile Cr(VI) form. In low ionic strength solutions, only Cr(VI) form as the chromate anion [CrO_4^{2-}] is found in oxidizing and circum-neutral pH conditions. At moderately to highly reducing conditions, chromium exists as Cr(III) at circum-neutral pH and is not soluble and readily precipitates with other cations, especially Fe(III) to form insoluble oxides (see Krupka et al. 2004 and EPA 1999b for more details on chromium geochemistry). At the Hanford Site, oxidized chromium as [CrO_4^{2-}] was used as a corrosion inhibiter in reactor cooling water and in some of the fuel processing activities. Several [CrO_4^{2-}] groundwater plumes are found in the 100 Areas near the Columbia River from the usage in reactor cooling water and in the 200 Areas from usage in fuel processing to extract plutonium (see Hartman et al. 2004). Thus, there is field evidence of chromate mobility through the vadose zone and upper unconfined aquifer at Hanford.

Also, the toxicity of chromium to animals (humans and especially fish such as young salmon smolts) and plants depends on the valence state of the chromium. The oxidized chromate form is much more toxic than the reduced Cr(III) form. When chromate interacts with some types of sediments it can be reduced to Cr(III) species, which are sparingly soluble and readily precipitate. However, at the Hanford Site, laboratory tests using Cr(VI)-spiked circum-neutral pH low-ionic strength waters suggest that Hanford sediments do not appear to reduce and immobilize significant amounts of chromate over time spans of days to a month (see references in Cantrell et al. 2003). It is not clear whether significant amounts of chromate have been reduced in the Hanford vadose zone over the 40 to 50 years of operations and cleanup efforts, but based on the observed chromate groundwater plumes it would appear not. Enriched organic sediments and the decay of plant matter might raise the probability of some reduction of chromate; however, there does not appear to be any quantitative data on this process and whether future Hanford agricultural soils will effectively reduce past chromium contamination is not known.

Carey et al. (1996) measured the K_d for Cr(VI) spiked into a 0.01 M calcium nitrate background electrolyte as a function of pH on several soils from New Zealand, two of which are predominately sands with low organic carbon contents, and 0.1 wt% hydrous iron oxides, and a total cation exchange capacity of 5 meq/100 g. These characteristics are very similar to Hanford Site Hanford formation sands. The slurry pH of the New Zealand sand soils was 6.0 and 6.5, which is slightly more acidic than the Hanford formation sand pH values. Batch K_d tests were performed at solid to solution ratio of 1 g per 10 mL of spiked background electrolyte for one day at various pH values. Based on extracting values of a plot of sorption isotherms at pH values between 5 and 7, estimates of the Cr(VI) K_d varies from <1 to <5 mL/g for the two New Zealand soils that are similar to Hanford formation sands. The K_d increases significantly when the system pH drops to 4 or lower reflecting the expected tendency for increased anion adsorption onto variably-charged surface sites that become progressively more positively charged as pH drops. This study of New Zealand sand soils suggests that future Hanford soils might sequester some chromate if they become somewhat enriched with organic matter so that pH values can drop below neutrality.

Based on an adequate Hanford Site-specific database and the literature cited, a "best" K_d value of 3 mL/g was chosen as a reasonable value to keep [CrO_4^{2-}] in the surface sediments and waste solids inadvertently brought to the surface during the drilling scenario or to account for some potential chromate reduction by decay of organic matter. This K_d value is larger than the recommended value for water-borne scenarios where the concern is rapid movement to groundwater and accessibility to residents that drink the water and to the Columbia River (see Last et al. 2004 and Krupka et al. 2004). Napier and Synder (2002) did not provide K_d values for chromium. In contrast the K_d value recommended in this report of 3 mL/g is much lower than the values of 30 to 70 mL/g recommended by Thibault et al. (1990), which were heavily weighted to adsorption of chromate onto acidic soils with high hydrous ferric oxide contents from the Savannah River Site. The pH and hydrous ferric oxide contents of Hanford sediments are not similar to Savannah River soil values, so the chromium K_d values chosen by Thibault et al. (1990) and Sheppard and Thibault (1990) are not relevant to the Hanford Site.

The K_d range for chromium was selected as 0.3 to 10 mL/g to allow risk sensitivity predictions. This range is larger than ranges chosen by Last et al. (2004) and Krupka et al. (2004) which both used a range of 0 to <1 mL/g. The range of Cr K_d values was expanded to account for the possibility of the future agricultural soils to be more acidic and contain more organic matter (potential chromate reductant) and hydrous oxides (potential for more adsorption onto positively-charged surface sites).

3.8 Cobalt

Cobalt can be found in nature in two valence states, Co(II) and Co(III); however, the Co(II) is by far more prevalent (Smith and Carson 1981). In low ionic strength and circum-neutral pH waters relevant to Hanford Site, cobalt aqueous speciation is predominately complexes with hydroxide and carbonate but precipitation/co-precipitation processes can limit the dissolved concentrations of cobalt (see Krupka and Serne 2002 for more cobalt geochemistry discussion and Eh-pH diagrams). There is an adequate Hanford Site-specific database of laboratory studies of the adsorption of cobalt onto Hanford sediments that have low organic matter content and natural slightly alkaline pH conditions in waters that contain no organic complexants. Most of the adsorption studies show moderate to strong adsorption occurs if the water is low ionic strength and does not include man-made chelating and complexing agents (e.g., ethylene diamine tetraacetic acid [EDTA], cyanide) used in fuel processing activities and waste-stream recovery

operations to capture specific isotopes such as uranium, cesium-137, and strontium-90. There are no Hanford-specific studies of cobalt adsorption onto agricultural soils or river bank deposits so the following literature was reviewed.

Lima and Mazzilli (1994) measured the adsorption of cobalt onto oven-dried river sediments from the Pinheiros River in Brazil using actual river water with pH 5.5 to 6.0. The river sediments were quite fine grained, i.e., 49% fine sand, 10% coarse sand and 40% silt/clay with a total cation exchange capacity of 11 meq/100 g, a value ~2.5 to 3 times larger than typical Hanford sand sediments. Batch adsorption tests as a function of pH, solid-to-solution ratio, and contact time were performed. Lima and Mazzilli (1994) found that the cobalt K_d was quite sensitive to pH and varied from 47 to 1660 mL/g as the pH varied between 4 and 8. The cobalt K_d also did not reach an equilibrium value over 15 days of contact. Thus there was a slow process that continued to remove cobalt from solution.

Bidoglio et al. (1994) studied the adsorption of cobalt (10^{-10} M) onto quartz sand from a bicarbonate-rich groundwater at pH 8.3 with and without the presence of 10 ppm humic acid. Ninety pore volumes of the groundwater were percolated through the quartz columns. Very little of the cobalt migrated through the 20-cm-long quartz column. In some tests, a 5-cm layer of manganese oxide was placed 5 cm from the inlet end. The profile of adsorbed cobalt inside these columns showed that the MnO_2 layer caused a large build up of cobalt in the manganese oxide layer. The manganese oxide could have oxidized Co(II) to Co(III) and effectively sequestered the cobalt irreversibly. The 10 ppm humic acid-laden groundwater did allow more cobalt to breakthrough out of the quartz column. However, no quantitative K_d information was presented in the manuscript thus it can only be stated that cobalt mobility is sensitive to the presence of dissolved organic matter in the pore water. See further discussions on the impacts of man-made organic ligands such as EDTA on cobalt adsorption in Krupka and Serne (2002). In general, the manmade chelating agents and, by inference from field studies, natural organic matter decay products, such as fulvic and humic acids, impact cobalt adsorption more so at basic pH conditions than acidic conditions.

Napier and Snyder (2002) and Last et al. (2004) did not review cobalt adsorption data so Coughtrey and Thorne (1983a, 1983b), Coughtrey et al. (1983, 1984a, 1984b, and 1985), Thibault et al. (1990) and Ames and Rai (1978) provide the primary cobalt K_d references used for this report. The most probable value found in Krupka et al. (2004), 2000 mL/g, in retrospect seems too large. However, the choice of a K_d for cobalt was not important in groundwater risk scenarios used for the Integrated Disposal facility (IDF) performance assessment because the only cobalt radionuclide is ^{60}Co, which has a relatively short half life of 5.7 years. Thus, little critical analyses was put into choosing cobalt's most probable K_d value for the IDF tabulation and its projected risk would have been very low even if a much smaller K_d value would have been chosen. Coughtrey and Thorne (1983a, 1983b), Coughtrey et al. (1983, 1984a, 1983b, and 1985), Thibault et al. (1990) and Ames and Rai (1978) recommend cobalt K_d values of 10 to 15, 60, and 30 to 1000 mL/g, respectively. For use in the scenarios of interest in this report a cobalt K_d value of 50 mL/g was chosen as a reasonable "best" value and a range of 10 to 1000 mL/g. The most probable value is slightly smaller than the one found in Thibault et al. (1990), which again is dominated by Savannah River sediment data that contains more hydrous ferric oxides that are very strong adsorbers of cobalt. Agricultural soils might contain higher dissolved organic complexants than the studies used by all these tabulations; however, most of the non-groundwater scenarios also require cobalt desorption to occur to remove the cobalt from the exposure pathway. Desorption hysteresis may counteract any tendency for enhanced cobalt mobility via organic complexants. Thus, these two competing processes should off set each other.

3.9 Iodine

Iodine can exist in sediment-natural water environments in three oxidation states -1 (iodide I^-), +5 (iodate IO_3^-), and 0 (I_2). However, the former two are the most prevalent at pH conditions found at the Hanford Site. Both iodide and iodate are mono-valent anions and are not expected to adsorb strongly to Hanford Site sediments that have a negative net surface charge at pH conditions of interest. Iodine aqueous species do adsorb more than chloride or pertechnetate and their adsorption tendencies are sensitive to the presence of organic matter. See Krupka et al. (2004) and EPA (2004) for more details on iodine geochemisty and speciation diagrams as a function of pH and Eh. There are no Hanford-specific studies on adsorption of iodine species on agricultural soils or river bank deposits so the following literature was reviewed.

Bird and Schwartz (1996) measured the K_d value for iodide spiked into Winnipeg River water (low ionic strength solution that is similar to rain water) onto four lake sediments. One of the lake sediments was sand that is similar to Hanford Site surface sediments. Under oxic conditions, the observed iodide K_d value was 0.2 mL/g.

Yoshida et al. (1998) used batch adsorption tests to measure the K_d value for trace amounts of iodide and iodate (added as ^{125}I tracers in distilled water) onto 69 different near-surface soils in Japan. The tests were performed at 1:10 wet soil to distilled water ratio and the contact time was 14 days. Within the group of soils (three different soils were in this group), the one with the most Hanford-relevant properties was labeled sand-dune regosols in their paper. The sand-dune regolith soils had mean cation exchange capacity of 1.4 meq/100 g and an organic carbon content of 0.06 % but the mean soil slurry pH was 6.3, which is slightly lower than at the Hanford Site. The mean K_d value for iodide on these sand-dune soils was 16 mL/g and for iodate was 14.1 mL/g. The K_d values for the three samples in the sand-dune group must have varied significantly because the standard deviations were 19.9 and 16.1 mL/g for the iodide and iodate, respectively. When the soils were autoclaved for 70 minutes at 121°C and the adsorption tests repeated, the K_d values dropped significantly to 0.7 ± 0.9 and 3.0 ± 3.1 mL/g for iodide and iodate, respectively. Yoshida et al. (1998) suggest that 86% of iodide and 50% of iodate sorption in the Japanese surface soils are attributable to microbial activities that are destroyed by the autoclaving.

At the Hanford Site, sub-surface sediments with very low organic content adsorb iodide anions with an average K_d value that ranges between 0.2 and 0.4 mL/g (see Um et al. 2004; Um and Serne 2005). Kaplan et al. (2000) found that the mineral illite could adsorb trace concentrations of iodide to yield a K_d as large as 15 mL/g. To accommodate the influence of greater organic matter content, increased micro-biological activity, and possibility of enriched silt/clay content in agricultural soils, the value chosen for the iodine K_d value is 3 mL/g and a range of 0 to 15 mL/g for sensitivity studies for scenarios of interest to this report. The recommended "best" value differs from Napier and Snyder's (2002) value of 15 mL/g and the best values from Last et al. (2004) (0.2 mL/g) and Krupka et al. (2004) (0.25 mL/g). In the former case, a value of 15 mL/g is based heavily on the iodide adsorption on illite and in the latter two tabulations the emphasis was on groundwater scenarios. Thibault et al. (1990) and Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1983b, and 1985) recommend a most probable iodine K_d value between 1 and 6 mL/g, depending on grain size. Thus, the recommendation of 3 mL/g is mid-way between most of the other non-Hanford focused tabulations and slightly larger than the Hanford groundwater scenario K_d values. The recommended range, 0 to 15 mL/g, is similar to the range chosen by Napier and Snyder (2002) and Krupka et al. (2004) but is larger that the range chosen by Last et al.

(2004), which was 0 to 2 mL/g. The increased K_d value range and the "best" K_d value were to accommodate the observed increased adsorption of iodide caused by organic matter and microbiological activity. Agricultural soils and river bank sediments may contain higher organic matter content and more microbiological activity than the sediments generally studied by Hanford Site geochemists.

3.10 Lanthanides (especially Europium)

In general, all the lanthanide elements exist in natural pore waters in the trivalent oxidation state at circum-neutral pH and mildly oxidizing conditions prevalent in the near-surface sediments at the Hanford Site. Aqueous speciation calculations suggest that inorganic complexes with hydroxide, and to a lesser extent inorganic anions such as carbonate, sulfate, and chloride, dominate over the free tri-valent cation in solution. The lanthanides are also rather insoluble such that hydrous oxide-hydroxide precipitates can be expected to keep solution concentrations quite low. Between precipitation and adsorption reactions, lanthanides show strong preferences for binding with sediments with high K_d values almost universally found. Krupka and Serne (2002) provide more details on europium geochemistry and aqueous speciation and solubility plots versus pH and Eh.

Although adsorption data for lanthanides at relevant Hanford Site conditions are sparse, data is adequate to objectively choose most probable and ranges in K_d values for the scenarios of interest. Cantrell et al. (2003) and Krupka and Serne (2002) provide discussion and observed K_d values. Wang et al. (2004) evaluated the interactions of europium (III) onto bentonite, used for backfill material in nuclear waste disposal, using computer modeling and literature information. Their literature review concluded that the K_d for europium varies as a function of pH and europium concentration present but almost universally is found to range from 100 to 10,000 mL/g. This recent study/review has the same conclusions as past Hanford-relevant studies of lanthanide adsorption onto sediments.

Recent adsorption studies by Wenming et al. (2001) and Xiangke et al. (2001) present data for some pure minerals and natural sediments (but at more acidic pH conditions than are found at Hanford Site) that point out the key controlling adsorption processes/tendencies for europium. Clay minerals such as smectites, which are the dominant clay mineral in Hanford Site sediments, strongly adsorb europium. In addition, aluminum oxides and ferric oxides also are strong adsorbents for europium. The K_d value for europium is quite sensitive to pH conditions and above pH 5 adsorption of europium is almost 100%. Wenming et al. 2001 and Xiangke et al. 2001 suggest that europium hydroxide aqueous species form "bridged" complexes with adsorbent surfaces. Desorption of previously adsorbed europium shows considerable hysteresis meaning that desorption K_d values are larger than the adsorption K_d values. Dissolved natural organic acids such as fulvic acid can lower the sorption of europium, but natural organic acids are quite low in pore waters at the Hanford Site today however may increase in the agricultural soils of the future. In selecting the recommended values the impacts of higher concentrations of organic acids and lower pH, which lower K_d values, were considered.

Given the past laboratory studies relevant to Hanford and the recent literature, which continues to support our past understanding, a "best" K_d value of 400 mL/g and a range of 50 to 3000 mL/g were chosen for the lanthanides for use in agricultural soil and river bank sediments interacting with low ionic strength and neutral pH natural waters. In a similar fashion to americium and bismuth, the desorption K_d value for lanthanides is generally larger than the adsorption K_d values so most sensitivity calculations should weight values >400 mL/g as more common. The current recommendation for the most probable or "best" K_d value for lanthanides, 400 mL/g, is lower that the value listed in Napier and Snyder (2002)

and larger than the values chosen by Last et al. (2004) and Krupka et al. (2004) for groundwater scenarios, 200 and 300 mL/g, respectively. The recommended value was raised to 400 mL/g to accommodate desorption hysteresis mechanisms. This value is similar to the Thibault et al. (1990) range for sands, 400 to 500 mL/g. The chosen range is slightly wider than those chosen by Last et al. (2004) and Krupka et al. (2004) to accommodate the desorption hysteresis impacts that are more important for the non-groundwater scenarios of interest to this K_d value tabulation.

3.11 Lead

Lead in natural pore waters is generally found only as the divalent free cation or complexed with various inorganic anions such as carbonate, sulfate and chloride. Lead is not soluble in Hanford Site pore waters in contact with sediments. Phosphate solids are especially insoluble, but hydroxides, oxides, carbonates and sulfates are also rather insoluble. There have been some studies of lead adsorption onto Hanford sediments given the fact that lead-lined nuclear reactor cores from decommissioned submarines are buried at Hanford (see summary in Rhoads et al. 1992). The K_d for lead is very large (>10,000 mL/g) in Hanford geochemical systems. See further discussions on lead geochemistry and aqueous complex speciation plots in EPA (1999b). There are no Hanford-specific studies on the adsorption of lead onto agricultural soils or river bank deposits so the following literature was reviewed.

Ulrich and Degueldre (1993) determined the influence of the ionic strength and of pH on the adsorption/desorption processes of lead on montmorillonite clay. For lead, a strong dependence of the adsorption and desorption processes on the ionic strength was observed at pH < 7, whereas, at higher pH values, this dependence totally disappears. Large K_d values were measured for lead. The K_ds range from 10^3 to 10^5 mL/g. When adsorption and desorption coefficients are compared, the lead K_d values are similar for both adsorption/desorption. Montmorillonite clays dominate the small wt % fraction of Hanford sediment clay-sized particles, however, it is difficult to correlate the K_d values in this paper with the bulk sand sized Hanford sediments.

Napier and Snyder (2002) list the most probable K_d value for lead as 80,000 mL/g while Last et al. (2004) do not discuss lead and Krupka et al. (2004) recommend a lead K_d value of 10,000 mL/g. Thibault et al. (1990) recommend a lead K_d value of 270 mL/g for a sand sediment and 16,000 for a loam soil. The author chose 600 mL/g as the "best" K_d value to represent non-groundwater scenarios of interest to this report and a range of 270 to 10,000 mL/g. Lead sorption is often described as being affected by sorption hysteresis, and the large K_d value found in most tabulations likely are indicative of a significant level of desorption difficulty. For any scenario where lead might be present in large enough amounts to be predominantly precipitated in discrete solids values larger that 1000 to values as high as 10,000 mL/g should be used in sensitivity calculations.

3.12 Neptunium

Neptunium is a redox sensitive element that can exist in five valence states (from +3 to +7) but in natural environments found at the near surface Hanford Site only the +4 and +5 oxidation states are relevant. The Np(V) aqueous species is the neptunyl oxy-cation (NpO_2^+) that can form carbonate complexes at pH values above 8.5 or when dissolved carbonate is significantly higher than normal. Most Np(V) solids are quite soluble so that precipitation is not expected. Under slightly reducing conditions neptunium is present in the environment as Np(IV) species, which are very insoluble. In circum-neutral

pH solutions, the reduced neptunium is generally fully hydrolyzed as $Np(OH)_4^0(aq)$ species that readily co-precipitates or adsorbs. Some minerals in natural sediments can reduce Np(V) aqueous species and cause Np(IV) species to bind tightly to the sediment surfaces. The Np(V) aqueous species do not form as strong of complexes with common anions such as carbonate, sulfate, and chloride as other actinides so the net charge on Np(V) aqueous complexes in often +1 leading to moderate to strong adsorption tendencies dependent upon pH of the soil/sediment water system. If Np(V) aqueous species get reduced to Np(IV) species adsorption/precipitation increases significantly. More discussion of neptunium geochemistry, adsorption tendencies, and diagrams of aqueous speciation calculations and solubility tendencies as a function of pH and Eh are found in Krupka et al. (2004) and EPA (2004). There are no Hanford-specific studies of neptunium onto agricultural soils or river bank deposits so the following literature was reviewed.

Sakamoto et al. (1990) measured the K_d for Np(V) onto four Japanese soils two of which are quartz and feldspars dominated sands that are quite similar to Hanford formation sediments at the Hanford Site. Batch adsorption tests using a 0.01 M sodium perchlorate background electrolyte spiked with 1×10^{-5} M Np(V) were performed at 30°C for 7 days. The solid to solution ratio was 1 g to 5 mL. The Np(V) K_d for the two sands was sensitive to the pH of the system. At pH values below 7, the K_d was less than 5 mL/g and as low as 1 mL/g. At pH values between 7 and 9, the neptunium (V) K_d value rose sharply to values between 7 and 15 mL/g for the two sands. Between pH values of 9 to 11 the Np(V) K_d values were fairly constant at 7 and 15 mL/g for the two sands.

Recently Niitsu et al. (1997) measured the adsorption on Np(V) species added to 0.1 M sodium perchlorate background electrolyte onto kaolinite clay as a function of pH and with and without the presence of dissolved humic acid (up to 5 g/L). In the pH range of interest to Hanford Site, pH 7 to 8.5, the K_d for neptunium varied from 2 to 20 mg/L and humic acid did not have an appreciable effect on the sorption.

Tanaka and Muraoka (1999) measured the adsorption of Np(V) onto <1 mm-sized particles of several sand sediments, soils, and crushed tuff and sandstone rocks that surround the proposed Shimokita low-level waste disposal site in Japan. Trace activities of Np(V) were placed in distilled water and contacted with the sorbents for 7 days. The adsorbed neptunium was desorbed using a sequence of ever more aggressive chemical reagents to ascertain how strong the neptunium adsorption was. The pH of the sand slurries, which most closely resemble Hanford Site sands, varied from 6.4 to 7.5 similar to the recent measurements of highly vegetated surface soils at the Hanford Site. The Np(V) K_d values for the sands that most closely resemble Hanford Site sands varied between 2.3 and 10 mL/g and the desorption K_d values into 0.5 M salt solutions ranged from 12 to 25 mL/g, thus showing some irreversibility. Based on the selective chemical reagent extractions, Tanaka and Muraokao (1999) suggested than Np(V) adsorption was associated with ion exchangeable sites in the sands.

Pratopo et al. (1991) measured the adsorption of Np(IV) present in 0.1 M carbonate solution onto quartz. The tests were performed in an argon filled glove box to keep the Np(IV) from oxidizing to the much more soluble Np(V) species (NpO_2^+). The observed K_d values were large, >130 mL/g, at pH values near 8 and up to 1000 mL/g at pH values greater than 12. Pratopo et al. (1993) measured the adsorption of Np(IV) aqueous species present in 0.1 M carbonate solution onto bentonite clay. The tests were performed in an argon-filled glove box to keep the Np(IV) from oxidizing to the much more soluble neptunyl species (NpO_2^+). The observed K_d values were large >100 mL/g at pH values near 5 and up to 10,000 mL/g at pH values greater than 8.

For near-surface environments of interest to the future agricultural and river bank sediments on the Hanford Site, neptunium may exist in the oxidized Np(V) state in bulk solution, but some of the dissolved Np(V) species may adsorb via a reduction mechanism, perhaps facilitated by decaying organic matter, to Np(IV) species that form strong bonds with sediment surfaces. Also, the desorption hysteresis phenomenon, which causes release of bound neptunium to be more difficult than the original adsorption process, was observed in some of the cited literature. Taking into consideration the possible reduction of some Np(V) and desorption hysteresis, a "best" K_d value of 25 mL/g with a range of 2 to 50 mL/g was chosen for the non-groundwater scenarios of interest. The best value is about two times higher than values recommended (see Last et al. 2004; Krupka et al. 2004) for water-borne scenarios used in other Hanford Site risk and performance assessment activities. For non-groundwater scenarios, desorption hysteresis is quite important and based on the results of Niitsu et al. (1997) natural organic complexes do not increase neptunium mobility; thus, most data suggest that neptunium K_d values for non-groundwater scenarios should be larger than values for groundwater/any waterborne scenarios. The recommended K_d value for neptunium is the same as used by Napier and Snyder (2002), the same as Thibault et al. (1990) for a loam soil, one-half the value recommended by Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1984b, and 1985) and on the upper end of ranges tabulated by Ames and Rai (1978) and Onishi et al. (1981). The recommended range is somewhat wider than the ranges recommended by Last et al. (2004) and Krupka et al. (2004) but smaller than the range reported in Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1984b, and 1985). The neptunium K_d range was increased over the range chosen by the other compilations for "groundwater" scenarios to emphasize that desorption hysteresis/reduction should be active in the "non-groundwater" scenarios of interest.

3.13 Nickel

Nickel is a transition metal, which is somewhat similar to cobalt, generally found in aqueous pore waters as the divalent free cation and as complexes with common inorganic anions such as carbonate, sulfate, chloride and hydroxide. Nickel sorption data suggests that it adsorbs fairly strongly to sediments when the pH of slurries is near neutral. In general, nickel seems to adsorb more strongly than cobalt in most sediments, including Hanford Site sands. It appears that nickel is also less prone to forming strong organic complexes with chelating agents used at Hanford Site and more prone to co-precipitating with other trace metals such as iron, manganese and aluminum when acidic wastes are neutralized. None of the aqueous speciation tabulations that we have been relying upon discuss nickel geochemistry but Baes and Mesmer (1976) and Pourbaix (1966) discuss aqueous speciation in the simple water-H^+-OH^- system and state that nickel aqueous speciation is quite similar to cobalt. There are no Hanford-specific studies of nickel adsorption onto agricultural soils or river bank deposits so the following literature was reviewed.

Stauton (2004) determined the K_d value for nickel on 13 soil types from France as a function of pH, dissolved organic carbon content, background electrolyte ($CaCl_2$ between 0.001 and 0.1 M), and competing trace metals. Most of the soils were finer grained than Hanford Site sands and had slurry pH values slightly more acidic than Hanford conditions. The K_d for the 0.01M $CaCl_2$ background solution condition, which is more saline than expected conditions in the near surface sediments at the Hanford Site ranged from 65 to 1830 mL/g. For the soils most similar to Hanford Site projected agricultural soils, the K_d ranged from 130 to 780 mL/g.

Christensen et al. (1996) measured the K_d value for nickel on 12 Danish sandy aquifer sediments using a 0.001 M $CaCl_2$ solution and found the K_d value to vary between 3 and 7250 mL/g. Most of the

variability correlated with the slurry pH of the system. Low K_d values were found for acidic conditions, and the highest K_d values were found for alkaline conditions. The Danish sediments with characteristics similar to Hanford Site sands, the K_d values ranged from 250 to 440 mL/g.

Martino et al. (2004) studied the adsorption of ^{63}Ni onto estuarine suspended solids from brackish waters from the Mersey Estuary, England. The equilibrium sediment to water distribution coefficient for nickel-63 (^{63}Ni) ranged from about 200 mL/g in the upper estuary to about 1200 mL/g in the marine end-member, and ^{63}Ni added to riverine sediment exhibited little tendency to desorb when re-suspended in saline water.

Brown et al. (1994) performed sorption and transport experiments to determine how vadose-zone microbes affect sorption of Ni(II) and Cd(II) on crushed volcanic tuff and transport of Ni^{2+} in the same medium. Sorption of Ni to the tuff was less in samples inoculated with microbes than in sterile samples. Since Ni(II) sorption was the same both in the presence and absence of microbes when a buffer was used, microbes appear to decrease sorption by decreasing solution pH. Nickel isotherms were linear up to initial concentrations of 10 mg/L and the average K_d was 184 mL/g for sterile sediment. This study suggests that the presence microbes do not significantly change the adsorption tendencies of nickel to soils; however the microbes can change pH conditions and pH is a key variable that controls nickel adsorption to soils.

Based on past Hanford studies of cobalt and nickel adsorption as summarized in the tabulations noted and the new literature reviewed, 200 mL/g was chosen as a "best" K_d value and a range of 50 to 1500 mL/g for non-groundwater Hanford Site scenarios of interest herein. The recommended best K_d value is considerably lower than the value presented in Napier and Snyder (2002), which simply chose a maximum value from limited Hanford data. The recommended K_d value is also lower than the most probable Ni K_d value (300 mL/g) presented in Krupka et al. (2004) and Thibault et al. (1990; [300 and 400 mL/g for loam and sand sediments, respectively), but higher than the value (20 mL/g) chosen by Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1983b, and 1985). A best K_d value of 200 mL/g was chosen as a reasonable value to show greater adsorption than cobalt but to allow for some decreased sorption as soil pH may decrease as soils retain more organic matter and to allow for the possibility of some complexing with dissolved organic matter. The recommended range is similar to ranges shown in Tables 1.2 and 1.3. The nickel K_d may exhibit some hysteresis during desorption such that values higher than 200 mL/g should be weighted more heavily in sensitivity calculations. This weighting would capture any risk sensitivity to the choice of K_d value. If sensitivity calculations suggest nickel is a key dose contributor, site specific laboratory adsorption-desorption are recommended.

3.14 Nitrate/Nitrite

No sorption experiments have been run using trace concentrations of nitrate or nitrite contacting Hanford Site sediments. Most of the Hanford Site literature and groundwater monitoring measurements show that nitrate is quite mobile and does not interact strongly with Hanford Site sediments. The fact that large groundwater plumes of nitrate exist below many of the disposal facilities at Hanford Site attests to its mobility (see Hartman et al. 2004). It has been found that much of the nitrite present in single-shell tank supernatant solutions that have leaked into the vadose zone gets oxidized to nitrate (see Serne et al. 2002b, 2002c).

There is a large mass of agricultural literature that explains a detailed microbiological-chemical cycling of the various forms of nitrogen present in the environment (N_2 gas, nitrate (NO_3^-), nitrite (NO_2^-), and ammonia (NH_3, NH_4^+). The valence state of the nitrogen species are N(0), N(V), and N(III) for the gas, nitrate, and nitrite/ammonia species. Significant quantities of nitrogen-bearing fertilizers are applied to agricultural soils around the Hanford Site such that if Hanford Site lands are released back to the public for farming, more detailed conceptual models of how to assess the nitrogen cycle in risk assessments may be warranted.

Seo and Lee (2005) used time reflectometry probes to measure the migration of nitrate, chloride, and phosphate spiked into 0.005 M $CaCl_2$ solution that was percolated through intact cores. The test conditions were column dimensions 10 cm diameter by 15 cm long. The columns were filled with a sandy loam (71% sand, 19% silt, and 10% clay) from the Knoxville, Tennessee Agricultural Experiment Station. The natural soil pH is 5.7 and the organic carbon content was 0.89%. Although no K_d values were reported, Seo and Lee (2005) state that the migration of nitrate and chloride through the columns was almost identical. Phosphate, however, was significantly retarded. Both the chloride and nitrate were assumed to be non-interacting solutes and thus would be assigned a K_d value of zero.

Qafoku et al. (2000) measured the retardation of nitrate percolating through 13 different subtropical and tropical subsoils that contained hydrous oxide-rich minerals with variably charged surface sites. The native pH for the subsoils ranged from 4.82 to 6.40 and their anion exchange capacity (AEC) ranged from 0.01 to 1.86 cmol/kg (meq/100 g). A relationship was found that related the K_d for nitrate (present in 5 mmol $Ca(NO_3)_2$ solution) versus the anion exchange capacity of these soils for pH values within the range of the native sediments. The relationship is

$$K_d = -0.1325+1.1505*AEC$$

where the units of K_d are mL/g and of anion exchange capacity are $cmol_c$/kg (centimoles of charge per kilogram of soil; same as old convention units meq per 100 g soil).

It is not clear whether this relationship would be applicable to the more alkaline relatively un-weathered Hanford formation sand sediments present at the Hanford Site. Also, it is not known what the anion exchange capacity is for Hanford Site sediments because it has not been measured. Anion exchange capacity is measured by the procedure found in Zelzny et al. (1996). If the Hanford Site surface soils and/or Columbia River bank sediments become enriched in decaying organic matter, the pH will drop and some of the minerals and particle coatings will exhibit net positive surface charges and thus anions such as nitrate, chloride (chlorine-36), selenate, selenide, iodide, iodate, and pertechnetate might adsorb more strongly than is generally found today. This phenomenon was accommodated in the K_d value recommendations for all anionic contaminants in this report.

At present, K_d values are provided for nitrate/nitrite assuming no microbiologic interaction and account for only inorganic adsorption reactions onto Hanford Site near-surface sediments. However, the "best" K_d value of 0.5 mL/g should be used for nitrate in a similar fashion as for chloride and technetium and the range should be set at 0 to 1 mL/g for sensitivity calculations. In the other tabulations, only Krupka et al. (2004) discusses nitrate K_d values. For groundwater scenarios, they recommended 0 mL/g for the most probable K_d value and a range of 0 to 0.6 mL/g.

The recommendations in this report for nitrate are based on the assumption that Hanford Site derived nitrate contamination that will be present in the future will mainly be solidified waste forms (mainly cementitious) that are inadvertently brought to the surface during well drilling activities or present at low concentrations in near-surface sediments as remnants of past liquid disposals . Because most of highly contaminated near-surface contaminated sediments will be removed to a depth of 15 feet and backfilled with clean sediments before the Hanford Site lands are released, high nitrate concentrations of DOE-Defense-waste origin probably will not be found in the near surface soils. In fact, most of the near surface nitrate- or nitrogen-containing sediments in future agricultural soils would likely come from application of fertilizers or less likely use of previously contaminated groundwater for irrigation.

3.15 Plutonium

The geochemistry of plutonium in near-surface environments germane to the Hanford Site can be quite complex. The four valence states +3, +4, +5, and +6 are all possible for plutonium species in solution or in solid precipitates. However, it is likely that dissolved plutonium will be dominated by the oxycations PuO_2^+ [Pu +5] and PuO_2^{2+} [Pu +6] in near-surface Hanford sites of interest. At circum-neutral pH and mildly oxidizing conditions both forms of plutonium would likely be present in solution as complexes with inorganic anions (hydroxide and carbonate), although similar to Np(V), the free cation PuO_2^+ [Pu(V)] can dominate speciation in the weak acid to neutral pH region of low ionic strength waters. Also similar to neptunium, aqueous plutonium species can be reduced when interacting with the surfaces of many common minerals found in Hanford Site sediments. Reduced plutonium, Pu(III) and Pu(IV), are relatively insoluble at neutral pH conditions and also strongly sorbed onto solids. For more details on plutonium geochemistry and adsorption tendencies see the summaries presented in EPA (1999b), Ames and Rai (1978), Onishi et al. (1981) and Rai and Serne (1978). Based on these publications in general, no matter what the redox conditions at circum-neutral pH, plutonium exhibits strong adsorption tendencies in most environments. There are no Hanford-specific studies on plutonium adsorption onto agricultural soils or river bank deposits so the following literature was reviewed.

Roussel-Debe (2005) measured the K_d values for plutonium onto six agricultural soils taken from near French nuclear reactors. The plutonium was added to the lab tests in an oxidized form, but no valence state measurements of the ending state of the plutonium were performed. The soil that was most similar to Hanford Site sands yielded a K_d value of 540 mL/g. Based on statistical correlations that showed the plutonium K_d value was most sensitive to particle size, Roussel-Debe (2005) recommended a default value of 2200 mL/g for plutonium sorbing to agricultural soils in France. However, the French soils in general had much more silt and clay content than Hanford Site sands.

Tanaka and Muraoka (1999) measured the adsorption of Pu(IV) onto <1 mm-size particles of several sand sediments, soils and crushed tuff and sandstone rocks that surround the proposed Shimokita low-level waste disposal site in Japan. Trace activities of Pu(IV) were placed in distilled water and contacted with the sorbents for 7 days. The adsorbed plutonium was desorbed using a sequence of ever more aggressive chemical reagents to ascertain how strong the adsorption was. The pH of the sand slurries, which most closely resemble Hanford Site sands varied from 6.4 to 7.5 similar to the recent measurements of highly vegetated surface soils at the Hanford Site. The Pu(IV) K_d values for the sands that most closely resemble Hanford Site sands varied between 250 and 700 mL/g and the desorption K_d values into 0.5 M salt solutions ranged from 2000 to 5000 mL/g, thus showing high irreversibility. Based on the

selective chemical reagent extractions, Tanaka and Muraoka (1999) suggested that plutonium was associated with hydrous iron and manganese phases in the sands.

Livens et al. (1994) measured the K_d value of plutonium on three fine-grained river estuary sediments proximate to Sellafield reprocessing plant. The plutonium K_d was determined from extracting the pore fluids from the saturated sediments and measuring the activity in each phase. The K_d values varied significantly with values 166, 730, and 1010 mL/g for the three sediments. No plutonium valence state measurements were made on the pore fluids. No explanation was offered for the wide range but it was noted that plutonium exhibited less adsorption than americium for these three river fine-grained sediments.

Lu et al. (2003) measured the adsorption of ^{239}Pu(V) at 2.33 x 10^{-7} M spiked into groundwater from the Yucca Mountain repository site onto fine colloids of hematite, montmorillonite, and silica as a function of time, temperature, ionic strength and colloid concentration. For all three adsorbents, the plutonium K_d was large 7 x 10^{+5}, 1 x 10^{+4}, and 7 x 10^{+3} mL/g for hematite, montmorillonite, and silica colloids, respectively. Desorption of ^{239}Pu from ^{239}Pu-loaded colloids was considerably slower than the adsorption process. The findings relevant to our sorption evaluation is the high K_d values for plutonium onto all the solids and the desorption hysteresis.

Linsalata and Cohen (1980) measured the K_d for Pu(IV) spiked into Hudson River estuary water [pH 7.4] onto clay-sized river bottom sediments and silty fine-sand river bottom sediments. The K_d values were determined after 10 days of equilibration and as a function of dissolved salt content, pH, variable dissolved carbonate, sulfate and humate concentrations. However, no plutonium valence state determinations were made on the final solutions. For clay-size river sediments, the measured plutonium K_d ranged from 200,000 to 600,000 mL/g regardless of the values of the dependent variables. For the silty fine-sand, the plutonium K_d values dropped to 60,000 mL/g. Increasing salinity to 24‰ (parts per thousand) or increasing the sulfate and carbonate concentrations to values 4 times larger than the estuary normal concentrations did not cause a lowering in K_d. The dissolved humate and total organic carbon content of the sediments did alter the K_d but Linsalata and Cohen (1980) do not state what the effects were. This study shows that plutonium K_d values, at least when starting species is Pu(IV), are rather insensitive to dissolved salt content but sensitive to available surface area (particle size) of the adsorbent and in general the K_d for plutonium is large.

Skipperud et al. (2000) measured the K_d for several plutonium species [Pu(III,IV), Pu(V,VI), and Pu(II,IV)-organic complex] spiked into seawater onto marine sediment from a fjord using 2 g of solids (dry weight basis) and 15 mL of seawater. The batch tests were run for 0.5 hour up to 180 days. The adsorption reactions were slow and even after 180 days had not reached steady state. The K_d values for the various types of spiked Pu as a function of time are shown in Table 3.1.

The K_d values shown in Table 3.1 increase with time and no pseudo-equilibrium was reached even after six months. Thus, the contact time between contaminated sea water and sediments should be taken into account in dose assessment models. The results indicate that the distribution coefficient, K_d, for plutonium depends on the plutonium species that is present in the experiments. Thus, sediments act as a sink for Pu(III, IV) (high K_d), while Pu(III, IV)-organic and Pu(V, VI) should be considered more mobile (lower K_d). Furthermore, the Pu-solids interaction results obtained from sequential extraction depends less on Pu-species than on time of contact (binding strength increases with time). Desorption K_d values indicate that the observed initial adsorption of plutonium to sediments reflects and is dependent on

Table 3.1. K_d Values (mL/g) for Various Plutonium Species as a Function of Time

Species	1 Week	1 Month	6 Months	Desorption After 6 Months
Pu(V, VI)	60 ± 17	199 ± 20	550 ± 160	1355 ± 15%
Pu(III,IV)	780 ± 160	2015 ± 950	6180 ± 2300	1930 ± 40%[(b)]
Pu(III,IV)-organic[(a)]	60 ± 15	135 ± 30	210 ± 60	1410 ± 30%

(a) Organic complex was 0.033 mg/L ethylene diamine tetraacetic acid (EDTA).
(b) Desorption value seems low and questionable.

plutonium speciation in the water soluble phase and that later, stronger sediment-plutonium interactions are rather independent of the original speciation. In terms of the long-term changes, transformation processes must be studied in order to assess rates of transfer between inert and mobile fractions due to contact time.

Emery et al. (1974) and Emery and Garland (1974) studied pond sediments and pond water at U Pond on the Hanford Site in 200 West Area. On average, the pond sediments contained 390 pCi/g total plutonium and the overlying waters contained 0.01 pCi/L total plutonium. If it is assumed that the pond sediments and water represent an equilibrium condition, then the in-situ K_d for plutonium is 3.9 x 10^{+7} mL/g. Emery et al. (1974) also extracted the pond sediments with several chemical reagents in a sequential fashion wherein each extract used became more vigorous in reaction. Over 73 to 93 % of the plutonium was not extractable from the pond sediments even with strong reagents. Emery and Garland (1974) and Emery et al. (1974) suggest that only 9% of the plutonium associated with the sediments would be available to the pond's food web. Emery and Garland (1974) and Emery et al. (1974) also subjected the pond water to filtration through a serial reactive resin bed and found that the dissolved americium was 37% non-ionic (removed by aluminum oxide resin, 60 to 80% cationic and 5% anionic in nature. The source of the plutonium reaching the U Pond was from plutonium purification and finishing processes, and it is possible that some of the plutonium reached the pond sediments as suspended particulates. Thus, the observed in-situ K_d value may be inflated over situations where the source is dissolved contaminants in waste waters. Emery and McShane (1978) describe detailed limnological and ecological studies at several Hanford ponds and ditches however only data on gross alpha and gross beta are presented for concentrations in sediments and waters. Thus no specific element K_d values could be calculated. Emery and McShane (1978) found no evidence that radiation dose at these facilities were limiting the algal, plant or animal communities present even though calculated maximum dose rates reached 1 R per week and maximum gross beta levels reach values of 10^4 pCi/L in the water.

Based on the past tabulations of plutonium K_d value s and the cited literature, it is recommended that the "best" or most probable plutonium K_d value of 600 mL/g be used and that the range be set at 200 to 5000 mL/g. The plutonium K_d exhibits hysteresis during desorption so values higher than 600 mL/g should be weighted more heavily in sensitivity calculations. The new recommended "best" K_d value and range are lower than and similar to the values tabulated in Napier and Snyder (2002), respectively. Napier and Snyder (2002) used a "best" value of 5000 mL/g. Last et al. (2004) and Krupka et al. (2004) recommended "best" values for plutonium K_d at 600 and 150 mL/g, respectively for groundwater scenarios. Both of these tabulations also used a high range value of 2000 mL/g. The range for agricultural soils was widened to 5000 mL/g to reflect desorption hysteresis being quite common. Desorption will be the key process that changes the concentration of contaminants in the non-groundwater scenarios of interest to this report. Thibault et al. (1990) recommended a plutonium K_d value for sands at

550 mL/g and Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1984b, and 1985) recommended a value of 5000 mL/g. Some of the tabulations may include studies where plutonium precipitation was inflating the measured K_d values; therefore, the author recommends a "best" K_d value of 600 mL/g and use of a wide range to cover desorption hysteresis and the likelihood that plutonium precipitation could have been present during the original waste solidification or sediment contamination events.

3.16 Polonium

No studies of polonium adsorption onto Hanford Site sediments are available in the literature and very little general literature exists regarding polonium adsorption. There is some literature on the distribution of ^{210}Po between solution and particulate matter in freshwater lakes, estuaries and the ocean and all of the references suggest that the bulk of polonium is found adsorbed or co-precipitated into the sediments as opposed to being in solution.

For example, Swarzenski et al. (1999) found 50 to 70% of the total ^{210}Po in marine waters in a Norwegian fjord was present in filterable solids. Although the actual concentration of suspended particles in the fjord water was not specified, but the mass was not large; therefore the in-situ K_d must be quite large. Wieland et al. (1991) studied the residence and settling times of particles and particle-reactive nuclides (evaluated from in situ tracer studies which can be used as diagnostic indicators of trace element pathways in lakes). Natural ^{210}Pb and ^{210}Pb fluxes through Lake Zurich (at 50 and 130 m depth) from 1983 to 1987 allowed the calculation of nuclide residence times as well as particle settling and transit velocities in Lake Zurich. The residence time of ^{210}Pb and stable lead in the lake is approximately 1 month. ^{210}Po (daughter of ^{210}Pb) was removed from Lake Zurich with removal times of 10 to 26 months indicating slow removal processes or efficient recycling in the lake water. Balistrieri et al. (1995) also studied the cycling of stable lead, ^{210}Pb, and ^{210}Po in Lake Sammanish, Washington, that exhibits seasonal changes from having the lower water column oxic and anoxic. The key finding that is relevant to our interest is that dissolved polonium was removed from the water column by suspended and bottom sediments less quickly than lead. Thus, in freshwater lakes, the K_d value for ^{210}Po should be less than that for ^{210}Pb.

Vaaramaa et al. (2003) determined the percentage of ^{210}Po that was particulate versus in a dissolved state using pressure filtration of five potable groundwaters taken from wells in Finland. Three of the waters exhibited low ionic strength, neutral pH, calcium bicarbonate dominated fluids common in granite aquifers. Two of the waters were slightly higher ionic strengths and dominated by sodium chloride. The granite waters are quite similar to Hanford Site pore waters. In all five waters, the chemical concentration of polonium was lower than or equal to 2×10^{-16} mol/L. The adsorption of polonium species on colloids or larger particles of other elements is the probable cause for the extremely low solution concentrations. For the three granitic waters, the percentage of ^{210}Po that is not bound to particles ranges from 32 to 65%. In the more saline waters <10% of the ^{210}Po is not bound to particles. Vaaramaa et al. (2003) suggest that most of the ^{210}Po in the groundwater is bound in particles having high concentrations of Fe, Mn, and humus. In other studies, they found that iron and aluminum colloids and suspended particles may adsorb polonium. In comparison to radium and uranium, the polonium is most prone to be associated with particles suspended in the groundwater.

Ulrich and Degueldre (1993) determined the influence of the ionic strength and of pH on the adsorption/desorption processes of lead, bismuth, and polonium onto montmorillonite clay. The ionic

medium had no influence on the sorption/desorption of both bismuth and polonium. For all of these nuclides, large K_d values were measured. The K_d values range from 10^4 to 10^7 mL/g for ^{210}Bi and ^{210}Po. When adsorption and desorption coefficients are compared, the bismuth and polonium adsorption K_d values were several orders of magnitude lower than those obtained for desorption. The chemical activities of free bismuth and polonium in the liquid phase are limited by the formation of bismuth and polonium-colloids prior to the sorption step. While the adsorption of lead was reversible, only very small amounts of bismuth and polonium could be desorbed from the montmorillonite (quasi-irreversible adsorption). The difference in the K_d values between adsorption and desorption is approximately one order of magnitude in the case of polonium. This suggests that polonium exhibits a high degree of sorption hysteresis.

Finally, Baes et al. (1984) (one of the few tabulations of environmental transport parameters that does discuss polonium; however limited to Oak Ridge National Laboratory conditions) and Thibault et al. (1990) suggest that polonium would adsorb fairly strongly to sediments. Napier and Snyder (2002) use a best value of 1100 mL/g for the polonium K_d value and a range of 196 to 1063 mL/g. Therefore, the "best" or most probable K_d value should be set at 400 mL/g, similar to its parent in the U decay chain, bismuth, and the range be set at 150 to 1100 mL/g based on Baes et al. (1984) and references in Napier and Syder (2002). These recommended K_d values are smaller than those recommended for lead. If doses from polonium ever rise large enough to merit concern some Hanford Site-specific polonium adsorption-desorption testing using appropriate sediments and pore waters would be needed to validate these recommended values.

3.17 Protactinium

No studies of protactinium adsorption onto Hanford sediments are available and very little general literature exists regarding protactinium adsorption. Thibault et al. (1990) relied on soil-to-plant transfer factors to estimate K_d values for protactinium. Because so little is known about the aqueous chemistry and adsorption properties of protactinium, geochemists working in nuclear waste disposal and risk assessment often choose low K_d values because protactinium exhibits a +5 valence state similar to neptunium. For conservatism, neptunium is often used as an analog for protactinium when choosing sorption fate (see for example Krupka et al. 2004). But for the non-groundwater scenarios of interest to this report, conservative K_d values would be larger values than for groundwater scenarios. The recent electronic databases query found the following publications that mention protactinium in subsurface environments.

There is data on the fate of protactinium in marine environments that show very strong adsorption onto fine-grained particles. For instance a recent article, Geibert and Usbeck (2004), measured the K_d value for protactinium adsorbing from several seawaters onto smectite clay, biogenic opal, calcite, and manganese oxides. The protactinium K_d values onto the fine-grained minerals ranged from $1.6 \times 10^{+6}$ mL/g for smectite, $6.1 \times 10^{+7}$ mL/g for manganese oxide, $1.7 \times 10^{+5}$ mL/g for calcite and $5 \times 10^{+5}$ mL/g for biogenic opal. It is difficult to determine how to use the information from the marine studies where it is generally found that daughter products of uranium and thorium, such as protactinium, readily adsorb onto the fine-grained suspended particles and rapidly descend to the ocean floor (for example see the references cited in the Onishi et al. 1981 tabulation). Based on Onishi et al. (1981) observed K_d values for most daughter products of uranium and thorium (and thorium itself) onto fine-grained particles are always large, $>10^{+4}$ mL/g. At the Hanford Site, the particle size distribution is much

larger than for marine sediments, so adsorption may be less because of the much smaller available surface area. However, it would appear that the concern that protactinium might form a weak sorbing aqueous species PaO_2^+ similar to the neptunyl species is not supported strongly by the marine experiments. Whatever the aqueous species of protactinium that is present in circum-neutral pH regimes (note seawater has a pH of 8.1), sorption appears to be quite large.

The "best" or most probable protactinium K_d value should be set at 400 mL/g, similar to the values for other daughter products in the uranium and thorium decay chains such as bismuth and polonium (see Table 1.2 or 1.3). Napier and Snyder (2002) list a "best" protactinium K_d value of 3600 mL/g, but do not list a range. The protactinium K_d range should be set at 150 to 10,000 mL/g to account for its seemingly very high association with solids (at least in marine environments) and to allow for wide ranging sensitivity calculations. If doses from protactinium ever rise large enough to merit concern some Hanford Site-specific adsorption-desorption testing using appropriate sediments and pore waters would be needed to validate the recommended "best" value and to better constrain the range. Geibert and Usbeck (2004) present a useful methodology for obtaining protactinium tracer for laboratory adsorption testing based on milking a short-lived tracer, ^{233}Pa from its parent ^{237}Np.

3.18 Radium

No sorption work has been done for radium using Hanford Site specific sediments or waters; however, there is adequate general literature to suggest that radium is fairly strongly adsorbed onto most sediments in contact with low ionic strength solutions with circum-neutral pH values. In solution, radium is found to exist solely as a free divalent cation or complexed to common inorganic anions, especially sulfate. Radium readily co-precipitates with calcium sulfate, gypsum, in brackish environments (Langmuir and Reise 1985). These co-precipitation processes also occur in waste disposal or natural environments that have elevated dissolved sulfate concentrations. Sulfate is the second most abundant dissolved anion in the natural groundwaters underlying the Hanford Reservation (see data in Hartman et al. 2004). These summary statements and more discussion on radium geochemistry can be found in EPA (2004) and Ames and Rai (1978).

Zhang et al. (2001) measured the adsorption of barium (an analog for radium) onto montmorillonite clay and found the bulk of the barium to adsorb onto the fixed charge sites on the basal plane of the clay sheet structure and to be rather insensitive to changes in pH and sensitive to cation competition (ionic strength) similar to expectations from classical ion exchange processes. However, a small fraction of barium also adsorbed on the montmorillonite edge sites, forming a strong inner-sphere surface complex through sharing of oxygen atom(s) from de-protonated –OH groups of the aluminum octahedral layer. This type of adsorption is considered quite strong and fairly irreversible. Perhaps this inner-sphere complex reaction leads to relatively strong adsorption for large-size divalent cations, such as radium.

Baraniak et al. (1999) studied the adsorption of ^{226}Ra spiked into groundwater onto sand, clay, and lime marl sediments from the Saxon Elbe river valley. Batch K_d tests were performed using from 1 to 10 grams of crushed solids into 5 to 50 mL of groundwater for contact times of up to 8 weeks at 14°C. The groundwater was a calcium-bicarbonate/sulfate dominated water with similar concentrations as Hanford Site groundwater and a pH of 7.1. For a crushed sandstone made up predominately of quartz, the radium K_d ranged from 62 to 178 mL/g. In long contact tests (up to 21 weeks), the radium K_d slowly increased but ~95% of the radium that adsorbed did so in the first 24 hours of contact. The very slow reaction that incorporates small additional amounts of radium was hypothesized by Baraniak et al. (1999)

as being radium incorporation/substitution into crystals of barite (barium sulfate a very insoluble compound). In fact, the K_d for radium is found to increase if additional barium (7×10^{-7} to 2.5×10^{-5} M) and sulfate (1.25×10^{-4} to 1×10^{-1} M) is added to the groundwater. Thus, it appears that two sequestering processes, classical surface adsorption and co-precipitation/replacement with barite, are active for radium.

Sun and Torgersen (2001) measured the distribution of ^{224}Ra between sediments and their pore waters at three locations off Long Island, New York. Although this is a marine system and not directly correlatable to Hanford Site, the K_d values for radium ranged from 4 to 85 mL/g with the median value 22 and an average of 24 mL/g. This range of K_d values and the mean suggest that radium sorption in some environments can be relatively low and more similar to strontium than divalent transition metals in waters with high concentrations of competing cations. This report relied on the Baraniak et al. (1999) and Sun and Torgersen (2001) to choose the range for the radium K_d for this compilation.

Aguado et al. (2004) sampled riverbed sediments from an estuary historically affected by waste discharged by several phosphate fertilizer plants, which contained enriched uranium-series radionuclides. A selective extraction technique, which relied on a sequence of more and more aggressive reagents, was used to determine the binding energy for ^{226}Ra to the sediment one year after anthropogenic discharges had ceased. The results obtained revealed that one year after ^{226}Ra inputs had stopped, the radionuclide was associated mostly with the more refractory portions of the sediment. Consequently, it was concluded that there was little potential for remobilization of ^{226}Ra contamination from sediments to the aqueous phase in the future under normal environmental conditions.

Brenner et al. (2004) used gamma spectroscopy to measure ^{226}Ra activities in sediment cores from 20 lakes and a wetland in Florida. Shallow sediments from two lakes (Round and Rowell) possess very high (>20 dpm/g) ^{226}Ra activities that exceed total ^{210}Pb activities, clearly illustrating disequilibrium between ^{226}Ra and supported ^{210}Pb. Supported ^{210}Pb activity is generally thought to come from in situ, ^{226}Ra containing detrital mineral particles, and is typically assumed to be in secular equilibrium with ^{226}Ra activity. Since 1966, Round Lake has been augmented hydrologically with ^{226}Ra-rich (~6.2 dpm/L) groundwater pumped from the local deep aquifer. Adsorption of dissolved ^{226}Ra to recent Round Lake sediments probably accounts for the high measured ^{226}Ra activities in the sediments and the pronounced disequilibrium between ^{226}Ra and supported ^{210}Pb in topmost deposits. They suspect that many Florida water bodies receive some ^{226}Ra-rich runoff and seepage from groundwater pumped for irrigation, residential use, industrial applications, and mining. This may account for increases in ^{226}Ra activity measured in shallow sediment cores from some Florida lakes. Significant groundwater pumping began within the last century, and there has been insufficient time for supported ^{210}Pb to come into equilibrium with adsorbed ^{226}Ra in uppermost deposits. One can, thus, estimate that ^{226}Ra present in wastewater is prone to adsorbing quite favorably to the freshwater sediments.

Sarkar et al. (1999) studied the adsorption of radium onto soils in Florida from highly saline "reject" water [total dissolved solids (TDS) = 6500 mg/L] from an electrodialysis reversal water treatment plant. Flow-through column results indicated that ^{226}Ra accumulated throughout the soil profile, and that only small amounts of ^{226}Ra escaped out of the column. Equilibrium geochemical modeling, using the computer code MINTEQA2, suggested that radium adsorption on sand was the primary mechanism responsible for ^{226}Ra retention in the soil column. In the absence of competing Ca, 100% of the ^{226}Ra was predicted to adsorb on sandy soil at neutral pH. The presence of Ca decreased overall retention of ^{226}Ra, due to competition for similar surface sites. The ^{226}Ra concentration in the system was too

low to induce direct precipitation of radium salts. Radium adsorption on sand was influenced by pH of the soil solution, with more radium adsorbed at higher pH.

Benes et al. (1997) collected 134 suspended and bed sediment samples from rivers and reservoirs in Czechoslovakia. They then determined the radioactive equilibrium between parents (^{238}U and ^{232}Th) and their daughters (^{226}Ra and ^{228}Ra), respectively in the solids. Benes et al (1997) found that the two radium isotopes were either in equilibrium with their parents or in the case of ^{228}Ra was often present in excess, which suggests that radium is readily removed from fresh water solution by adsorption reactions.

Willett and Bond (1995) studied the adsorption of ^{226}Ra onto soils from the Alligator Rivers Region of the Northern Territory in Australia. All sorption studies were conducted with a 1/5 ratio of soil (oven-dry equivalent) to background electrolyte of 0.0025 M $MgSO_4$. This solution was used because it was similar in composition to the retention pond water at the Ranger uranium mine. The reaction period for the batch sorption tests was 24 hours. For a sand soil with low cation exchange capacity (1 to 2.5 meq/100 g), organic carbon content of 0.1 to 0.7 % and a natural pH of 5.6 to 5.7, the ^{226}Ra K_d values ranged from 3000 to 5000 mL/g. Once adsorbed only <1% of the sorbed radium was displaced on re-suspension of the samples in the background electrolyte.

Kadko et el. (1987) measured the ^{226}Ra concentration in both the marine sediments and its pore water in eastern equatorial Pacific Ocean waters just north of the Galapagos Islands off the western coast of Central America. The ^{226}Ra activity in pore waters ranged from 0.5 to 7 dpm/kg of seawater and the ^{226}Ra content in the sediments ranged from 10 to 70 dpm/g. These two measurements can be combined to get an estimate of the ^{226}Ra K_d by assuming that a kilogram of seawater has a density of 1.03 g/mL. The calculated radium K_d range is $1.4 \times 10^{+3}$ to $1.4 \times 10^{+5}$ mL/g, but these values are likely too high for Hanford Site use because some of the ^{226}Ra in the sediments is bound in crystalline mineral lattices and not truly part of the exchangeable portion of the sediment. Thus, any radium present in Hanford wastes is not likely to become incorporated into crystalline lattice sites in surface soils or Columbia River bank sediments in the time periods of interest to performance assessments.

Napier and Snyder (2002) recommended a "best" radium K_d value of 500 mL/g and a range of 214 to 467 mL/g. Thibault et al. (1990) recommends a K_d value of 500 mL/g for sand. For groundwater scenarios Krupka et al. (2004) recommends a value of 14 mL/g and a range of 5 to 200 mL/g. Onishi et al. (1981) is the only other reference listed in Table 1.3 that mentions radium and they provide a range from 200 to 500 mL/g. From the mentioned tabulations and all the generic radium studies just described, a radium K_d value of 200 mL/g was chosen for the "best" or most probable value and a range of 5 to 500 mL/g for sensitivity analyses for the agricultural and river bank soil scenarios described earlier. A lower "best" K_d value was selected than recommended by Napier and Snyder (2002) and Thibault et al. (1990) to honor the lower K_d values found by Baraniak et al. (1999) and Sun and Torgersen (2001) and to stay consistent with classical ion exchange as being a dominant sequestration mechanism for radium. Because the future Hanford agricultural soils and river bank sediments will remain rather coarse in particle size, the K_d might be lower than many contaminants that adsorb more so by variable charged hydrous oxides, or co-precipitate/adsorb with high pH sensitivity such as transition metals, lanthanides, and most lower valence state actinides. Selecting the wide range (5 to 500 mL/g) would allow sensitivity studies to determine whether radium is in fact a significant dose contributor for the agricultural soil and river bank sediment substrates and non-groundwater scenarios of interest. If sensitivity studies show radium may be a significant dose contributor, then laboratory studies using appropriate radium-spiked soils and sediments should be performed to validate radium K_d values.

3.19 Selenium

Adequate Hanford specific adsorption literature exists for selenium because of recent work performed for the low-activity glass waste project, (i.e., renamed IDF) in which selenate species were used (Um and Serne 2005). Krupka et al. (2004) and Cantrell et al. (2003) review the Hanford specific literature, including the recent studies published in Um and Serne (2005). In natural waters of interest to the Hanford Site selenium is found in two forms and valence states, selenate (SeO_4^{2-}) [Se(VI)] and selenite (SeO_3^{2-}) and/or ($HSeO_3^{2-}$) [Se(IV)]. Interestingly, elemental selenium can be a solubility control across most pH values for moderately reducing redox conditions (Krupka et al. 2004, Figure 3.8). Mixed iron hydroxide-selenium oxides may also be controlling the concentrations of dissolved selenium in natural pore waters if high concentrations are present. A recent review of the aqueous speciation thermodynamics reports that the stability constants for several aqueous species in older literature are quite suspect and new recommendations are offered (Seby et al. 2001). However, adsorption reactions likely are the main controller of selenium in the scenarios of interest to this report based on the likely very low concentrations of selenium and the key radionuclide of interest, ^{79}Se. More detailed discussions on selenium geochemistry, including aqueous speciation diagrams as a function of pH and Eh, and adsorption properties are found in Krupka et al. (2004) and Ames and Rai (1978). Although not completely determined, the selenate form of selenium is the most likely form present in the Hanford near-surface soils and sediments based on our geochemical experience.

Dhillon and Dhillon (1999) measured the K_d for eight surface soils from India that are much finer-grained than Hanford sands. The form of selenium used was selenite traced with ^{75}Se radioisotope that was not specified as to species. The range of K_d values was 1 to 241 mL/g with the higher values for pH conditions in the acidic range 4 to 6. The soil that resembled Hanford sands most closely yielded a K_d value that varied from 1 to 8.3 mL/g.

Singh et al. (1981) determined the Langmuir adsorption constants for five Indian surface soils using both sodium selenite and sodium selenate spiked into a very dilute sodium chloride solution. None of the soils are as coarse grained or exhibit as low of cation exchange capacity as the Hanford soils. For the Indian soil that has characteristics closest to the Hanford Site sands, the K_d for selenite varied from 5 to 20 mL/g as the selenite equilibrium concentration drops from 7.4 to 0.2 mmol/L. For this same soil the K_d for selenate varied from 7 to 33 mL/g as the selenate equilibrium concentration drops from 9 to 0.13 mmol/L. Contrary to studies discussed in the following paragraphs, selenate adsorbed more than selenite in Singh et al. (1981) studies. No explanation for this apparent discrepancy is available.

Dong et al. (1999) studied the adsorption of selenite spiked into 0.01 M calcium chloride background electrolyte onto an iron oxide reach acidic soil from China. The soil contained 12% by weight iron oxides, had 38% clay content, 0.78% organic matter, a slurry pH of 4.78 and a cation exchange capacity of 10.1 meq/100 g. Batch adsorption tests were carried out in the background electrolyte at pH 6.3 to 6.8 for about 60 hours at solution to solid ratios of 150 to 500 mL/g. The average selenite K_d for the soil was 477 mL/g, but if the soil was treated with citrate dithionite to remove the iron oxides the K_d dropped to between 11 and 16 mL/g. There was also a slight bit of hysteresis in that the desorption K_d values were 10 to 30% larger that the adsorption K_d values. The selenite K_d values for the iron oxide removed soil are similar to values found for Hanford coarse sands that were contacted with trace concentrations of selenate (see review discussion in Cantrell et al. 2003) suggesting that there may not be significant difference between adsorption of selenite and selenate once most of the iron oxides are removed.

Del Debbio (1991) measured the adsorption of selenite (SeO_3^{2-}) onto alluvium, interbed sediment and crushed basalt rock from the Idaho National Laboratory, Idaho Falls, Idaho. The alluvium and interbed sediment are somewhat similar to the near surface soils at the Hanford Site in terms of calcium carbonate content and mineralogy, but they are more fine grained and would be designated as sandy loam and silt as opposed to Hanford Site materials being categorized as sand or gravelly sands. The Idaho solids were contacted with a groundwater that is very similar in chemical composition to Hanford Site groundwaters, at a ratio of 1 g solid to 20 mL groundwater. The batch contact time was six days. The adsorption of selenite was found to vary significantly with the concentration of selenite present in the water. As the initial concentration of selenite varied from ~10^{-7} to 6 x 10^{-5} M, the K_d for selenite dropped from 17 to 4 and 63 to 6 mL/g for the interbed sediment and alluvium, respectively. The K_d values for the low end of the selenite concentrations studied are close to the value recommended in this report, 15 mL/g, especially if the Idaho values decrease because they are for finer grained particles than the Hanford solids of interest. Again, this compilation relies on the apparent similarity between K_d values for selenite and selenate when hydrous oxide contents of the solids are low to make this comparison.

Soils in the alluvial fan in the western San Joaquin Valley, California, have been extensively studied to understand the geochemistry of selenite and selenate species of selenium. Dissolution and leaching of soil salts by irrigation water is a primary source of selenium to shallow groundwater in the western San Joaquin Valley. The following references present a very detailed geochemical understanding of selenium that is transferable to most environments: Fio and Fujii (1990), Fio et al. (1991), Neal et al. (1987a, 1987b), Neal and Sposito (1989), Sposito et al. (1988), Sposito et al. (1991), and Wright (1999). Within these references sorption studies showed that selenate is not adsorbed to the alluvial fan soils, whereas selenite is rapidly adsorbed. The data show that >50% of the soluble Se(IV) added to the soils in a rate study was adsorbed after 8 hours, and maximum adsorption was essentially reached after about 24 hours. The similar adsorption rates and maximum partitioning under sterile and un-sterile conditions indicate that biological activity probably did not alter the concentration of Se(IV). Selenite adsorption by the alluvial fan soils decreased uniformly with increasing pH in the range 4 to 9 and was independent of soil series above pH 6. Considerable hysteresis was found between selenite adsorption and desorption. Desorption was measured by replacing 100 mL of the solution in the centrifuge bottles after the adsorption step with 100 mL of 0.005 M $CaSO_4$ solution. The centrifuge bottles were returned to the shaker and the concentration of Se was measured after 0.5, 1, 4, 8, and 24 hours. About 88% of the Se(IV) remained adsorbed at the end of the desorption experiment. No discernible change in the amount of selenite adsorbed was found as a result of increased chloride concentration or through the addition of 16 mmol Na_2SO_4. In contrast, an initial concentration of phosphate comparable to that of selenite resulted in a decrease of selenite adsorbed by approximately one-half. Selenite is resistant to leaching and therefore can represent a potential long-term source of Se to groundwater.

In contrast, selenate behaved as a conservative constituent under alkaline and oxidized conditions and was easily leached from the alluvial fan soils. Selenate adsorption in contrast to the results obtained for selenite, was not detected over the pH range of 5.5 to 9 in either the NaCl or $NaClO_4$ background electrolyte. The authors concluded from their results that Se(VI) behaves similarly to SO_4, and forms weakly bonded, outer-sphere surface complexes. In general, outer sphere complexes are weaker in nature than inner sphere complexes and thus more amenable to reversible adsorption-desorption.

Theoretical calculations, presented in the suite of San Joaquin references, for the oxidation of selenium by NO_3^- and oxygen show favorable differences in Gibbs free energies for the oxidation, indicating that nitrate can act as an electron acceptor for the oxidation of selenium. Management of

nitrogen fertilizer applications might help to control the oxidation and mobilization of Se and other trace constituents into the environment. The results for the San Joaquin Valley soils indicated that, at native levels of NO_3, effective microbial catalysis of SeO_4^{2-} reduction, occurred in the soil under the conditions of the experiments in agreement with isolation of bacterial species that can respire SeO_4^{2-} while oxidizing organic acids typical of suboxic soil environments.

Goldberg and Glaubig (1988) studied selenite and selenate sorption on a calcareous, montmorillonitic soil as a function of solution pH (2-11) at two initial total selenium concentrations. Selenate sorption was not observed at any pH value for either initial selenium concentration. Selenite sorption exhibited a maximum near pH 3, a sharp decline to pH 6, and a sorption plateau above pH 7. Selenite sorption as a function of pH was studied on reference minerals representative of the dominant mineral constituents of the studied soil, which included montmorillonite, kaolinite, and calcite. Selenite sorption on the clay minerals increased at low pH, exhibited a peak near pH 5, and decreased at higher pH. Selenite sorption on calcite increased from pH 6 to 8, peaked between pH 8 and 9, and decreased above pH 9. The soil sorption plateau above pH 7 virtually disappeared after removal of calcite, indicating that calcite plays an important role in selenite sorption onto calcareous soils. The lack of selenate adsorption onto the soil studied even at pH values as low as 2 is likely caused by a lack of any significant amounts of variable charged hydrous oxides in the soil. Many soils with measurable quantities of hydrous oxides do show measurable anion adsorption at acidic pH values.

Chao and Sanzolone (1989) concluded that in soils developed through intensive leaching and weathering, selenium tends to be associated with oxide minerals and a great proportion of the selenium is resistant to chemical dissolution. For soils with high pH and low content of oxide minerals, selenium is present as mobile selenate and can be easily extracted.

Despite the fact that aqueous selenium in low ionic strength circum-neutral waters are anionic, Hanford specific adsorption on coarse sand sediments (see Um and Serne 2005 and data compiled in Cantrell et al. 2003) studies show moderate adsorption is occurring. Unlike pertechnetate, nitrate, and iodine aqueous species, selenium sorbs with K_d values greater than 5 mL/g. For the "non-water" scenarios of interest to this report, a K_d value of 15 mL/g was chosen to represent the "best" or most probable value and a range of 3 to 30 mL/g was chosen for selenium adsorption onto future Hanford agricultural soils and river bank sediments. The high end of the range has not been observed in Hanford specific studies but will allow for some conservatism in the sensitivity calculations to ascertain whether selenium is a significant risk contributor. The "best" K_d value and range differ (are higher and wider, respectively) from those tabulated in Napier and Snyder (2002), which did not have access to the most current IDF project selenate adsorption studies. The selenium adsorption value estimates (150 to 500 mL/g dependent on particle size) in Thibault et al. (1990) are not measurement and are based on soil-to-plant transfer factors. The Thibault et al. (1990) values are quite large and do not seem reasonable, certainly not for Hanford specific conditions. Coughtrey and Thorne (1983 a, 1983b) and Coughtrey et al. (1983, 1984a,b, and 1985) recommend a selenium K_d value of >9 mL/g. Last et al. (2004) and Krupka et al. (2004) recommend most probable K_d values of 5 and 7 mL/g and ranges of 3 to 10 and 3 to 15 mL/g, respectively for groundwater scenarios. This study recommends a slightly higher "best" K_d value than these two groundwater scenario based tabulations to account for some potential desorption hysteresis and potential for lower pH conditions in organic rich soils, which would favor more anion adsorption. The K_d range was expanded to 30 mL/g to allow some conservatism to be introduced into the

predictions. If sensitivity studies show selenium may be a significant risk contributor, then laboratory studies using appropriate selenium-spiked soils and sediments should be performed to validate the K_d values.

3.20 Strontium

There is a large Hanford-specific database for adsorption of strontium, which has been tabulated and discussed in Cantrell et al. (2003), Krupka et al. (2004) and Ames and Rai (1978). General literature on strontium adsorption is also very large. All available literature suggest that strontium adsorbs moderately to sediments and follows quite simple ion exchange relationships for most circumstances. At Hanford in some selected environments it is suggested that radio-strontium may also exchange for stable strontium and calcium in carbonate minerals in a similar fashion as ^{14}C exchanges for ^{12}C species in the carbonate solids. The sources of ^{90}Sr in the scenarios of interest for this report are likely solidified waste forms and residual contaminated near-surface sediments. Both sources of ^{90}Sr contamination might engage in these isotope exchange reactions with carbonate minerals present in the near-surface soils and with carbonate that forms on cementitious waste inadvertently brought to the surface.

Only one new study was found in the literature review for near-surface or agricultural soils. Shimada et al. (1996) determined K_d values, transfer coefficient by direct foliar absorption (K) and the transfer coefficients for root uptake for ^{90}Sr and ^{137}Cs for several Japanese soils. The strontium K_d values were found to be 10 to ~300 mL/g for ^{90}Sr. Another study with data for deep sediments similar to Hanford's is also discussed. Del Debbio (1991) measured the adsorption of strontium [Sr^{2+}] onto alluvium, interbed sediment and crushed basalt rock from the Idaho National Laboratory, Idaho Falls, Idaho. The alluvium and interbed sediment are somewhat similar to the near surface soils at the Hanford Site in terms of calcium carbonate content and mineralogy but they are more fine grained and would be designated as sandy loam and silt as opposed to Hanford Site materials being categorized as sand or gravelly sands. The Idaho solids were contacted with a groundwater, which is very similar in chemical composition to Hanford-site groundwaters, at a ratio of 1 g solid to 20 mL groundwater. The batch contact time was six days. The adsorption of strontium was not found to vary significantly with the concentration of strontium present in the water. As the initial concentration of strontium varied from ~10^{-6} to 5 x 10^{-4} M, the K_d for strontium ranged from 190 to 110 and 52 to 35 mL/g for the interbed sediment and alluvium, respectively. The K_d values for the high end of the strontium concentrations studied by Del Debbio (1991) are close to the value recommended in this report, 50 mL/g.

Based primarily on the large Hanford strontium K_d database, the "best" or most probable K_d value was chosen to be 50 mL/g, which is larger than values chosen by Last et al. (2004, 22 mL/g) and Krupka et al. (2004, 14 mL/g) and which represent surface adsorption onto sediments for waterborne scenarios. To keep the ^{90}Sr available longer for the non-groundwater scenarios of interest to this report and to account for the hysteresis in K_d caused by the isotope exchange into carbonate minerals, the higher value of 50 mL/g is recommended. For a K_d range to use in sensitivity calculations, 5 to 200 mL/g was chosen, which is essentially the same as the ranges recommended by Napier and Snyder (2002) and Krupka et al. (2004). There is adequate strontium adsorption data such that Last et al. (2004) recommend using a log normal probability distribution on the range of K_d values around the mean value. However, while this choice might be acceptable for strontium and cesium adsorption data, the adsorption data population for other contaminants is not large enough to defend choosing a probability distribution function.

In comparison to the other data tabulations for Sr K_d values shown in Table 1.3, the most probable or "best" value chosen in this report is larger than the value recommended by Thibault et al. (1990), which offers 15 mL/g. Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1984b, and 1985) did not tabulate strontium K_d data.

3.21 Technetium

There is a large Hanford-specific database for adsorption of technetium in its oxidized form, pertechnetate [TcO_4^-, Tc(VII)]. General literature on pertechnetate adsorption is also very large. Both types of adsorption data suggest that pertechnetate does not adsorb to most sediments and soils and adsorbs weakly to some. Hanford-specific data is reviewed in Cantrell et al. (2003) and Krupka et al. (2004). Technetium is redox sensitive and can be reduced to a very insoluble form by strong reductants such as sulfide often present in natural reducing environments. Ferrous iron can also reduce pertechnetate but not as readily as it reduces chromate. Reducing conditions probably will not be found in the near-surface scenarios of interest to this report. However, to allow technetium to be available longer for the scenarios of interest, the possibility of some technetium reduction was considered, perhaps by decaying organic matter in the agricultural soil and river bank sediments. General technetium geochemistry and adsorption tendencies are summarized in much more detail in Krupka and Serne (2002), Krupka et al. (2004) and EPA (2004).

Based on the Hanford-specific technetium adsorption database and plausible geochemical differences caused by addition of more organic matter to the soils and sediments of interest and allowing for the source of much of the technetium to be in waste tailings inadvertently brought to the ground surface, a "best" or most probable K_d value of 0.5 mL/g and a range of 0 to 1 mL/g for sensitivity calculations is recommended. Napier and Snyder (2002) selected a most probable technetium K_d value of 2.0 mL/g and a range of -3.4 to 0.57 mL/g, which does not include their recommended value.

The recommended "best" K_d value and range are the same as the values chosen for chloride (^{36}Cl), and nitrate. The recommended "best" K_d value is larger than the value of 0 mL/g recommended for groundwater scenarios found in Last et al. (2004) and Krupka et al. (2004) because of the need to account for the possibility of some technetium reduction and resistance to desorption out of disaggregated solid wastes. Thibault et al. (1990), Coughtrey and Thorne (1983a, 1983b) and Coughtrey et al. (1983, 1984a, 1983b, and 1985) recommended technetium K_d values of 0.1 and 0.11 mL/g, respectively. The recommended K_d range, 0 to 1 mL/g, is also somewhat larger than used in the groundwater scenario recommendations for the same reasons as a higher most probable K_d value was chosen.

3.22 Tritium

Tritium is often used as a tracer for water molecules in column breakthrough testing and is assumed to define the zero K_d condition. Alternatively, one could assume that the anions often used as water tracers define the zero K_d condition and ignore the concept of anion exclusion. The column experiments performed by Gee and Campbell (1980) used both tritium and chloride as tracers and they found chloride broke through the columns slightly earlier than tritium. This observation was used to quantify the anion exclusion process by assuming that tritium was the true conservative (non-interacting tracer; $K_d = 0$). It is conceivable that tritium as the water molecule (THO) or hydroxyl species (OT^-) where T= ^3H can enter into isotope exchange reactions with water molecules adsorbed to solids (as waters of hydration) or with

hydroxyl groups on the surfaces of hydrous oxides present on the surfaces of solids. If significant, such isotope exchange reactions can keep tritium available in the near surface agricultural and river bank sediments of interest herein.

A "best" K_d value of 0.2 mL/g was chosen arbitrarily, the lowest of all values chosen in this report, to describe tritium's isotope exchange potential. Also, the K_d range to use for sensitivity analyses was chosen as 0 to 1 mL/g, consistent with the other very mobile constituents (chloride-36, nitrate, and technetium) in this report. With a half-life of 12.34 years, tritium should not be a significant risk factor for very long once all activities cease at Hanford. Napier and Snyder (2002) selected a most probable tritium K_d value of 0.7 mL/g with a range of 0 to 0.7 mL/g. The only other K_d tabulation that discusses tritium was Thibault et al. (1990); for a sand they recommend a tritium K_d value of 0.06 mL/g and 20 mL/g for loam.

3.23 Uranium

There is adequate Hanford Site specific data on the adsorption of uranium onto Hanford sediments from circum-neutral pH and low ionic strength waters to develop technically defensible K_d values to use for the scenarios of interest where the original source of uranium was some liquid waste stream contacting Hanford sediments (Cantrell et al. 2003; Krupka and Serne 2002; and Krupka et al. 2004). There is also a large quantity of general literature that complements and corroborates the Hanford-specific data (EPA 1999b). In the near-surface sediments of interest for the agricultural and river bank sediments and scenarios being considered, uranium geochemistry should be dominated by oxidized uranium [U(VI)]. The key aqueous species are carbonate complexes of the uranyl [UO_2^{2+}] cation such as $UO_2(CO_3)_2^{2-}$ and $UO_2(CO_3)_3^{4-}$. The uranyl complexes are anionic or at pH values below 6 neutrally charged (Krupka et al. 2004, Figure 3.12). Although fairly soluble, uranyl minerals do exist and are stable in Hanford near-surface environments as evidenced by ongoing studies in the 300 Area at Hanford (Serne et al. 2002a; Zachara et al. 2005). Plausible controlling solids for uranyl forms of uranium include alkali and alkaline-earth uranyl silicates such as boltwoodite, uranyl silicate (uranophane), alkali and alkaline earth oxy hydroxides such as clarkeite, and mixed uranyl carbonates. When uranium is present at very low concentrations (low ppm to sub ppm) adsorption may be the only retardation mechanism that occurs between sediments and natural pore waters. When this is the case, uranium is moderately mobile in Hanford sediments because the uranyl carbonate complexes do not adsorb appreciably at pH conditions above 7.

If the source of the uranium in the future near-surface environments of interest comes from cementitious or glass waste forms or from contaminated sediments in which discrete uranium bearing precipitates are present that are inadvertently brought to the surface, then uranium fate should be treated differently from all the other contaminants discussed in this report. Uranium geochemistry and uranium leaching and/or release from environments with a combination of low dissolved carbonate and high pH are highly dependent on the interrelated dissolved carbonate and pH. Upon water leaching, fresh or young cement and vitrified borosilicate glasses both generate solutions with higher than ambient pH values. Cement leachate also increases dissolved calcium concentrations in the nearby pore waters and glass leachate contains high sodium concentrations that further react with Hanford sediments to exchange sodium for calcium on sediment surface exchange sites. The net pore water/sediment reactions in the near vicinity of leaching cement or glass promote the precipitation of calcium carbonate such that the residual pore water exhibits low dissolved carbonate, low dissolved calcium, and higher than ambient pH.

This geochemical state promotes sequestration of uranium within the sediments surrounding the impacted pore water. The effects are quite dramatic such that even small amounts of solidified waste (cement or glass) can influence uranium fate. Thus, even though this K_d value tabulation was assuming that there would be insignificant mass of solidified waste brought to the surface to impact contaminant K_d values, uranium is the one exception. In addition, based on the common occurrence of co-precipitated or discrete uranyl solid phases in near-surface Hanford sediments in the 300 Area (and likely other disposal sites), that are not influenced by cement or glass, uranium deserves special treatment. Finally, with the knowledge that simplified risk assessments for the "non-groundwater" scenarios of interest use only K_d values to quantify all retardation (as opposed to separating solubility and adsorption processes into two distinct retardation processes), the "best" or most probable and range of K_d values to use for the non-groundwater scenarios of interest for uranium in this compilation are split into two categories.

For situations where the uranium source was discrete uranium-bearing soils, cement, or glass waste, a desorption K_d greater than 10 mL/g is justified. Cement and waste glass secondary minerals are very good at sequestering uranium. High uranium sequestration is observed until all the free calcium hydroxide in hydrated cement is converted to calcite (calcium carbonate see further discussion in Serne et al. 1996) and until the pH of fluids surrounding the weathering glass drops below 9, because the geochemical conditions during the early phases of leaching favor calcite precipitation and low aqueous concentrations of carbonate. Recall that uranium complexes with dissolved carbonate are the key reason that uranium remains mobile in pore fluids interacting with sediments. If the dissolved carbonate is kept low because of calcite precipitation, there is less tendency for the anionic uranyl carbonate aqueous complexes to dominate. Fresh or young cement has a large source of soluble calcium that can reduce the carbonate concentrations in pore fluids to such low values that the strong and very soluble uranyl-carbonate complexes dissociate and allow the free uranyl cation to adsorb/co-precipitate. The same phenomenon occurs when glass weathering releases high concentrations of sodium, which exchanges with calcium on the surrounding soil cation-exchange sites resulting in high dissolved calcium that forces calcite to precipitate. The glass weathering reactions also increase the pH of the near by pore fluids, which also promotes calcite precipitation and the lowering of dissolved carbonate concentrations.

However, for both cement and glass waste forms after long time periods, the excess calcium (in the cement waste) and sodium (in the glass) is depleted and there will be a net influx, via partially air-filled pores, of carbon dioxide to the vadose zone. The carbon dioxide causes pore fluid pH values to drop to values near 8.3 and replenishes the dissolved carbonate (bicarbonate is the dominant species at this pH) in the pore fluids. The increasing dissolved carbonate can then start to complex and enhance the mobility of previously sequestered uranium. The same time-dependent reactions can re-mobilize uranium that was originally precipitated as discrete minerals in contaminated sediments or adsorbed to sediment surfaces under conditions when there was less carbonate present in solution. Thus, at long time periods uranium will become more mobile and likely percolate deeper into the sediment profile and become a potential threat to the groundwater pathways. Although only a crude knowledge of the time-dependent dynamics for the weathering of cement and glass waste forms exists, the reactions may be completed in a matter of a few hundred years for small masses of solid waste forms brought to the surface and mixed with near-surface sediments. Depending on the assumed mass of uranium present in a cementitious or glass waste form that is intercepted by drilling activities and inadvertently brought to the ground surface, it would be more technically defensible to run two time periods wherein the first few hundred years use uranium desorption K_d values between 10 and 50 mL/g; then for later time periods, the desorption K_d should be

reduced to values that range from 0 to 10 mL/g for the non-water surface exposure of drilling tailings from drilling through solidified waste scenario and for contaminated sediments that contain discrete uranium mineral precipitates.

Tables 1.2 and 1.3 list two recommended "best" K_d values and ranges for uranium. For the short-time period (arbitrarily set at 200 years from the time when the wastes are brought to ground surface), a "best" uranium K_d value of 30 mL/g and a range of 5 to 50 mL/g is recommended. For the longer time period (arbitrarily set at >200 years from the time the uranium-bearing wastes were brought to the ground surface), a "best" uranium K_d value of 5 mL/g and a range of 0 to 20 mL/g is recommended.

These recommendations differ from those used by Napier and Synder (2002), where the "best" or most probable K_d value for uranium was set at 7 mL/g and the range was 0.08 to 3.5 mL/g, even though it does not even include the most probable value. The two-category recommended uranium K_d values and ranges have higher most probable values than the two groundwater-scenario based tabulations of Last et al. (2004, 0.8 mL/g) and Krupka et al. 2004, 1 mL/g). The recommended uranium K_d ranges are much wider than the range chosen by Last et al. (2004, 0.2 to 4 mL/g) but narrower than the range chosen by Krupka et al. (2004, 0.1 to 80 mL/g). Krupka et al. (2004) did consider some of the waste form reactions that lower dissolved carbonate concentrations in choosing their range. The only other K_d value tabulation that listed values for uranium was Thibault et al. (1990). They recommended a uranium K_d value of 35 mL/g for sands and 15 mL/g for loams.

3.24 Additional Information

A few other relevant observations were found during the review of recent literature. A study of the vertical transport of ^{60}Co, ^{137}Cs, and ^{226}Ra in agricultural soils placed in a 1 m^2 cross section lysimeter facility with crop rotation and plowing to depths of 20 cm each year showed that after nine years there was very little vertical migration of these three contaminants below the 20-cm depth of plowing (Shinonaga et al. 2005). Shinonaga et al. (2005) concluded that using large K_d values for these three contaminants such as those tabulated by Sheppard and Thibault (1990) are justified. The Sheppard and Thibault (1990) K_d values are the same as those found in Thibault et al. (1990) and listed in Table 1.3. The recommended K_d values in this report for these three radionuclides are also large and not too different from Sheppard and Thibault (1990).

Echevarria et al. (2005) measured the adsorption of niobium, a fission product for which very little data has been reported in the literature. Some risk assessments have predicted that niobium may be a significant risk driver because a small K_d value is often chosen in order to accommodate the known Nb(V) valence state. The assumption is often made that Nb(V) forms NbO_2^+ ions similar to neptunyl (NpO_2^+) that under some conditions does show low sorption tendencies. Echevarria et al. (2005) measured niobium adsorption onto three sediments from France. For the sediment with characteristics most similar to Hanford sands, they found a niobium K_d value of 1980 mL/g. The other two sediments, both dominated by silt and clay, yielded niobium K_d values ~3000 mL/g. The niobium adsorption was slow with solution concentrations still decreasing after three days of contact such that the authors suggested it might take up to 30 days to reach a true equilibrium. They also suggest that the reaction may be slow hydrolysis and precipitation of niobium hydroxides. It thus appears that niobium may not be as mobile as some risk assessments have assumed based on potential similarities to neptunium. This information is provided in the hope that future risk predictions for "exotic" contaminants, for which little experimental data are available, at least have this one source of measured data.

For readers interested in plant and animal transfer factors from soils there is a recent report that compiles such factors, Robertson et al. (2003).

4.0 References

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Appendix A

Past Letter Reports on Agricultural Soil K_d Values

Selected K_d Values for Agricultural Soils

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October 3, 1997
Updated by R. Jeff Serne
May 17, 1999

K_d Value Selection Process: A systematic process was used to select K_d values for the radionuclide transport simulation (Table A.1). In each case the largest value within the range of likely values was selected. Whenever possible, selected K_d values were based on data generated from experiments conducted with Hanford sediments and aqueous phases of low ionic strength, neutral to basic pH levels, and oxidizing conditions. The selected K_d values of C, Cl, I, Np, Pb, Ra, Se, Sr, Tc, tritium, and U were based on Hanford Site data (see Appendix B in this report). Of these selected K_d values, Cl, I, Ru, and Tc K_d values were increased to account for the likely increase in adsorption to the organic matter that is likely to be present in the solid phase. The K_d values for which there were no Hanford Site data available were based on non-Hanford Site reported data for agricultural soils, silt textured soils or freshwater sediments (Bi, Fe, Mn, K, Pa, Po, Re, Rn, and Th).

Table A.1. Selected K_d Values (mL/g) for Agricultural Soils

Rad.	Selected Conservative K_d Values for Agricultural Soils[(a)] (mL/g)	Reported K_d Range (mL/g)	Number of Reported K_d's	Rational	Ref[(b)]
Ac	1500	--	0	No Hanford soil data available. Estimate based on Am-K_d data. Am is close to Ac on the periodic chart and both have +3 oxidation states. As reviewed by Kaplan et al., reported Am-K_d's in Hanford sediments range from 67 to >1200.	1
Am	1500	--	2	As reviewed by Kaplan et al. reported Am-K_d's in Hanford sediments range from 67 to >1200.	1
Bi	900	--	0	No Hanford soil data available. For silt soils, Thibault et al. (1990) estimated a geometric mean K_d of 450.	2
C	7.0[c]	0.03 to 4.56	6	Hanford sediment data. ^{14}C exists as anionic $H^{14}CO_3^-$ or $^{14}CO_3^{2-}$ species. Some loss of aqueous ^{14}C-carbonate will occur due to partitioning to gas phase (CO_2[g]) and isotopic exchange with calcite, which controls ^{12}C concentrations through solubility in Hanford sediments.	3
Ce	1500	3 to >2000 but always >1000 for all but acid conditions	>5	Hanford sediment data. Ce exists as hydrolyzed species that are very sensitive to pH of the porewater. Sorption is very high in neutral pH solutions (K_d > 1500). Benson (1960) found Ce sorbed to Hanford soils would exchange with other cations when pH was greater than 7.4.	16
Cl	1	-0.008 to -0.013	2	Hanford sediment data. Soluble anion. Selected K_d value increased to account for the likely presence of organic matter in the solid phase.	4
Cm	1500	--	0	No Hanford soil data available. Estimate based on Am-K_d data. Cm chemical behavior is very close to that of Am, both have +3 oxidation states and are close to each other on the periodic chart. As reviewed by Kaplan et al. reported Am-K_d's in Hanford sediments range from 67 to >1200.	1
Cs	2000	>200 to 10,000	>20	Hanford sediment/groundwater system, 540 to 3180 mL/g (5 and 8). K_d consistently has median value ~2000 for Hanford sediments and low-ionic strength neutral pH solutions. Mica/illite minerals "fix" Cs and make it difficult to exchange off sediment.	5, 8, 22
Fe	3500	--	0	No K_d tests per se have been made on Hanford sediments. But Fe present in reactor cooling water was found to be bound (98%) to small particulates (<0.3 µm). The iron was not cation exchangeable using high NaCl solution [Roberstson and Perkins (1975), Roberstson et al. 1973]. Iron in Hanford sediments is likely precipitated and bound strongly. Under oxidizing conditions Fe is present as ferric, which quite insoluble at neutral pH. K_d's for marine sediments are >10,000 ml/g. (Onishi et al. 1981).	23

Table A.1. (contd)

Rad.	Selected Conservative K_d Values for Agricultural Soils[a] (mL/g)	Reported K_d Range (mL/g)	Number of Reported K_d's	Rational	Ref[b]
I	15	0.05 to 15	21	Hanford sediment data. Soluble anion that has been shown to be sorbed to Hanford sediments, perhaps to Fe-oxides or carbonates in these soils. Selected K_d value increased to account for the likely presence of organic matter in the solid phase.	4, 5, 6
K	10	2 to 9	10	No Hanford soil data available. For agricultural soils, Baes and Sharp estimated a geometric mean K_d of 5.5 based on reported K_d range of 2 to 9.	10
Mn	2400	--	0	No Hanford K_d data per se are available. Studies of Mn in reactor cooling water show that Mn differs from Fe and is mostly soluble and cationic as opposed to particulate. Mn adsorbed to Columbia River sediments does desorb appreciably when immersed in seawater [Roberstson and Perkins (1975), Evans and Cutshall 1973]. We suggest that Mn fate be considered similar to Ni.	
Np	25	2.4 to 21.7	10	Hanford sediment data. Exists primarily as NpO_2^+.	5, 6, 8, 9
Ni	2400	50 to 2350	>10	Hanford sediment data. 440 to 2350 mL/g (5) Broad range of sediments, including those from Hanford, 50 to 230 mL/g (18)	5, 18
Pa	3600	--	0	No Hanford soil data available. For silt soils, Thibault et al. (1990) estimated a geometric mean Pa-K_d of 1800. Pa exists in the periodic chart between Th and U. In nature it generally has a +5 oxidation state. It does not behave like Np(V) in solution, nor like Th or U.	2
Pb	80,000	13,000 to 79,000	>50	Hanford sediment data. Pb^{2+} can (co)precipitates readily and sorbs strongly to sediments	7
Po	1100	196 to 1063	6	No Hanford soil data available. For agricultural soils, Baes and Sharp estimated a geometric mean K_d of 540 based on reported K_d range of 196 to 1063.	10
Pu	5000	80 to 4300	7	Hanford sediment data. Pu(V, VI): Hanford subsoils, pH 4 to 12, 80 to >1980 mL/g (19). Washington A Sediment (Hanford) K_d = 100 mL/g (21), Washington B Sediment (Hanford) K_d = 4300 mL/g (21).	19, 21
Ra	500	214 to 467	4	Hanford sediment data. Like alkaline earth (K_d: Ra>Ba>Sr>Ca>Mg)	11
Re	80	--	0	No Hanford soil data available. For silty soils. Thibault et al. (1990) estimated a geometric mean Re-K_d of 40.	2
Rn	0.1	--	0	No Hanford soil data available. Rn is essentially an inert gas. Precipitation and adsorption is not important.	12

Table A.1. (contd)

Rad.	Selected Conservative K_d Values for Agricultural Soils[a] (mL/g)	Reported K_d Range (mL/g)	Number of Reported K_d's	Rational	Ref[b]
Ru	500	40 - 750	5	Rhodes (1957a) has Hanford specific data. K_d is highest for solutions with neutral pH and drops off when there are acid conditions or basic conditions above 9. Ru in the presence of high nitrate forms mobile nitroso compounds. At Hanford chemical processing wastes disposed to ground allowed rapid migration of Ru. However Ru not in the presence of nitrate does exhibit moderate to strong adsorption (K_d = 40 to 400 ml/g). Roberstson and Perkins (1975) found that Ru in reactor cooling water was mainly bound to fine-grained particulates that were filtered out before reaching groundwater or the Columbia River.	16
Se	2	-3.4 to 0.78	3	Hanford sediment data. Soluble anion, SeO_4^{2-}	5
Sb	5000	180 to >4000	4	No Hanford soil data available. Sb-125 K_d values at the Savannah River Site burial grounds were 180, 2300, 3800, and >4000 mL/g	20
Sr	180	5 to 173	>25	Hanford sediment data. Na System, 173 mL/g, 49 to 50 mL/g (15) Ca System, 8 to 13 mL/g, 5 to 19 mL/g (15) 5 to 120 mL/g (16) 19.1 to 21.5 mL/g (5) Na System, pH 7 to 11, 14.9 to 25.1 mL/g (17)	15, 16, 5, 17
Sn	900	--	0	No Hanford soil data available. For silty soils. Thibault et al. (1990) estimated a geometric mean Re-K_d of 450.	2
Tc	2	-3.4 to 0.57	45	Hanford sediment data. Soluble anion, TcO_4^-. Selected K_d value increased to account for the likely presence of organic matter in the solid phase.	4, 5, 6
Th	600,000	2000 to 510,000	17	No Hanford soil data available. For agricultural soils, Baes et al. (10) estimated a geometric mean K_d of 150,000 based on reported K_d range of 2000 to 510,000. It is apparent that the higher Th-K_d's included in their data set represented precipitation reactions. Thus, a lower Th-K_d than the upper limit is suggested for this simulation.	10
^3H	0.7	0.00 to 0.7	>13	Hanford sediment data. Typically, a K_d = 0 is used for ^3H. ^3H may substitute for ^1H in water on clays and other hydrated soil constituents. The upper limit of the reported ^3H-K_d values is hard to rationalize. Thus, a somewhat lower ^3H-K_d than the upper limit is suggested for this simulation.	13

Table A.1. (contd)

Rad.	Selected Conservative K_d Values for Agricultural Soils[(a)] (mL/g)	Reported K_d Range (mL/g)	Number of Reported K_d's	Rational	Ref[(b)]
U	7	0.08 to 3.48[(d)]	51	Hanford sediment data. UO_2^{2+} is highly mobile in carbonate systems. The suggested value is greater than the upper limit because the sediments used to generate this range generally had quite low organic matter concentrations. It is anticipated that the agricultural soils will have relatively high organic matter concentrations.	5, 6, 14
Y	1500	--	0	No Hanford soil data available. Baes et al. (1984, Table 2.13) estimated that the geometric mean for Y-K_d values for agricultural soils and clays of pH 4.5 to 9 is 510 mL/g, with a range of 160 to 1640 mL/g.	10

(a) Estimated largest K_d value likely to exist in a hypothetical agricultural soil located on the Hanford Site.
(b) References: 1 = Kaplan et al. 1995; 2 = Thibault et al. 1990; 3 = Martin 1996; 4 = Gee and Campbell 1980; 5 = Serne et al. 1993; 6 = Kaplan et al. 1996; 7 = Rhoads et al. 1992; 8 = Routson et al. 1976; 9 = Sheppard et al. 1976; 10 = Baes et al. 1984; 11 = Ames and Rai 1978; 12 = Tanner 1980; 13 = Jones et al. 1980; 14 = Lindenmeier et al. 1995; 15 = Routson et al. 1978; 16 = Rhodes 1957b; 17 = Nelson 1959; 18 = Serne and Relyea 1983; 19 = Rhodes 1957a; 20 = Stone et al. 1984, 21 = Glover et al. 1976; 22 = Kaplan et al. 1998, 23 = Robertson and Perkins 1975.
(c) The mobility of ^{14}C in surface soils may not be governed by adsorption processes, as described by the K_d metric. Instead, partitioning into the gas phase and isotopic dilution with ^{12}C in the dissolved phase and in the solid phase (e.g., calcite) may be more important processes controlling aqueous ^{14}C concentrations.
(d) This range of data omits one value, U-K_d = 79.4, that is being treated as an outlier.

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Appendix B

K_d Values of Hanford Sediments

Last Revision: May 18, 1999

K_d VALUES of HANFORD SEDIMENTS

Last revisions are shown in red and were made on May 18, 1999.

Table B.1. C-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.05 M) Conditions

C-K_d (mL/g)	Experimental Conditions				
	C[(a)] (nCi/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(b)]
4.06	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 30 days	1
4.37	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 30 days	1
3.8	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 30 days	1
3.47	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 30 days	1
4.56	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 30 days	1
3.74	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 30 days	1
0.05	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, Residence time = 2.69 d	1
0.05	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, Residence time = 2.44 d	1
0.07	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, Residence time = 8.37 d	1
0.12	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, Residence time = 8.21 d	1
0.04	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, Residence time = 22.3 d	1
0.03	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, Residence time = 21.2 d	1
0.09	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, Residence time = 3.8 d	1
0.07	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, Residence time = 3.7 d	1

(a) ^{14}C spike was placed in Hanford groundwater containing about 70 mg/L total alkalinity (as $^{12}CO_3^{2-}$).
(b) Reference: 1 = Martin 1996.

Table B.2. Cl-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.05 M) Conditions

Cl-K_d (mL/g)	Experimental Conditions				
	Cl (Mole/L)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
-0.013	0.01	Synthetic groundwater	Hanford surface soil (Soil B), pH 8.2, CEC 5 meq/100 g	Column	1
-0.008	0.01	Synthetic groundwater	Hanford surface soil (Soil B), pH 8.2, CEC 5 meq/100 g	Column	1
(a) References: 1 - Gee and Campbell 1980					

Table B.3. I-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.05 M) Conditions

I-K_d (mL/g)	Experimental Conditions				
	^{125}I (nCi/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
0.7	200	Hanford groundwater	CGS-1, sand, pH 7.7, CEC = 2.6 meq/100 g	Batch	1
1.4	200	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch	1
1.3	200	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	Batch	1
7	200	0.003 M carbonate/sulfate	Rupert, sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
8	200	0.0006 M carbonates/sulfates	Rupert, sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
11	200	0.014 M carbonate/sulfate	Rupert, sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
15	200	0.003 M nitrate/chloride	Rupert, sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
10	200	0.0006 M nitrate/chloride,	Rupert, sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
4	200	0.014 M nitrate/chloride	Rupert, sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
0.2	100	Hanford groundwater, Contact time = 14 d	Trench 94, course sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
2.1	100	Hanford groundwater, Contact time = 200 d	Trench 94, course sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
3.2	100	Hanford groundwater, Contact time = 260 d	Trench 94, course sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
9.8	100	Hanford groundwater, Contact time = 330 d	Trench 94, course sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
2.0	100	Hanford groundwater, Contact time = 14 d	Trench AE-3, silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
2.1	100	Hanford groundwater, Contact time = 200 d	Trench AE-3, silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3

Table B.3. (contd)

I-K_d (mL/g)	Experimental Conditions				
	^{125}I (nCi/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
3.1	100	Hanford groundwater, Contact time = 260 d	Trench AE-3, silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
4.1	100	Hanford groundwater, Contact time = 330 d	Trench AE-3, silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
1.1	100	Hanford groundwater, Contact time = 14 d	TBS-1, Sand, pH 8.2, CEC = 6 meq/100 g	Batch	3
0.05	100	Hanford groundwater, Contact time = 200 d	TBS-1, Sand, pH 8.2, CEC = 6 meq/100 g	Batch	3
10.5	100	Hanford groundwater, Contact time = 260 d	TBS-1, Sand, pH 8.2, CEC = 6 meq/100 g	Batch	3
6.8	100	Hanford groundwater, Contact time = 330 d	TBS-1, Sand, pH 8.2, CEC = 6 meq/100 g	Batch	3
0.04 ± 0.07 (20 analyses)	100	Hanford groundwater, Contact time =14 d	ILAW Borehole [299-E17-21] Sediment, pH 8.75 ± 0.15; CEC 6.18 ± 2.18 meq/100 g (20 analyses)	Batch	4

(a) References: 1 = Serne et al. 1993; 2 = Gee and Campbell 1980, 3 = Kaplan et al. 1996, 4 = Kaplan et al. 1998.

Table B.4. Pb-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.05 M) Conditions

Pb-K_d (mL/g)	Experimental Conditions				
	Pb (µg/L)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
13,000 to 79,000	0.001 to 1	Hanford groundwater (Well 6-S3-25)	218-E-12B Burial Ground Hanford Sediment, Sand, pH 8.35, Smectite, illite, plagioclase dominated, CEC = 5.1 meq/100 g	>50 Batch Tests, contact time = 7 to 10 days	1
~13,000 to ~30,000	0.001 to 1	Hanford groundwater (Well 6-S3-25)	218-E-12B Burial Ground Hanford Sediment, Sand, pH 8.35, Smectite, illite, plagioclase dominated, CEC = 5.1 meq/100 g	>8 Batch Tests, contact time = 30 days	1

(a) References: 1 = Rhoads et al. 1992.

Table B.5. Np-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.05 M) Conditions

Np-K_d (mL/g)	Experimental Conditions				
	^{237}Np (nCi/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
21.7	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	Batch	1
2.4	1480	0.002 M Ca	Burbank, loamy sand, pH 7, CEC = 4.9 meq/100 g	Batch	2
20.2	25	Distilled water	Ritzville, silt loam	Batch	3
15.4	25	Distilled water	Burbank, loamy sand, pH 7, CEC = 4.9 meq/100 g	Batch	3
14.5	100	Hanford groundwater, contact time = 7 d	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	4
20.0	100	Hanford groundwater, contact time = 77 d	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	4
2.6	100	Hanford groundwater, contact time = 7 d	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	4
14.7	100	Hanford groundwater, contact time = 77 d	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	4
3.7	100	Hanford groundwater, contact time = 7 d	Trench TBS-1, Sand, pH 8.2, CEC = 6 meq/100 g	Batch	4
4.4	100	Hanford groundwater, contact time = 77 d	Trench TBS-1, Sand, pH 8.2, CEC = 6 meq/100 g	Batch	4

(a) References: 1 = Serne et al. 1993; 2 = Routson et al. 1976; 3 = Sheppard et al. 1976; 4 = Kaplan et al. 1996.

Table B.6. Ra-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.05 M) Conditions

Ra-K_d (mL/g)	Experimental Conditions				
	Ra (mg/L)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
354	7	Simulated river water	Utah, sandy soil, 2-5% calcite, quartz and feldspar, pH 7.9	Batch	1
289	7	Simulated river water	Utah, sandy soil, 2-5% calcite, quartz and feldspar, pH 7.6	Batch	1
467	7	Simulated river water	Utah, sandy soil, 2-5% calcite, quartz and feldspar, pH 7.8	Batch	1
214	7	Simulated river water	Utah, sandy soil, 2-5% calcite, quartz and feldspar, pH 7.7	Batch	1

(a) References: 1 = Ames and Rai (1978) referenced Serne (1974) = Personal communication with R.J. Serne, PNNL.

Table B.7. Se-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.01 M) Conditions

Se-K_d (mL/g)	Experimental Conditions				
	Se (mg/L)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
0.78	0.1	Hanford groundwater	CGS-1, sand, pH 7.7, CEC = 2.6 meq/100 g	Batch	1
-3.44	0.1	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch	1
-2.4	0.1	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	Batch	1
6.73 ± 1.90 (20 analyses)	100nCi/ml	Hanford groundwater, Contact time = 14 d	ILAW Borehole [299-E17-21] Sediment, pH 8.75 ± 0.15; CEC 6.18 ± 2.18 meq/100 g (20 analyses)	Batch	2
(a) References: 1 = Serne et al. 1993, 2 = Kaplan et al. 1998.					

Table B.8. Tc-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.05 M) Conditions

Tc-K_d (mL/g)	Experimental Conditions				
	^{95}Tc (nCi/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
0.1	100[(b)]	Hanford groundwater	CGS-1, sand, pH 7.7, CEC = 2.6 meq/100 g	Batch	1
0.1	100[(b)]	Hanford groundwater	Touchet Bed, loamy sand	Batch	1
0.1	100[(b)]	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	Batch	1
-2.77	2	0.003 M carbonate/ sulfates	Ringold, loam, pH 8.8, CEC = 12 meq/100 g	Batch	2
-1.13	2	0.0006 M carbonates/sulfates	Ringold, loam, pH 8.8, CEC = 12 meq/100 g	Batch	2
-0.04	2	0.014 M carbonate/sulfate	Ringold, loam, pH 8.8, CEC = 12 meq/100 g	Batch	2
0.57	2	0.003 M nitrate/chloride	Ringold, loam, pH 8.8, CEC = 12 meq/100 g	Batch	2
0.54	2	0.0006 M nitrate/chloride	Ringold, loam, pH 8.8, CEC = 12 meq/100 g	Batch	2
-0.51	2	0.014 M nitrate/chloride	Ringold, loam, pH 8.8, CEC = 12 meq/100 g	Batch	2
0.07	2	0.003 M carbonate/ sulfates	Rupert ,sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
-1.62	2	0.0006 M carbonates/sulfates	Rupert ,sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
-0.31	2	0.014 M carbonate/sulfate	Rupert ,sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
0.06	2	0.003 M nitrate/chloride	Rupert ,sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
0.52	2	0.0006 M nitrate/chloride	Rupert ,sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2
0.38	2	0.014 M nitrate/chloride	Rupert ,sand, pH 8.2, CEC = 5.0 meq/100 g	Batch	2

Table B.8. (contd)

Tc-K_d (mL/g)	Experimental Conditions				
	^{95}Tc (nCi/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
-0.16	0.33	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.05	0.67	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.01	1.0	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.04	3.3	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.06	6.67	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.05	10	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.05	33	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.04	66.7	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.03	100	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.06	0.33	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
0.12	0.67	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.11	1.0	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.05	3.3	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.01	6.67	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.02	10	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.03	33	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.03	66.7	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.01	100	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.02	100	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.02	100	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
0.08	100	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
0.11	100	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch	3
-0.01	100	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.19	100	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3

Table B.8. (contd)

Tc-K_d (mL/g)	Experimental Conditions				
	^{95}Tc (nCi/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
0.03	100	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
0.11	100	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
-0.03	100	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch	3
-0.19	100	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch	3
0.07	100	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch	3
0.07	100	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch	3
-0.01 ± 0.01 (20 analyses)	100(b)nCi /ml	Hanford groundwater, Contact time = 14 d	ILAW Borehole [299-E17-21] Sediment, pH 8.75 ± 0.15; CEC 6.18 ± 2.18 meq/100 g (20 analyses)	Batch	4

(a) References: 1 = Serne et al. 1993; 2 = Gee and Campbell 1980; 3 = Kaplan et al. 1996, 4 = Kaplan et al. 1998.
(b) ^{95m9}Tc (not ^{95}Tc) was used in experiment.

Table B.9. ^{3}H-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.05 M) Conditions

^{3}H-K_d (mL/g)	Experimental Conditions				
	^{3}H (ng/L)	Aqueous Phase	Solid Phase[(a)]	Expt'l Method	Ref[(b)]
0.05			Rupert sand, 91% sand, 7% silt, 2% clay	Column	1
0.1			Rupert sand, 91% sand, 7% silt, 2% clay	Batch	1
0.5			Rupert sand, 91% sand, 7% silt, 2% clay	Batch	1
0.04			Rupert sand, 91% sand, 7% silt, 2% clay	Column	1
0.1			Rupert sand, 91% sand, 7% silt, 2% clay	Batch	1
0.3			Rupert sand, 91% sand, 7% silt, 2% clay	Batch	1
0.06			Ringold Formation, loamy sand, 81% sand, 15% silt, 4% clay	Column	1
0.1			Ringold Formation, loamy sand, 81% sand, 15% silt, 4% clay	Batch	1
0.7			Ringold Formation, loamy sand, 81% sand, 15% silt, 4% clay	Batch	1
0.1			Ringold Formation, loamy sand, 81% sand, 15% silt, 4% clay	Batch	1
0.4			Ringold Formation, loamy sand, 81% sand, 15% silt, 4% clay	Batch	1
0.1			Hanford sand, pH 8.0	Column	1
0.01			Hanford sand, pH 8.0	Batch	1

(a) References: 1 = Jones et al. 1980.

Table B.10. U-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.01 M) Conditions

U-K_d (mL/g)	Experimental Conditions				
	U (ng/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[a]
1.98	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	40% saturated column	1
0.49	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	40% saturated column	1
2.81	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	38% saturated column	1
0.62	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	22% saturated column	1
0.45	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	30% saturated column	1
0.54	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	23% saturated column	1
0.62	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	25% saturated column	1
0.40	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	17% saturated column	1
0.10	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	7% saturated column	1
0.08	100	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	7% saturated column	1
1.7	50	Hanford groundwater	CGS-1, sand, pH 7.7, CEC = 2.6 meq/100 g	Batch	2
2.3	50	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	Batch	2
79.3[b]	50	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch	2
1.1	200	Hanford groundwater, pH 8.5	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
1.5	200	Hanford groundwater, pH 8.3	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
1.4	200	Hanford groundwater, pH 8.4	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
2.1	200	Hanford groundwater, pH 9.1	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch	3
0.8	200	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, 40% Saturated	3
1.5	200	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, 75% Saturated	3
0.9	200	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, 100% Saturated	3
0.42	50	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	Column, 34% Saturated	3
0.51	50	Hanford groundwater	Trench-8, loamy sand, pH 7.9, CEC = 5.2 meq/100 g	Column, 39.4% Saturated	3
2.48	50	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, 52% Saturated	3
1.96	50	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, 63% Saturated	3

Table B.10. (contd)

U-K_d (mL/g)	Experimental Conditions				
	U (ng/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
1.24	50	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, 81% Saturated	3
0.91	50	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Column, 100% Saturated	3
4.6	50	Hanford groundwater	McGee Ranch, Silty loam, pH 8.2	Column, 60% Saturated	3
1.58	50	Hanford groundwater	McGee Ranch, Silty loam, pH 8.2	Column, 100% Saturated	3
0.5	350	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 7 d	3
0.8	350	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 260 d	3
0.9	350	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 330 d	3
1.1	350	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact time = 398 d	3
1.25	350	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch, Contact time = 7 d	3
1.6	350	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch, Contact time = 260 d	3
2.1	350	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch, Contact time = 330 d	3
2.05	350	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch, Contact time = 398 d	3
1.63	350	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact time = 7 d	3
3.23	350	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact time = 260 d	3
3.4	350	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact time = 330 d	3
3.48	350	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact time = 398 d	3
0.21	5	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact Time =30 d	3
0.16	7	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact Time =30 d	3
0.1	22	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact Time =30 d	3
0.18	52	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact Time =30 d	3
0.11	81	Hanford groundwater	Trench 94: Course Sand, pH 8.2, CEC = 5.3 meq/100 g	Batch, Contact Time =30 d	3
0.25	2	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact Time =30 d	3
0.64	4	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact Time =30 d	3
0.52	7	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact Time =30 d	3

Table B.10. (contd)

U-K_d (mL/g)	Experimental Conditions				
	U (ng/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
0.48	23	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact Time =30 d	3
0.35	47	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact Time =30 d	3
0.53	67	Hanford groundwater	Trench AE-3: Silty loam, pH 8.3, CEC = 6.4 meq/100 g	Batch, Contact Time =30 d	3
0.62 ± 0.12 (20 analyses)		Hanford groundwater, Contact time = 14 d	ILAW Borehole [299-E17-21] Sediment, pH 8.75 ± 0.15; CEC 6.18 ± 2.18 meq/100 g (20 analyses)	Batch	4

(a) References: 1 = Lindenmeier, et al. 1995; 2 = Serne et al. 1993; 3 = Kaplan et al. 1996, 4 = Kaplan et al. 1998.
(b) This K_d values appears too large and will be treated as an outlier.

Table B.11. Cs-K_d Values Under Neutral-to-High pH, Low Organic Material Concentrations, Oxic, Low-Ionic Strength (≤0.01 M) Conditions

Cs-K_d (mL/g)	Experimental Conditions				
	U (nCi/mL)	Aqueous Phase	Solid Phase	Expt'l Method	Ref[(a)]
2055±597 (20 analyses)	25	Hanford groundwater, Contact time = 14 d	ILAW Borehole [299-E17-21] Sediment, pH 8.75 ± 0.15; CEC 6.18 ± 2.18 meq/100 g 20 analyses)	Batch	1
2190 ± 870 (9 analyses)	50	Hanford groundwater	CGS-1, sand, pH 7.7, CEC = 2.6 meq/100 g	Batch	2
7610 ± 4690 (9 analyses)	50	Hanford groundwater	TBS-1, loamy sand, pH 8.2, CEC = 6 meq/100 g	Batch	2

(a) References: 1 = Kaplan et al. 1998. 1995; 2 = Serne et al. 1993.

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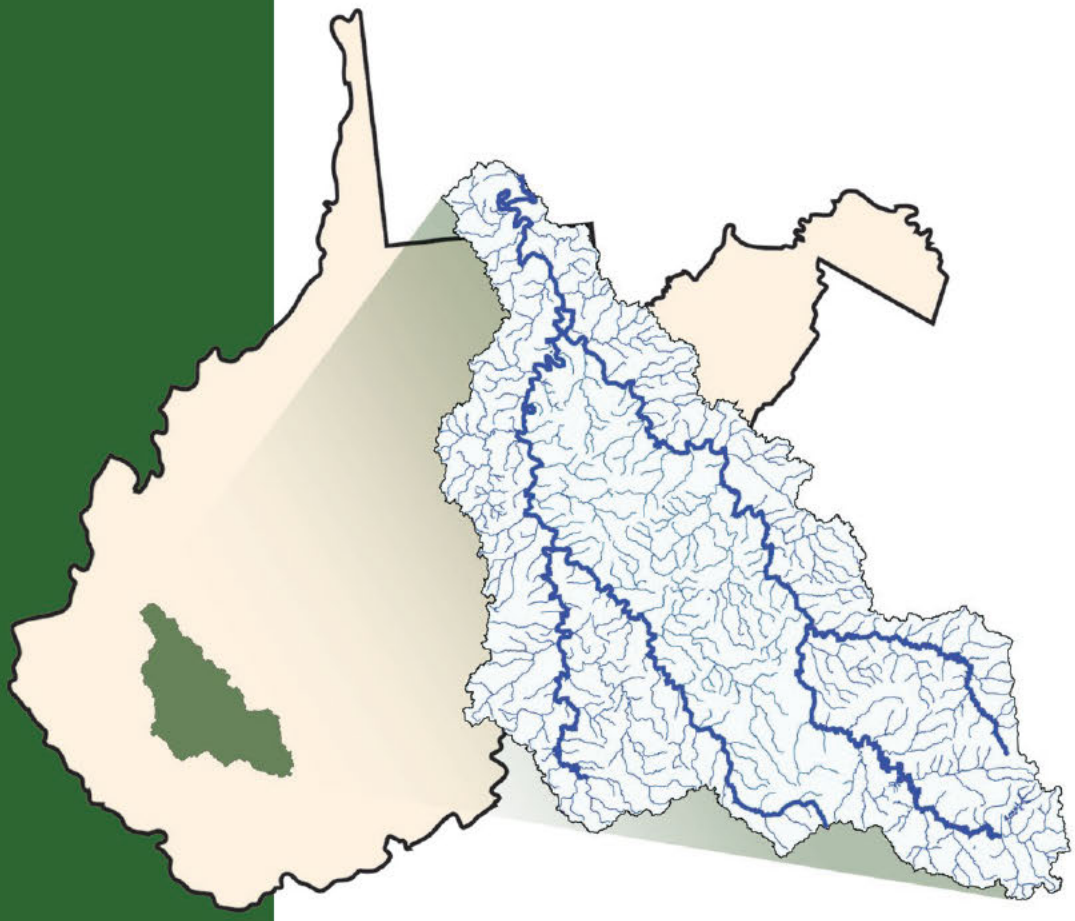

Final Approved Report

Total Maximum Daily Loads for Selected Streams in the Coal River Watershed, West Virginia

Prepared for:

West Virginia Department of Environmental Protection
Division of Water and Waste Management
Watershed Branch, TMDL Section

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Total Maximum Daily Loads for Selected Streams in the Coal River Watershed, West Virginia

Final Approved Report

September 2006

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4. Marsh Fork
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ACRONYMS AND ABBREVIATIONS

7Q10	7-day, 10-year low flow
AMD	acid mine drainage
AML	abandoned mine land
AnnAGNPS	Annualized Agricultural Non-point Source
BMP	best management practice
BOD	biochemical oxygen demand
CFR	Code of Federal Regulations
CSO	combined sewer overflow
CSR	Code of State Rules
DEM	Digital Elevation Model
DESC-R	Dynamic Equilibrium In-stream Chemical Reactions model
DMR	[WVDEP] Division of Mining and Reclamation
DNR	Department of Natural Resources
DO	dissolved oxygen
DWWM	[WVDEP] Division of Water and Waste Management
ERIS	Environmental Resources Information System
FCLES	Fecal Coliform Loading Estimation Spreadsheet
FS	Forest Service
GAP	Gap Analysis Program Land Cover Program
GIS	geographic information system
gpd	gallons per day
GPS	global positioning system
GWLF	Generalized Watershed Loading Functions
HAU	Home Aeration Unit
LA	load allocation
MF	membrane filter counts per test
MOS	margin of safety
µg/L	micrograms per liter
mL	milliliter
MDAS	Mining Data Analysis System
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NOAA-NCDC	National Oceanic and Atmospheric Administration, National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NPS	non-point source
OOG	Office of Oil and Gas
ORSANCO	Ohio River Valley Water Sanitation Commission
OWR	Office of Water Resources

POTW	publicly owned treatment works
PSD	public service district
SMCRA	Surface Mining Control and Reclamation Act
SSO	sanitary sewer overflow
STATSGO	State Soil Geographic database
TMDL	Total Maximum Daily Load
TSS	total suspended solids
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UT	unnamed tributary
WAP	Watershed Assessment Program
WLA	wasteload allocation
WVDEP	West Virginia Department of Environmental Protection
WVSCI	West Virginia Stream Condition Index
WVU	West Virginia University

EXECUTIVE SUMMARY

The Coal River watershed is in southwestern West Virginia and encompasses approximately 891 square miles. The majority of the watershed lies within Boone and Raleigh counties. Smaller portions of the watershed lie in Kanawha, Lincoln, Logan, Putnam, and Fayette counties. Major tributaries include Marsh Fork, Clear Fork, Pond Fork, Spruce Fork, Little Coal River, and Coal River.

This report includes Total Maximum Daily Loads (TMDLs) for various impaired streams in the Coal River watershed. A TMDL establishes the maximum allowable pollutant loading for a waterbody to comply with water quality standards, distributes the load among pollutant sources, and provides a basis for actions needed to restore water quality.

In West Virginia water quality standards are codified at Title 47 of the *Code of State Rules* (CSR), Series 2, and titled *Legislative Rules Department of Environmental Protection, Requirements Governing Water Quality Standards*. The standards include designated uses of West Virginia waters and numeric and narrative criteria to protect those uses. The West Virginia Department of Environmental Protection routinely assesses use support by comparing observed water quality data to criteria and reports impaired waters every 2 years as required by section 303(d) of the Clean Water Act ("303(d) list"). The act requires that TMDLs be developed for listed impaired waters. This report presents TMDLs for many of the impairments identified on the 2004 Section 303(d) List, and for additional impaired or threatened waters determined subsequently.

West Virginia's final 2004 section 303(d) list includes 127 impaired streams in the Coal River watershed. The impairments are related to numeric water quality criteria for fecal coliform bacteria, dissolved aluminum, total iron, total manganese, total selenium, and pH. Many of the listed waters are also biologically impaired based on the narrative water quality criterion of 47 CSR 2–3.2.i, which prohibits the presence of wastes in state waters that cause or contribute to significant adverse impacts on the chemical, physical, hydrologic, and biological components of aquatic ecosystems.

Since 1997, the U.S. Environmental Protection Agency (EPA), Region 3, has developed West Virginia TMDLs under the settlement of a 1995 lawsuit, *Ohio Valley Environmental Coalition, Inc., West Virginia Highlands et al.* v. *Browner et al*. The lawsuit resulted in a consent decree between the plaintiffs and EPA. The consent decree established a rigorous schedule for TMDL development and required TMDLs for the impaired waters on West Virginia's 1996 section 303(d) list. The schedule included TMDL development dates that extend through March 2008. This report accommodates the timely development of the remaining Coal River watershed TMDLs as required by the consent decree.

Impaired waters were organized into six TMDL subwatersheds. Those subwatersheds were further divided into 299 subwatersheds for modeling purposes. The second subwatershed delineation provided a basis for georeferencing pertinent source information and monitoring data and presenting the TMDLs.

The Mining Data Analysis System (MDAS) was used to represent the source-response linkage for total aluminum, manganese, iron, and fecal coliform bacteria. MDAS is a comprehensive data management and modeling system that is capable of representing loads from non-point and point sources in the watershed and simulating in-stream processes. TMDLs for pH impairments were developed using a surrogate approach where it was assumed that reducing instream metal (iron and aluminum) concentrations, allowing for attainment of water quality criteria (or TMDL endpoints), would also result in attainment of the water quality standard for pH. This assumption was verified by applying the Dynamic Equilibrium In-stream Chemical Reactions (DESC-R) model. MDAS was also linked with DESC-R to address dissolved aluminum TMDLs in the watershed. West Virginia's numeric water quality criteria and an explicit margin of safety were used to identify endpoints for TMDL development.

Sediment TMDLs were developed under a reference watershed approach. The Generalized Watershed Loading Functions (GWLF) watershed-loading model was integrated with a stream routing model (Tetra Tech Stream Module) that examined stream bank erosion and depositional processes. Load reductions for sediment-impaired waters were based on the sediment loading present in the unimpaired reference watershed.

Sources contributing to metals and pH impairments include an array of non-point sources (diffuse sources), as well as discrete point sources (permitted discharges). Most of the point sources in the watershed that discharge metals are mining-related. The most significant non-point sources are abandoned mine lands and bond forfeiture sites, but land disturbance activities that introduce excess sediment are additional problematic sources of metals in the watershed.

Both point and non-point sources contribute to the fecal coliform bacteria impairments in the watershed. By far, the most significant non-point sources are those related to the inadequate treatment of sewage. Failing onsite systems and direct discharges of untreated sewage often result in exceedances to the fecal coliform criterion. Precipitation runoff from residential areas is another non-point source of fecal coliform bacteria. Agricultural sources of fecal coliform bacteria are rare because only minimal agricultural landuse is present in the watershed.

Point sources of sediment include permitted mining activities and stormwater discharges from construction sites greater than 1 acre. Non-point sources of sediment include abandoned mine lands, bond forfeiture sites, roads, oil and gas operations, timbering, agriculture, and urban and residential land disturbance. The presence of individual non-point source categories and their relative significance vary by subwatershed.

Biological integrity/impairment is based on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index. The first step in TMDL development for biologically impaired waters is stressor identification. Section 6 discusses the stressor identification process. Identified causative stressors to the benthic communities include metals toxicity, pH toxicity, organic enrichment, sedimentation, and ionic toxicity.

Stressor identification was followed by stream-specific determinations of the pollutants for which TMDLs must be developed. The biological stressors, metals and pH toxicity, were identified in waters that also violated water quality criteria for iron, aluminum, or pH. It was determined that implementation of those pollutant-specific TMDLs would address the biological

impairment. Where organic enrichment was identified as the biological stressor, the waters also demonstrated violations of the numeric criteria for fecal coliform bacteria. It was determined that implementation of fecal coliform TMDLs would remove untreated sewage and thereby reduce the organic and nutrient loading causing the biological impairment. Sediment TMDLs were developed where the stressor identification process indicated sedimentation as a causative stressor. Available information regarding the pollutants that cause ionic toxicity and their associated impairment thresholds were insufficient in this TMDL development timeframe. TMDL development has been deferred, and the waters have been retained on the 303(d) list.

The main section of the report describes the TMDL development and modeling processes, identifies impaired streams and existing pollutant sources, discusses future growth, provides assurance that the TMDLs are achievable, and documents the public participation associated with the process. The main report also contains a detailed discussion of the allocation methodologies applied for various impairments. The employed methodologies prescribe allocations that achieve water quality criteria throughout the watershed. Various provisions attempt to achieve equity between categories of sources, and target pollutant reductions from the most problematic sources. Nonpoint source reductions were not specified beyond that of natural (background) levels. Similarly, point source reductions were no more stringent than numeric water quality criteria.

The subwatershed appendices focus on the impaired waters and applicable TMDLs (sum of wasteload allocations + sum of load allocations + margin of safety) in specified subwatersheds. Applicable TMDLs are displayed in Section 4 of each appendix. Accompanying spreadsheets provide applicable TMDLs, wasteload allocations to individual point sources, and example allocations of loads to categories of non-point sources that achieve the TMDL load allocations. Also provided is an interactive ArcExplorer geographic information system (GIS) project that allows for the exploration of spatial relationships among the source assessment data. This accommodates expedient determination of subwatershed allocations.

An additional report and spreadsheet are provided relative to the temporary revision of the dissolved aluminum water quality criteria for warmwater fisheries. Please see Section 2.2 for details regarding the criteria revision and related implementation guidance.

The TMDLs presented herein, and others developed for the Lower Kanawha River and the North Branch/Potomac River watersheds, represents the second major group of West Virginia TMDLs developed by WVDEP. Considerable resources were used to acquire recent water quality and pollutant source information upon which the TMDLs are based. The TMDL modeling is among the most sophisticated available and incorporates sound scientific principles. TMDL outputs are presented in various formats to assist user comprehension and facilitate use in implementation.

1. REPORT FORMAT

This report consists of a main section, appendices, a supporting GIS application, and spreadsheet data tables. The main section describes the overall TMDL development process for the Coal River watershed, identifies impaired streams, and outlines the source assessment of metals, pH, fecal coliform, and biological stressors. It also describes the modeling process and Total Maximum Daily Load (TMDL) allocations and lists measures that will be taken to ensure that the TMDLs are met. The main section is followed by six appendices that describe specific conditions in each of the six subwatersheds for which TMDLs were developed. The applicable TMDLs are displayed in Section 5 of each appendix. The main section and appendices are supported by a compact disc containing an interactive ArcExplorer GIS project that provides further details on the data and allows the user to explore the spatial relationships among the source assessment data. With this tool, users can magnify streams and other features of interest. Also included on the CD are spreadsheets (in Microsoft Excel format) that provide the data used during the TMDL development process, as well as detailed source allocations associated with successful TMDL scenarios. A Technical Report that describes the detailed technical approaches used throughout the TMDL development process is also included.

2. INTRODUCTION

The West Virginia Department of Environmental Protection (WVDEP), Division of Water and Waste Management (DWWM), is responsible for the protection, restoration, and enhancement of the state's waters. Along with this duty comes the responsibility for TMDL development in West Virginia.

2.1 Total Maximum Daily Loads

Section 303(d) of the federal Clean Water Act and the U.S. Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (at Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to identify waterbodies that do not meet water quality standards and to develop appropriate TMDLs. A TMDL establishes the maximum allowable pollutant loading for a waterbody to achieve compliance with applicable standards. It also distributes the load among pollutant sources and provides a basis for the actions needed to restore water quality.

A TMDL is composed of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for non-point sources, and natural background levels. In addition, the TMDL must include a margin of safety (MOS), implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. TMDLs can be expressed in terms of mass per time or other appropriate units. Conceptually, this definition is denoted by the following equation:

$$\text{TMDL} = \text{sum of WLAs} + \text{sum of LAs} + \text{MOS}$$

Since 1997, West Virginia's TMDLs have been developed by USEPA Region 3, under the settlement of a 1995 lawsuit, *Ohio Valley Environmental Coalition, Inc., West Virginia Highlands et al.* v. *Browner et al*. The lawsuit resulted in a consent decree between the plaintiffs and USEPA. The consent decree established a rigorous schedule for TMDL development and required TMDLs for the impaired waters on West Virginia's 1996 section 303(d) list. The schedule included TMDL development dates that extend through March 2008. WVDEP's TMDL program accommodates the timely development of the remaining TMDLs required by the consent decree.

WVDEP is developing TMDLs in concert with a geographically based approach to water resource management in West Virginia—the Watershed Management Framework. Adherence to the Framework ensures efficient and systematic TMDL development. Each year, TMDLs are developed in specific geographic areas. The Framework dictates that in 2005 TMDLs should be pursued in Hydrologic Group B, which includes the Coal River watershed. Figure 2-1 depicts the hydrologic groupings of West Virginia's watersheds; the legend includes the year of each TMDL finalization target.

WVDEP is committed to implementing a TMDL process that reflects the requirements of the TMDL regulations, provides for the achievement of water quality standards, and ensures that ample stakeholder participation is achieved in the development and implementation of TMDLs. A 48-month development process enables the agency to carry out an extensive data generating and gathering effort to produce scientifically defensible TMDLs. It also allows ample time for modeling, report finalization, and frequent public participation opportunities.

The TMDL development process begins with pre-TMDL water quality monitoring and source identification and characterization. Informational public meetings are held in the affected watersheds. Data obtained from pre-TMDL efforts are compiled, and the impaired waters are modeled to determine baseline conditions and the gross pollutant reductions needed to achieve water quality standards. WVDEP then presents its allocation strategies in a second public meeting, after which Final TMDL reports are developed. The draft TMDL is advertised for public review and comment, and a third informational meeting is held during the public comment period. Public comments are addressed, and the draft TMDL is submitted to USEPA for approval. The TMDLs in this report are scheduled to be finalized by December 2005.

This report presents TMDLs for many of the impairments identified on the 2004 Section 303(d) List, and for additional impaired or threatened waters determined subsequently. All remaining Coal River impairments for which USEPA committed to TMDL development by 2008 are addressed.

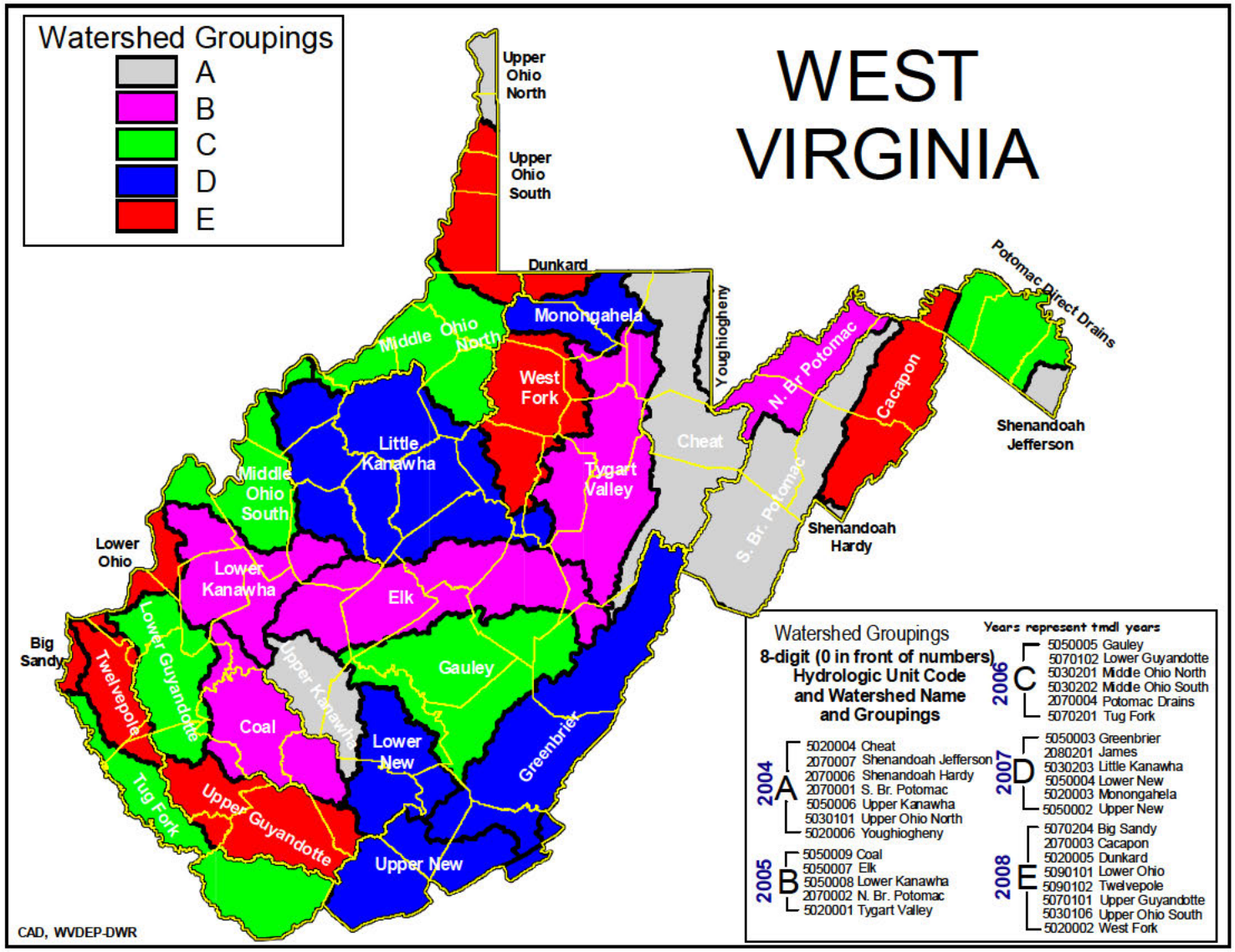


Figure 2-1. Hydrologic groupings of West Virginia's watersheds.

2.2 Water Quality Standards

The determination of impaired waters involves comparing in-stream conditions to applicable water quality standards. In West Virginia water quality standards are codified at Title 47 of the *Code of State Rules* (CSR), Series 2, titled *Legislative Rules Department of Environmental Protection, Requirements Governing Water Quality Standards*. These standards can be obtained online from the West Virginia Secretary of State internet site (http://www.wvsos.com/csr/verify.asp?TitleSeries=47-02).

Water quality standards consist of three components: designated uses; narrative and/or numeric water quality criteria necessary to support those uses; and an antidegradation policy. Appendix E of the Standards contains the numeric water quality criteria for a wide range of parameters, while Section 3 contains the narrative water quality criteria.

Designated uses include: aquatic life protection, water contact recreation, and public water supply. Most of the waterbodies in the Coal River watershed are designated as warmwater fisheries. Clear Fork above Dorothy, Hopkins Fork, Marsh Fork above Sundial, and Stephens Lake are the only waterbodies in the Coal River watershed considered troutwaters. For the impaired waters of this report, West Virginia numeric water quality criteria for warmwater fisheries and troutwaters vary only with respect to iron. Only Hopkins Fork, Clear Fork above Dorothy and Marsh Fork above Sundial are impaired with respect to the troutwater iron criterion.

The Standards include numeric criteria for aquatic life protection for dissolved aluminum, total iron, total selenium, and pH. Human health protection criteria are provided for fecal coliform bacteria, total manganese, total selenium, and pH. Numeric criteria are shown in Table 2-1.

Table 2-1. West Virginia water quality criteria

POLLUTANT	USE DESIGNATION				
	Aquatic Life				Human Health
	Warmwater Fisheries		Troutwaters		Contact Recreation/Public Water Supply
	Acute[a]	Chronic[b]	Acute[a]	Chronic[b]	
Aluminum, dissolved (µg/L)	750	87	750	87	--
Iron, total (mg/L)	--	1.5	--	0.5	1.5
Manganese, total (mg/L)	--	--	--	--	1.0[c]
Selenium, total (ug/L)	20	5	20	5	10
pH	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0	No values below 6.0 or above 9.0

	USE DESIGNATION
Fecal coliform bacteria	**Human Health Criteria** Maximum allowable level of fecal coliform content for Primary Contact Recreation (either MPN [most probable number] or MF [membrane filter counts/test]) shall not exceed 200/100 mL as a monthly geometric mean based on not less than 5 samples per month; nor to exceed 400/100 mL in more than 10 percent of all samples taken during the month.

[a] One-hour average concentration not to be exceeded more than once every 3 years on the average.

[b] Four-day average concentration not to be exceeded more than once every 3 years on the average.

[c] Not to exceed 1 mg/L within the five-mile zone upstream of known public or private water supply intakes used for human consumption.

Source: West Virginia Water Quality Standards, 2005.

All West Virginia waters are subject to the narrative criteria in Section 3 of the Standards. That section, titled "Conditions Not Allowable in State waters," contains various general provisions related to water quality. The narrative water quality criterion at Title 47 CSR Series 2 – 3.2.i prohibits the presence of wastes in state waters that cause or contribute to significant adverse impacts on the chemical, physical, hydrologic, and biological components of aquatic ecosystems. This provision is the basis for "biological impairment" determinations. Biological impairment signifies a stressed aquatic community, and it is discussed in detail in Section 6.

On January 9, 2006, EPA approved a revision to the dissolved aluminum criteria. The warmwater chronic aquatic life protection criterion is changed from 87 µg/L to 750 µg/L from the date of approval until July 4, 2007. During that period, the 750 µg/L criterion is effective for Clean Water Act purposes in warmwater fisheries. If no further legislative action is taken, the 87 µg/L criterion will again become applicable.

At the time TMDLs in this report were originally developed, EPA had not approved this revision, and draft dissolved aluminum TMDLs were presented based upon the previously applicable, 87 µg/L criterion. In response to EPA's approval action, DEP reevaluated the impairment status of Coal River Watershed streams and developed alternative TMDLs, load allocations and wasteload allocations pursuant to the 750 µg/L warmwater dissolved aluminum criterion. Those TMDLs and allocations are presented in the Dissolved Aluminum Addendum documents.

Because of the temporary nature of the criterion value, the draft aluminum TMDLs for warmwater fisheries that were based upon the 87 µg/L criterion remain a component of this document. All displays of aluminum impairments contained in this main report, the appendix reports and the "Coal Metals TMDL Allocations" spreadsheet relate to the 87 µg/L criterion. However, those TMDLs are viable only if the warmwater criterion reverts to the 87 µg/L value in the future. The TMDLs and allocations that are actionable at this time are those presented in the Dissolved Aluminum Addendum and the "Coal River Dissolved Aluminum Addendum TMDL_Allocations" spreadsheet.

On June 29, 2005, EPA approved a revision to the West Virginia Water Quality Standards that altered the zone of applicability of the manganese water quality criterion for the public water supply designated use. The criterion is now applicable only in the five-mile zone upstream of known public or private water supply intakes used for human consumption. The revision necessitated DEP's identification of intakes and revaluation of prior impairment decisions.

DEP secured the Bureau of Public Health's (BHP) database of water supply intakes and determined locations where surface waters are currently used for human consumption. County sanitarians and BPH regional offices were also contacted to seek their guidance relative to any existing intakes that may not be contained in the database. DEP regional office field personnel were similarly queried.

Based upon the intake locations derived from the aforementioned sources, five-mile distances were delineated in an upstream direction along watercourses to determine streams within the zone of applicability of the criterion. DEP then assessed compliance with the criterion by reviewing available water quality monitoring results from streams within the zone and evaluated the base condition portrayed by the TMDL model. TMDLs are presented for waters where the criterion is applicable and where sampling and/or modeling indicate impairment relative to the criterion.

After reevaluation, the criterion was determined to not be applicable to the majority of waters that were previously identified as impaired relative to manganese. Identified intakes include those operated by the City of Saint Albans, Lincoln PSD at Alum Creek and Boone Raleigh PSD at Whitesville. The source water for all intakes is the Coal River. No waters within the five-mile zones of the Saint Albans or Lincoln PSD intakes are manganese impaired. The Boone Raleigh PSD intake creates a zone of manganese applicability in the headwaters of the Coal River subwatershed and the lower reaches of Marsh Fork and Clear Fork watersheds. Available information demonstrates that Coal River, Marsh Fork and Clear Fork are not manganese impaired. However, Little Marsh Fork (WVKC-46-A) and its tributary Brushy Fork (WVKC-46-A-4) are within the zone of applicability and have been determined to be impaired relative to manganese. As such, manganese TMDLs are presented for Little Marsh Fork and Brushy Fork.

3. WATERSHED DESCRIPTION AND DATA INVENTORY

3.1 Watershed Description

The Coal River watershed, U.S. Geological Survey (USGS) 8-digit hydrologic unit code (05050009), lies mostly within Boone and Raleigh counties and also in portions of Kanawha, Lincoln, Logan, Putnam, and Fayette counties in southern West Virginia, as shown in Figure 3-1. The Coal River watershed, a component of the Kanawha River watershed, encompasses nearly 891 square miles. The Coal River runs through the eastern portion of the watershed. Major tributaries include Marsh Fork, Clear Fork, Pond Fork, Spruce Fork, Little Coal River, and Coal River. The average elevation in the watershed is 1,487 feet. The highest point is at 3,196 feet on Pilot Knob, which is in the southern portion of the watershed, on the boundary of Boone and Raleigh counties. The minimum elevation is 564 feet at the mouth of the Coal River near Saint Albans.

Landuse and land cover estimates were obtained from vegetation data gathered from the West Virginia Gap Analysis Land Cover Project (GAP). The Natural Resource Analysis Center and the West Virginia Cooperative Fish and Wildlife Research Unit of West Virginia University (WVU) produced the GAP coverage. The GAP database for West Virginia was derived from satellite imagery taken during the early 1990s, and it includes detailed vegetative spatial data. Additional information regarding the GAP spatial database is provided in the appendices of the Technical Report. The categories for vegetation cover were consolidated to create six landuse categories, summarized in Table 3-1.

As Table 3-1 shows, the dominant landuse type in the Coal River watershed is forest, which constitutes 91.5 percent of the total landuse area. Other important landuse types are urban/residential (2.4 percent), pasture (2.8 percent), and barren/mining land (2.5 percent). Individually, all other land cover types compose less than 0.8 percent of the total watershed area.

The total population for the entire Coal River watershed, derived from the 2000 U.S. Census data, is approximately 64,000 people.

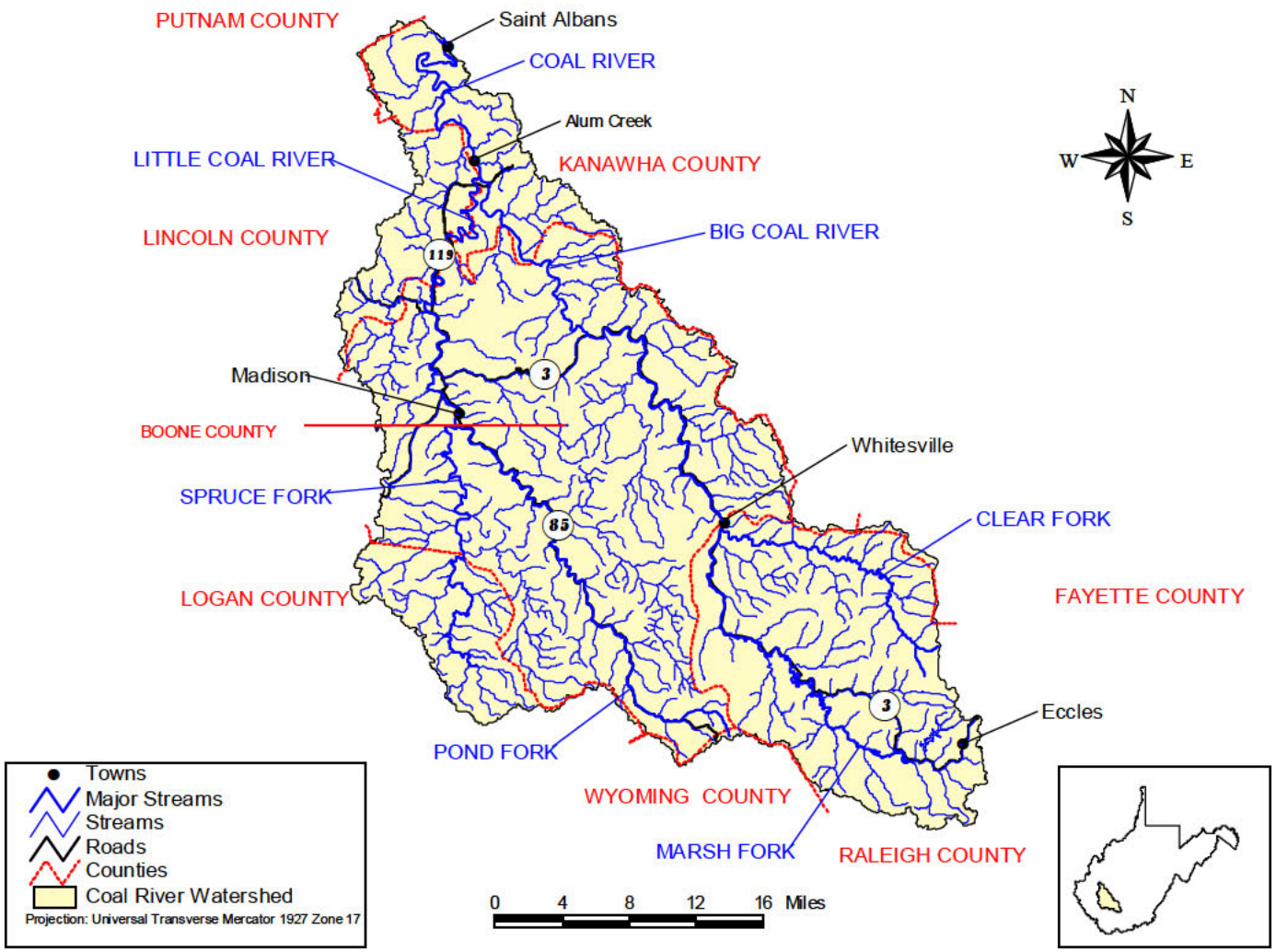


Figure 3-1. Location of the Coal River watershed.

Table 3-1. Landuse according to GAP analysis for the Coal River watershed

Landuse Type	Area of Watershed		
	Acres	Square Miles	Percentage
Agriculture	543.5	0.8	0.1
Barren/Mining	14,347.8	22.4	2.5
Forest	521,546.2	814.9	91.5
Pasture	16,100.2	25.2	2.8
Urban/Residential	13,807.1	21.6	2.4
Water	3,544.5	5.5	0.6
Total	569,889.5	890.5	100.0

3.2 Data Inventory

Various sources of data were used in the TMDL development process. The data were used to identify and characterize sources of pollution and to establish the water quality response to those sources. Review of the data included a preliminary assessment of the watershed's physical and socioeconomic characteristics and current monitoring data. Table 3-2 identifies the data used to support the TMDL assessment and modeling effort for the Coal River watershed. These data describe the physical conditions of the watershed, the potential pollutant sources and their contributions, and the impaired waterbodies for which TMDLs need to be developed. Prior to TMDL development, WVDEP collected comprehensive water quality data throughout the watershed. This pre-TMDL monitoring effort contributed the largest amount of water quality data to the process and is summarized in the Technical Report. The geographic information is provided in the ArcExplorer GIS project included on the CD version of this report.

3.3 Impaired Waterbodies

WVDEP conducted extensive water quality monitoring from July 2002 through June 2003 in the Coal River watershed. The results of that effort were used to confirm the impairments of waterbodies identified on previous 303(d) lists and to identify other impaired waterbodies that were not previously listed as such.

In this TMDL development effort, modeling at baseline conditions demonstrated additional pollutant impairments to those identified via monitoring. The prediction of impairment through modeling is validated by applicable federal guidance for 303(d) listing. Despite best efforts, WVDEP could not perform water quality monitoring and source characterization at frequencies or sample location resolution sufficient to comprehensively assess water quality under the terms of applicable water quality standards, and modeling was needed to complete the assessment. Also, the baseline condition portrayal of the cumulative impact of multiple point sources discharging at existing permit limits sometimes resulted in model prediction of impairment. Where existing pollutant sources were predicted to cause noncompliance with a particular criterion, the subject water was characterized as impaired for that pollutant.

TMDLs were developed for impaired waters in six subwatersheds (Figure 3-2): Marsh Fork, Clear Fork, Pond Fork, Spruce Fork, Little Coal River, and Coal River. The impaired waters for which TMDLs have been developed are presented in Table 3-3. The table includes the stream code, subwatershed, stream name, and impairments for each stream.

Table 3-2. Datasets used in TMDL development

Type of Information		Data Sources
Watershed physiographic data	Stream network	West Virginia Division of Natural Resources (DNR)
	Landuse	WV Gap Analysis Project (GAP)
	Counties	U.S. Census Bureau
	Cities/populated places	U.S. Census Bureau
	Soils	State Soil Geographic Database (STATSGO) U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) soil surveys
	Cataloging Unit boundaries	U.S. Geological Survey (USGS)
	Topographic and digital elevation models (DEMs)	National Elevation Dataset (NED)
	Dam locations	USGS
	Roads	U.S. Census Bureau TIGER, WVU WV Roads
	Water quality monitoring station locations	U.S. Census Bureau, WVDEP, USEPA STORET
	Meteorological station locations	National Oceanic and Atmospheric Administration, National Climatic Data Center (NOAA-NCDC)
	Permitted facility information	WVDEP Division of Water and Waste Management (DWWM), WVDEP Division of Mining and Reclamation (DMR)
	Timber harvest data	USDA, Forest Service (FS)
	Oil and gas operations coverage	WVDEP Office of Oil and Gas (OOG)
	Abandoned mining coverage	WVDEP DMR
Monitoring data	Historical Flow Record (daily averages)	USGS
	Rainfall	NOAA-NCDC
	Temperature	NOAA-NCDC
	Wind speed	NOAA-NCDC
	Dew point	NOAA-NCDC
	Humidity	NOAA-NCDC
	Cloud cover	NOAA-NCDC
	Water quality monitoring data	USEPA STORET, WVDEP
	National Pollutant Discharge Elimination System (NPDES) data	WVDEP DMR, WVDEP DWMM
	Discharge Monitoring Report data	WVDEP DMR, Mining Companies
	Abandoned mine land data	WVDEP DMR, WVDEP DWMM
Regulatory or policy information	Applicable water quality standards	WVDEP
	Section 303(d) list of impaired waterbodies	WVDEP, USEPA
	Non-point Source Management Plans	WVDEP

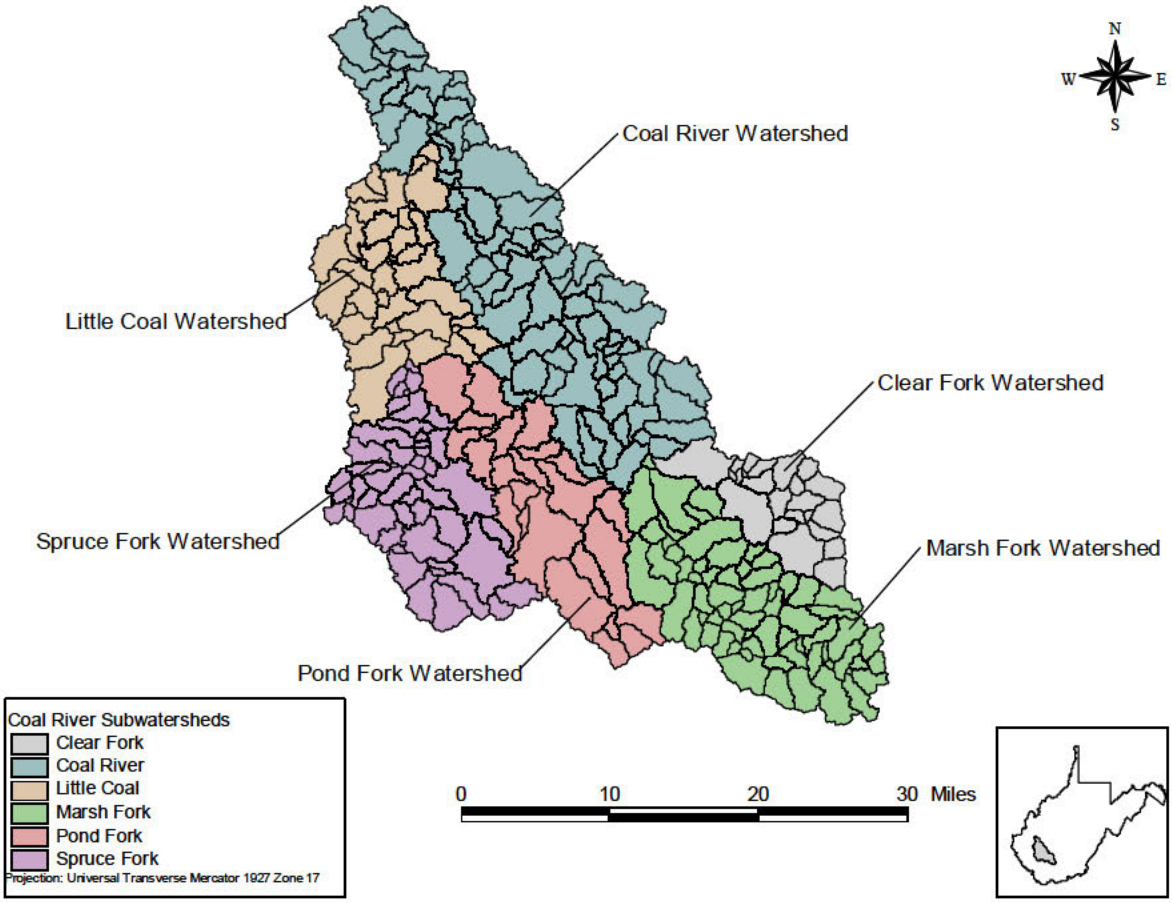


Figure 3-2. The six subwatersheds of the Coal River watershed.

Table 3-3. Waterbodies and impairments for which TMDLs have been developed

Subwatershed	Stream Code	Stream Name	Dis Al	Fe	Mn	pH	Se	Bio	FC	Sed
Marsh Fork	WVKC-46	Marsh Fork		X					X	
	WVKC-46-A	Little Marsh Fork	X	X	X					
	WVKC-46-A-4	Brushy Fork	X	X	X					
	WVKC-46-B	Ellis Creek		X						
	WVKC-46-C	Hazy Creek		X						
	WVKC-46-E	Stink Run		X					X	
	WVKC-46-F	Horse Creek		X						
	WVKG-46-G	Peachtree Creek		X						
	WVKG-46-G-1	Drews Creek		X						
	WVKC-46-G-2	Martin Fork	X	X		X				
	WVKC-46-G-3	Millers Fork		X						
	WVKC-46-H	Dry Creek							X	
	WVKC-46-I	Rock Creek		X					X	
	WVKC-46-I.7	Flat Branch							X	
	WVKC-46-I-1	Righthand Fork							X	
	WVKC-46-J	Sandlick Creek		X				X	X	X
	WVKC-46-J-2	Bee Branch	X			X				
	WVKC-46-J-3	Right Fork/Sandlick Creek						X	X	X
	WVKC-46-J-4	Wingrove Branch		X					X	
	WVKC-46-J-7	Harper Branch		X						
	WVKC-46-K	Cove Creek		X					X	
	WVKC-46-K-2	UNT/Cove Creek RM 1.2							X	
	WVKC-46-L	Breckenridge Creek							X	
	WVKC-46-L-1	UNT/Breckenridge Creek RM 2.7							X	
	WVKC-46-M	Spanker Branch							X	
	WVKC-46-N	Maple Meadow Creek		X				X	X	
	WVKC-46-N.9	Claypool Hollow							X	
	WVKC-46-N-1	Rockhouse Fork		X					X	
	WVKC-46-O	Dingess Branch		X					X	
	WVKC-46-P	Surveyor Creek		X				X	X	X
	WVKC-46-Q	Millers Camp Branch	X	X				X	X	X
	WVKC-46-Q-0.1	Clay Branch							X	
	WVKC-46-Q-1	Stephens Branch		X						
	WVKC-46-Q-3	Shockley Branch		X						
	WVKC-46-Q-4	Laurel Branch		X						

Table 3-3. (continued)

Subwatershed	Stream Code	Stream Name	Al	Fe	Mn	pH	Se	Bio	FC	Sed
Marsh Fork (continued)	WVKC-46-Q-5	Jehu Branch		X						
Clear Fork	WVKC-47	Clear Fork	X	X				X	X	
	WVKC-47-E	Sycamore Creek		X					X	
	WVKC-47-F	Stonecoal Branch	X	X		X		X		X
	WVKC-47-G	Long Branch	X	X						
	WVKC-47-G-1	Dow Fork	X	X		X				
	WVKC-47-I	Fulton Creek		X						
	WVKC-47-K	White Oak Creek		X				X	X	
	WVKC-47-K-1	Left Fork/White Oak Creek		X						
	WVKC-47-L	Toney Fork		X					X	
	WVKC-47-L-1	Buffalo Fork		X						
	WVKC-47-N	McDowell Branch		X					X	
	WVKC-47-P.5	Lick Run		X				X	X	X
Pond Fork	WVKC-10-U	Pond Fork	X	X				X	X	X
	WVKC-10-U-3	Robinson Creek	X	X						
	WVKC-10-U-4	Jacks Branch		X						
	WVKC-10-U-5	Bull Creek		X						
	WVKC-10-U-7	West Fork	X	X				X		X
	WVKC-10-U-7-B	Whites Branch		X					X	
	WVKC-10-U-7-I	James Creek		X			X			
	WVKC-10-U-8	Casey Creek		X			X	X		X
	WVKC-10-U-9	Beaver Pond Branch		X			X			
	WVKC-10-U-21	Lacey Branch		X						
Spruce Fork	WVKC-10-T	Spruce Fork	X	X					X	
	WVKC-10-T-1	Sparrow Creek							X	
	WVKC-10-T-2	Laurel Branch							X	
	WVKC-10-T-3	Low Gap Creek							X	
	WVKC-10-T-5	Hunters Branch	X	X		X				
	WVKC-10-T-7	Sixmile Creek							X	
	WVKC-10-T-8	Bias Branch		X				X	X	
	WVKC-10-T-9	Hewett Creek	X	X					X	
	WVKC-10-T-9-A	Meadow Fork							X	
	WVKC-10-T-9-B	Missouri Fork						X	X	
	WVKC-10-T-9-B.5	Isom Branch							X	
	WVKC-10-T-9-C	Craddock Fork		X					X	
	WVKC-10-T-9-C-2	Sycamore Branch							X	

Table 3-3. (continued)

Subwatershed	Stream Code	Stream Name	Al	Fe	Mn	pH	Se	Bio	FC	Sed
Spruce Fork (continued)	WVKC-10-T-9-D	Baldwin Fork		X				X	X	X
	WVKC-10-T-10	Stollings Branch							X	
	WVKC-10-T-11	Spruce Laurel Fork	X	X				X		X
	WVKC-10-T-11-F	Sycamore Fork		X						
	WVKC-10-T-11-K	Dennison Fork		X						
	WVKC-10-T-13	Rockhouse Creek		X					X	
	WVKC-10-T-15	Beech Creek		X			X			
	WVKC-10-T-15-A	Left Fork/Beech Creek		X			X			
	WVKC-10-T-16	Seng Camp Creek		X						
	WVKC-10-T-19	Trace Branch		X			X			
	WVKC-10-T-22	White Oak Branch		X						
	WVKC-10-T-25	Laurel Fork		X						
	WVKC-10-T-24	Brushy Fork		X						
Little Coal River	WVKC-10	Little Coal River							X	
	WVKC-10-E	Cobb Creek							X	
	WVKC-10-F	Dicks Creek		X						
	WVKC-10-H	Little Hewitt Creek	X	X		X				
	WVKC-10-I	Big Horse Creek		X				X	X	X
	WVKC-10-I-2	Laurel Fork		X					X	
	WVKC-10-I-3	Peters Cave Fork		X					X	
	WVKC-10-I-6	Dodson Fork		X				X	X	X
	WVKC-10-I-8	Rich Hollow		X						
	WVKC-10-J	Little Horse Creek		X				X	X	X
	WVKC-10-J-8	UNT/Little Horse Creek RM 2.4							X	
	WVKC-10-L	Camp Creek							X	
	WVKC-10-N	Rock Creek						X	X	
	WVKC-10-N-2	Hubbard Fork						X	X	
	WVKC-10-N-3	Right Fork/Rock Creek						X	X	
	WVKC-10-N-4	Left Fork/Rock Creek						X	X	
	WVKC-10-O	Lick Creek						X	X	
	WVKC-10-P	Turtle Creek						X	X	
Coal River	WVKC	Coal River							X	
	WVKC-2	Browns Creek						X	X	X
	WVKC-4	Smith Creek						X	X	X
	WVKC-4-C	Little Smith Creek						X	X	
	WVKC-5	Falls Creek							X	

Table 3-3. (continued)

Subwatershed	Stream Code	Stream Name	Al	Fe	Mn	pH	Se	Bio	FC	Sed
Coal River (continued)	WVKC-8	Fuquay Creek							X	
	WVKC-9	Crooked Creek						X	X	
	WVKC-11	Alum Creek							X	
	WVKC-11-A	UNT/Alum Creek RM 1.5							X	
	WVKC-11-B	Little Alum Creek							X	
	WVKC-13	Brier Creek							X	
	WVKC-19	Lick Creek						X	X	
	WVKC-14	Fork Creek		X						
	WVKC-16	Bull Creek		X						
	WVKC-21-A	Honeycamp Fork		X						
	WVKC-21	Brush Creek		X				X	X	X
	WVKC-21-C	Ridgeview Hollow		X				X	X	X
	WVKC-24	Drawdy Creek		X					X	
	WVKC-26	Short Creek							X	
	WVKC-27	Toneys Branch		X					X	
	WVKC-29	Joes Creek		X					X	
	WVKC-29-A	Left Fork/Joes Creek							X	
	WVKC-31	Laurel Creek	X	X					X	
	WVKC-31-A	Sandlick Creek		X				X	X	X
	WVKC-31-B	Hopkins Fork		X					X	
	WVKC-31-B-2	Big Jarrells Creek		X					X	
	WVKC-31-B-3	Logan Fork		X						
	WVKC-31-C	Cold Fork	X	X		X				
	WVKC-31-G	Little Laurel Creek		X						
	WVKC-31-H	Mudlick Fork		X						
	WVKC-32	Horse Branch	X	X		X				
	WVKC-33	Haggle Branch	X	X		X				
	WVKC-34	Jakes Branch		X						
	WVKC-35	White Oak Creek	X	X			X			
	WVKC-35.8	UNT/Coal River RM 52.7	X	X		X				
	WVKC-35-D	Threemile Branch	X	X		X				
	WVKC-35-E	Left Fork/White Oak Creek	X	X			X			
	WVKC-39	Little Elk Creek	X	X						
	WVKC-42	Seng Creek		X			X		X	
	WVKC-43	Elk Run		X						

Note: UNT = unnamed tributary.

WVDEP attempted to develop the TMDLs necessary to address all impairments in each listed waterbody. However, circumstances prevented TMDL development for Raines Fork (WVKC-47-E-4), where biological impairment was identified after pre-TMDL monitoring and TMDL development. In other instances, the biological stressor identification process did not singularly identify causative pollutants or tolerance thresholds. All waters and impairments excluded from TMDL development in this effort have been retained on West Virginia's Section 303(d) list of impaired waters.

4. METALS AND pH SOURCE ASSESSMENT

This section identifies and examines the potential sources of aluminum, iron, manganese, selenium, and pH impairments in the Coal River watershed. Sources can be classified as point (permitted) or non-point (nonpermitted) sources.

A point source, according to 40 CFR 122.3, is any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, and vessel or other floating craft from which pollutants are or may be discharged. The National Pollutant Discharge Elimination System (NPDES) program, established under Clean Water Act sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources. For purposes of this TMDL, NPDES-permitted discharge points are considered point sources.

Non-point sources of pollutants are diffuse, nonpermitted sources. They most often result from precipitation-driven runoff. For the purposes of these TMDLs only, wasteload allocations are given to NPDES-permitted discharge points, and load allocations are given to discharges from activities that do not have an associated NPDES permit, such as mine forfeiture sites and abandoned mine lands, including tunnel discharges, seeps, and surface runoff. The decision to assign load allocations to abandoned and reclaimed mine lands does not reflect any determination by WVDEP or USEPA as to whether there are, in fact, unpermitted point source discharges within these landuses. In addition, by establishing these TMDLs with mine drainage discharges treated as load allocations, WVDEP and USEPA are not determining that these discharges are exempt from NPDES permitting requirements.

The physiographic data discussed in the previous section enabled the characterization of pollutant sources. As part of the TMDL development process, WVDEP performed additional field-based source-tracking activities; the resulting information was supplemental to the other available source characterization data. WVDEP staff recorded physical descriptions of pollutant sources and the general condition of the stream in the vicinity of the sources. WVDEP collected global positioning system (GPS) data and water quality samples for laboratory analysis as necessary to characterize the sources and their impacts. Source-tracking information was compiled and electronically plotted on maps using GIS software. Detailed information, including the locations of pollutant sources, is provided in the subwatershed appendices, the Technical Report, and the ArcExplorer project on the CD version of this TMDL report.

4.1 Metals and pH Point Sources

Metals and pH point sources are classified by the mining- and non-mining-related permits issued by WVDEP. The following sections discuss the potential impacts and the characterization of these source types.

4.1.1 Mining Point Sources

The Surface Mining Control and Reclamation Act of 1977 (SMCRA, Public Law 95-87) and its subsequent revisions were enacted to establish a nationwide program to protect the beneficial uses of land or water resources, protect public health and safety from the adverse effects of current surface coal mining operations, and promote the reclamation of mined areas left without adequate reclamation prior to August 3, 1977. The SMCRA requires a permit for development of new, previously mined, or abandoned sites for the purpose of surface mining. Permittees are required to post a performance bond that will be sufficient to ensure the completion of reclamation requirements by a regulatory authority in the event that the applicant forfeits its permit. Mines that ceased operations before the effective date of SMCRA (often called "pre-law" mines) are not subject to the requirements of the SMCRA.

SMCRA Title IV is designed to provide assistance for the reclamation and restoration of abandoned mines; whereas, Title V states that any surface coal mining operations must be required to meet all applicable performance standards. Some general performance standards include the following:

- Restoring the land affected to a condition capable of supporting the uses that it was capable of supporting prior to any mining
- Backfilling and compacting (to ensure stability or to prevent leaching of toxic materials) to restore the approximate original contour of the land, including all highwalls
- Minimizing disturbances to the hydrologic balance and to the quality and quantity of water in surface water and groundwater systems both during and after surface coal mining operations and during reclamation by avoiding acid or other toxic mine drainage

Untreated mining-related point source discharges from deep, surface, and other mines typically have low pH values (i.e. they are acidic) and contain high concentrations of metals (iron, aluminum, and manganese). Mining-related activities are commonly issued NPDES discharge permits that contain effluent limits for total iron, total manganese, nonfilterable residue, and pH. Most permits also include effluent monitoring requirements for total aluminum. WVDEP's Division of Mining and Reclamation (DMR) provided a spatial coverage of the mining-related NPDES permit outlets. The discharge characteristics, related permit limits and discharge data for these NPDES outlets were acquired from West Virginia's ERIS database system. The spatial coverage was used to determine the location of the permit outlets. Additional information was needed, however, to determine the areas of the mining activities. WVDEP DMR also provided spatial coverage of the mining permit areas and related SMCRA Article 3 permit information. This information includes both active and inactive mining facilities, which are classified by type of mine and facility status. The mines are classified into eight different categories: coal surface

mine, coal underground mine, haul road, coal preparation plant, coal reprocessing, prospective mine, quarry, and other. The haul road and prospective mine categories represent mining access roads and potential coal mining areas.

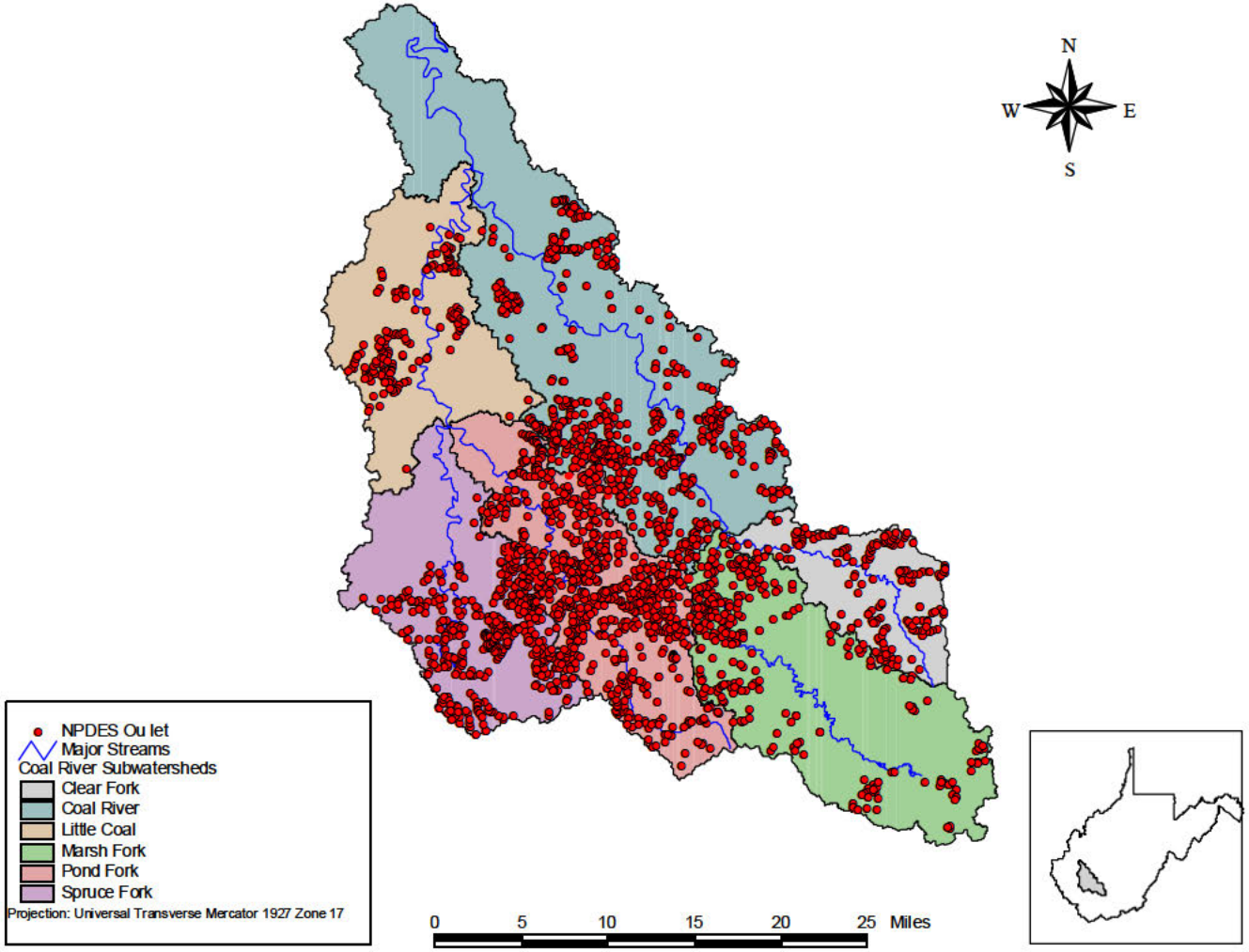
WVDEP DWWM personnel used the information contained in the SMCRA Article 3 and NPDES permits to further characterize the mining point sources. Information gathered included type of discharge, pump capacities, and drainage areas (including total and disturbed areas). Using this information, the mining point sources were then represented in the model and assigned individual wasteload allocations for metals.

In the six TMDL watersheds, there are 240 mining-related NPDES permits, with 2661 associated outlets. A complete list of the permits and outlets is provided in Appendix F of the Technical Report. Figure 4-1 illustrates the extent of the mining NPDES outlets in the watershed.

4.1.2 Non-mining Point Sources

WVDEP DWWM controls water quality impacts from non-mining activities with point source discharges through the issuance of NPDES permits. WVDEP's OWRNPDES GIS coverage was used to determine the locations of these sources, and detailed permit information was obtained from WVDEP's ERIS database.

Non-mining point sources of metals may include the wastewater discharges from water treatment plants and industrial manufacturing operations. In addition, the discharges from construction activities that disturb more than 1 acre of land are legally defined as point sources. The sediment introduced from such discharges can contribute metals. All other non-mining NPDES permits (i.e., the wastewater discharges) must discharge at a pH between 6.0 and 9.0. Based on the types of activities and the minimal flow of their discharges, these permitted non-mining sources are believed to be negligible. Under these TMDLs, these minor discharges are assumed to operate under their current permit limits and will be assigned WLAs that allow them to discharge at their current permit limits.



NOTE: Some mapped features in close proximity to each other may plot as one location on the map.

Figure 4-1. Mining NPDES outlets in the six selected subwatersheds of the Coal River watershed.

4.1.3 Construction Stormwater Permits

WVDEP issued a general NPDES permit (permit WV0115924) to regulate stormwater flowing into streams from discharges associated with construction activities. Registration under the permit is required for construction activities with a land disturbance of greater than 1 acre. These permits require that the site have properly installed best management practices ((BMPs), such as silt fences, sediment traps, seeding and mulching, and riprap) to prevent or reduce erosion and sediment runoff. Both the land disturbance and the permitting process associated with construction activities are transient. After construction is completed and sites are stabilized, water quality impacts are minimized. Individual registrations under the general permit are typically limited to a period of less than 1 year. There are three construction stormwater permits, one each in Marsh Fork, Spruce Fork and Pond Fork watersheds. Because the total disturbed area associated with these permits is small and the disturbance is of short duration, they were considered a negligible source of metals.

4.2 Metals and pH Non-point Sources

In addition to point sources, non-point sources can contribute to water quality impairments related to metals and pH. Abandoned mine lands (AML) contribute acid mine drainage (AMD), which produces low pH and high metals concentrations in surface and subsurface water. Similarly, facilities that were subject to the Surface Mining Control and Reclamation Act of 1977 during active operations and subsequently forfeited their bonds and abandoned operations can be a significant source of metals and low-pH. Also, land disturbing activities that introduce excess sediment are additional non-point sources of metals.

4.2.1 Abandoned Mine Lands

WVDEP's Office of Abandoned Mine Lands & Reclamation (AML&R) was created in 1981 to manage the reclamation of lands and waters affected by mining prior to passage of SMCRA in 1977. AML&R's mission is to protect public health, safety, and property from past coal mining and to enhance the environment through the reclamation and restoration of land and water resources. The AML program is funded by a fee placed on coal. Allocations from the AML fund are made to state and tribal agencies through the congressional budgetary process.

WVDEP's Office of AML&R identified locations of AMLs in the Coal River watershed. In addition, source-tracking efforts by WVDEP DWWM and AML&R identified additional AML sources (discharges, seeps, portals, culverts, refuse piles, diversion ditches, and ponds). Field data, such as GPS locations, water samples, and flow measurement, were collected to locate these sources and characterize their impact on water quality. Based on this work, AMLs represent a significant source of metals in selected subwatersheds of the Coal River watershed.

Abandoned mine lands were modeled in the Coal River TMDLs. A total of 3,756 acres of AML area, 55 AML seeps, and 346 miles of highwall were identified in the Coal River watershed and incorporated into the TMDL model.

4.2.2 Bond Forfeiture

As stated previously, mining permittees are required to post a performance bond to ensure the completion of reclamation requirements. When a bond is forfeited, WVDEP assumes the responsibility for the reclamation requirements. The Office of Special Reclamation in WVDEP's Division of Land Restoration made information and data associated with bond forfeiture sites available. There are six bond forfeiture sites in the Coal River watershed.

4.2.3 Sediment Sources

On the basis of previous watershed modeling (e.g., *Metals and pH TMDLs for the Elk River Watershed* [USEPA 2001] and *Metals, pH, and Fecal Coliform TMDLs for the Upper Kanawha River Watershed, West Virginia [WVDEP 2005]*), which evaluated sediment/metal interactions and general soil properties in West Virginia, it was concluded that certain sediments contain high levels of aluminum, iron, and to a lesser extent, manganese (Watts et al. 1994). Land disturbance can increase sediment loading to impaired waters, and the control of sediment-producing sources might be necessary to meet water quality criteria for metals during high-flow conditions. Potential sediment-related non-point sources of metals are forestry operations, oil and gas operations, roads, agriculture, and barren lands. The number and size of these sources in the Coal River watershed are summarized below and presented in detail in the appendices of this report.

Forestry
The West Virginia Bureau of Commerce's Division of Forestry provided information on forest industry sites (registered logging sites) in the Coal River watershed. This information included the harvested area and the subset of land disturbed by roads and landings for 34 registered logging sties in the watershed.

West Virginia recognizes the water quality issues posed by sediment from logging sites. In 1992, the West Virginia Legislature passed the Logging Sediment Control Act. The act requires the use of BMPs to reduce sediment loads to nearby waterbodies. Without properly installed BMPs, logging and associated access roads can increase sediment loading to streams.

According to the Division of Forestry, illicit logging operations account for approximately an additional 2.5 percent of the total harvested forest (registered logging sites) throughout West Virginia. These illicit operations do not have properly installed BMPs and can contribute to sediment to streams.

Oil and Gas
The WVDEP Office of Oil and Gas (OOG) is responsible for monitoring and regulating all actions related to the exploration, drilling, storage, and production of oil and natural gas in West Virginia. It maintains records on more than 40,000 active and 25,000 inactive oil and gas wells, manages the Abandoned Well Plugging and Reclamation Program. The OOG also ensures that surface water and groundwater are protected from oil and gas activities.

Oil and gas data incorporated into the TMDL model were obtained from the WVDEP OOG GIS coverage. There are 1,354 active oil and gas wells in the watersheds addressed in this report.

Runoff from unpaved access roads to these wells and the disturbed areas around the wells might contribute sediment to adjacent streams.

Roads
Heightened stormwater runoff from paved roads can increase erosion potential. Unpaved roads can contribute sediment through precipitation-driven runoff. Roads that traverse stream paths elevate the potential for direct deposition of sediment. Road construction and repair can further produce increased sediment loads if BMPs are not properly employed.

Information on roads was obtained from various sources, including the 2000 TIGER/Line shapefiles from the U.S. Census Bureau and the WV Roads GIS coverage prepared by WVU. Unpaved roads that were not included in either GIS coverage were digitized from topographic maps.

Agriculture
Agricultural activities can contribute sediment loads to nearby streams; however, there is very little agricultural activity in the Coal River watershed. Row crop agriculture occurs on approximately 0.1 percent of the watershed, as shown by the GAP data (Table 3-1) and source-tracking efforts throughout the watershed.

Other Land-Disturbing Activities
As stated previously, WVDEP issues general NPDES permits to regulate sediment contributions to streams from discharges associated with construction activities that have surface disturbances greater than 1 acre. Construction activities disturbing less than 1 acre are not subject to construction stormwater permitting. There are three construction stormwater permits in the watershed.

4.3 Selenium Sources

As shown previously in Table 3-3, there are nine waterbodies listed as impaired pursuant to West Virginia's water quality criteria for selenium (Table 2-1): James Creek, Casey Creek, Beaver Pond Branch, Beech Creek, Left Fork/Beech Creek, Trace Branch, White Oak Creek, Left Fork/White Oak Creek, and Seng Creek. These impaired waterbodies are shown in Figure 4-2.

These streams were listed based on data collected by WVDEP (from July 2002 through June 2003) during the pre-TMDL stream monitoring effort. As shown in Table 4-1, 157 observations were taken on these nine streams and 65 violated the chronic aquatic life criterion for total selenium (5.0 ug/L), 10 observations violated the acute aquatic life criterion (20.0 ug/L), and 15 observations violated the Human Health not-to-exceed criterion of 10 ug/L.

Table 4-1. Water quality observations for selenium in the Coal River watershed were collected for the TMDL development process.

Watershed	Stream Name	DNR Code	Mile Point	Total Observations	Non-Detect Observations	Total Selenium (ug/L)			Water Quality Criteria Violations		
						Ave	Min	Max	5 ug/L	20 ug/L	10 ug/L
Coal River	White Oak Creek	WVKC-35	0.1	14	14	ND	ND	ND	0	0	0
Coal River	White Oak Creek	WVKC-35	2.7	11	8	7.0	6.0	8.0	3	0	0
Coal River	White Oak Creek	WVKC-35	3.9	11	2	8.6	6.0	20.0	8	1	0
Coal River	White Oak Creek	WVKC-35	5.7	8	1	7.6	7.0	9.0	7	0	0
Coal River	Left Fork/White Oak Creek	WVKC-35-E	0.0	10	2	10.1	6.0	20.0	5	2	1
Coal River	Left Fork/White Oak Creek	WVKC-35-E	3.7	1	0	7.0	7.0	7.0	1	0	0
Coal River	Seng Creek	WVKC-42	0.0	14	4	7.1	6.0	9.0	10	0	0
Coal River	Seng Creek	WVKC-42	3.9	11	0	15.8	8.0	30.0	4	2	5
Pond Fork	Beaver Pond Branch	WVKC-10-U-9	0.0	7	0	13.3	7.0	22.0	2	1	4
Pond Fork	Casey Creek	WVKC-10-U-8	0.0	10	5	6.0	6.0	6.0	5	0	0
Pond Fork	James Creek	WVKC-10-U-7-I	0.0	10	1	7.5	6.0	11.0	8	0	1
Spruce Fork	Beech Creek	WVKC-10-T-15	0.0	12	8	7.3	6.0	9.0	4	0	0
Spruce Fork	Beech Creek	WVKC-10-T-15	1.7	11	10	6.0	6.0	6.0	1	0	0
Spruce Fork	Beech Creek	WVKC-10-T-15	3.6	11	11	ND	ND	ND	0	0	0
Spruce Fork	Left Fork/Beech Creek	WVKC-10-T-15-A	0.0	11	1	23.5	7.0	53.0	3	4	3
Spruce Fork	Trace Branch	WVKC-10-T-19	0.0	5	0	7.3	5.3	10.0	4	0	1

Source: WVDEP, DWWM

ND = Non-detect

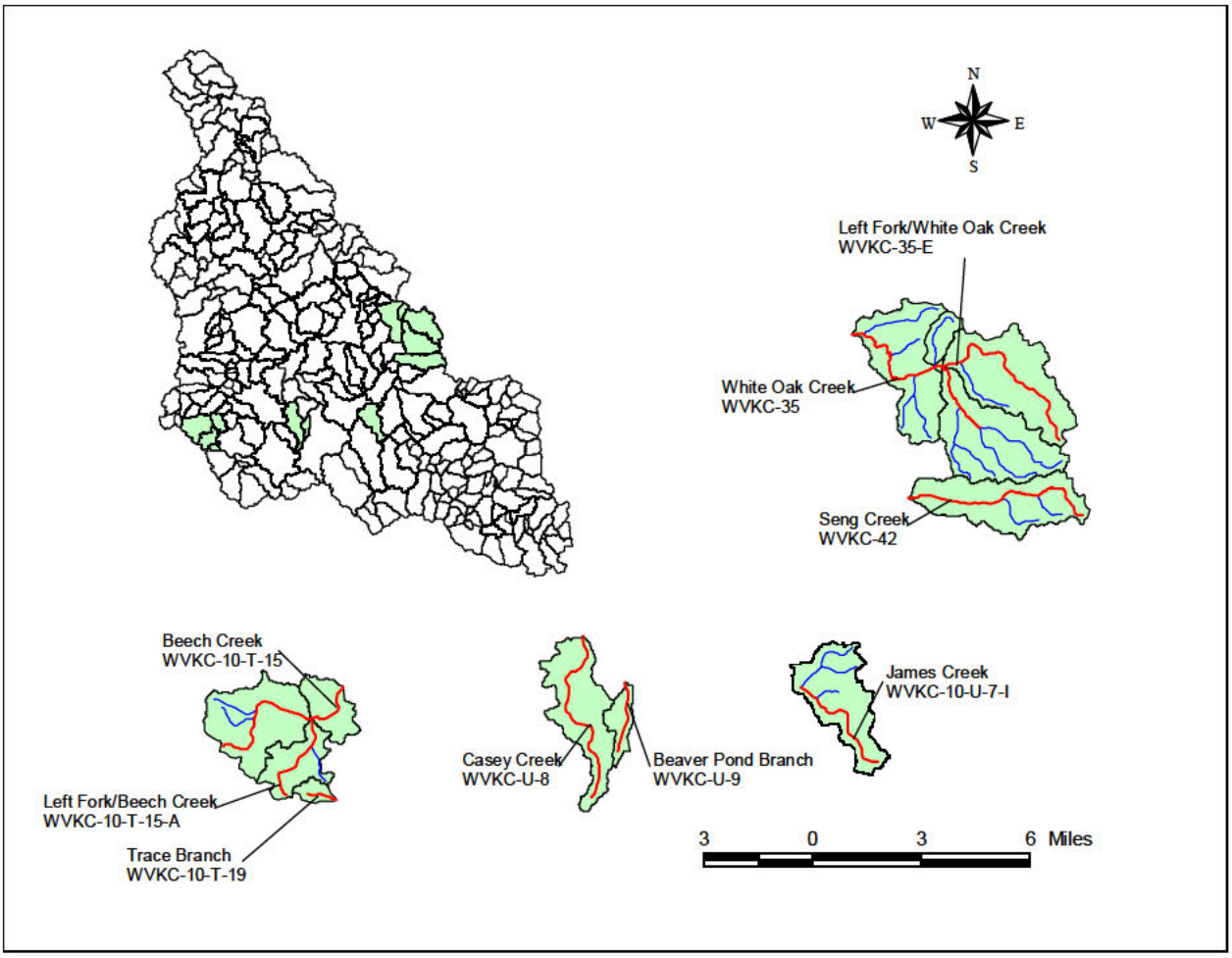


Figure 4-2. Location of the selenium impaired watersheds

Selenium is a naturally occurring element that is found in Cretaceous marine sedimentary rocks, coal and other fossil fuel deposits (Dreher, 1992; CCREM 1987; USEPA 1987; Haygarth 1994). When such deposits are mined, mobilization of selenium is typically enhanced from crushing of ore and waste materials along with the resulting increase in surface area of material exposed to weathering processes. Studies have shown that selenium mobilization appears to be associated with various disturbance activities associated with surface coal mining in Wyoming and western Canada (Dreher and Finkelman 1992; McDonald and Strosher 1998). In West Virginia, coals that contain the highest selenium concentrations are found in a region of south central West Virginia where the Allegheny and upper Kanawha Formations of the Middle Pennsylvanian are mined (WVGES 2002). As shown in Figure 4-3, some of the highest selenium concentrations (8 to 12 ppm) were found in the central portion of the Coal River watershed where the selenium impaired streams are located.

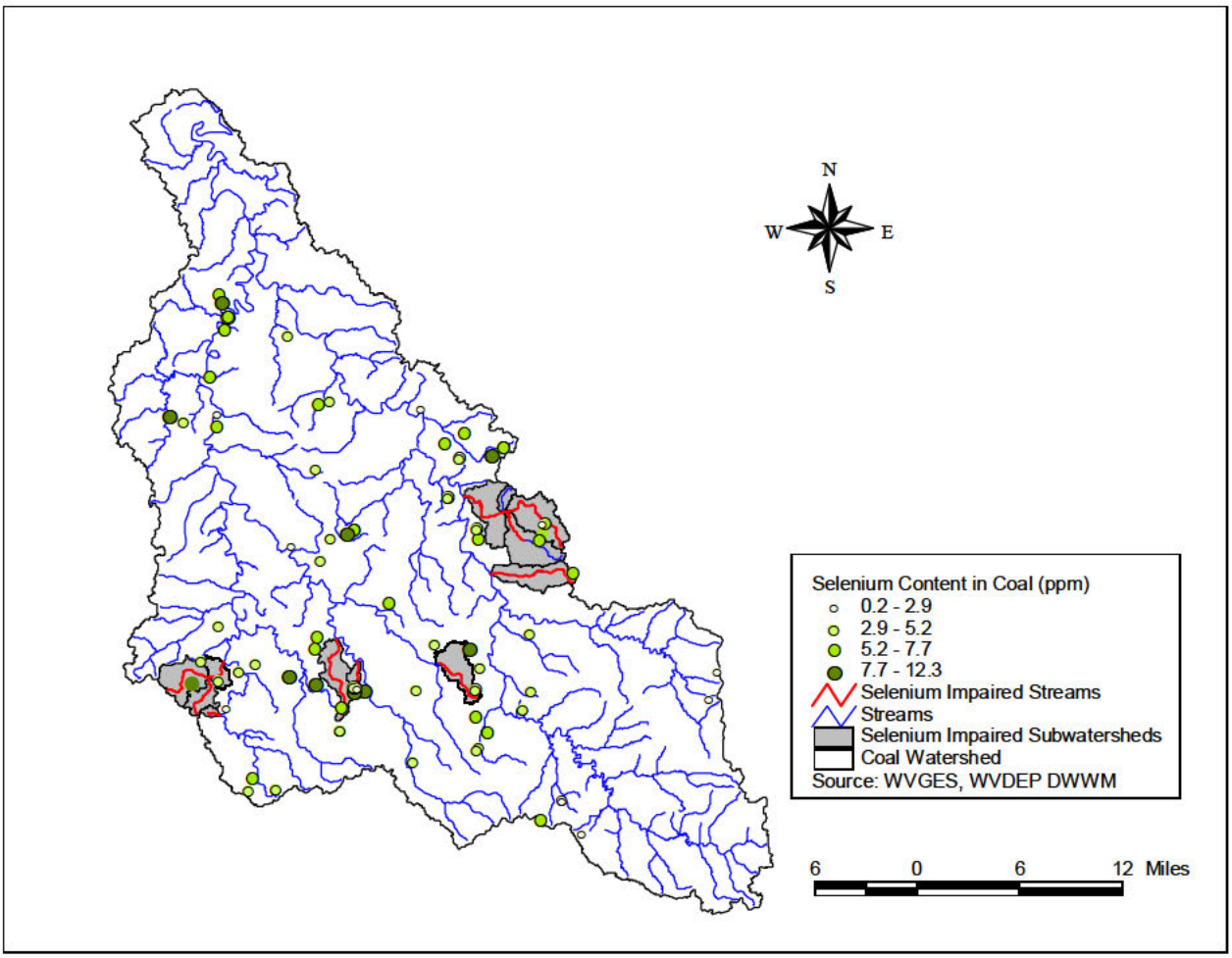


Figure 4-3. Selenium content in coal in the Coal River watershed

Although WVDEP monitored selenium throughout the Coal River watershed, elevated instream concentrations were identified only in the aforementioned waters. Extensive surface mining operations exist in the watersheds of the selenium impaired streams, and in the headwater areas, active mining is the dominant landuse. Given the high selenium content of coals in this region, and the prevalence of mining activity, subsurface disturbances associated with the extensive surface mining operations is the likely cause of the selenium impairment. Furthermore, in the cases in which stream samples were taken at different locations throughout an impaired stream, the samples nearest the headwaters showed higher selenium concentrations than those at the mouth of the stream. This is due to natural attenuation and increased dilution of selenium as it travels downstream from the source in the headwaters. Figures 4-6 and 4-7 illustrate the decreasing trend in selenium concentration in the downstream direction in Seng Creek. Figures 4-4 and 4-5 illustrate the impact of the highly contaminated headwater, Left Fork of Beech Creek, on the mainstem of Beech Creek.

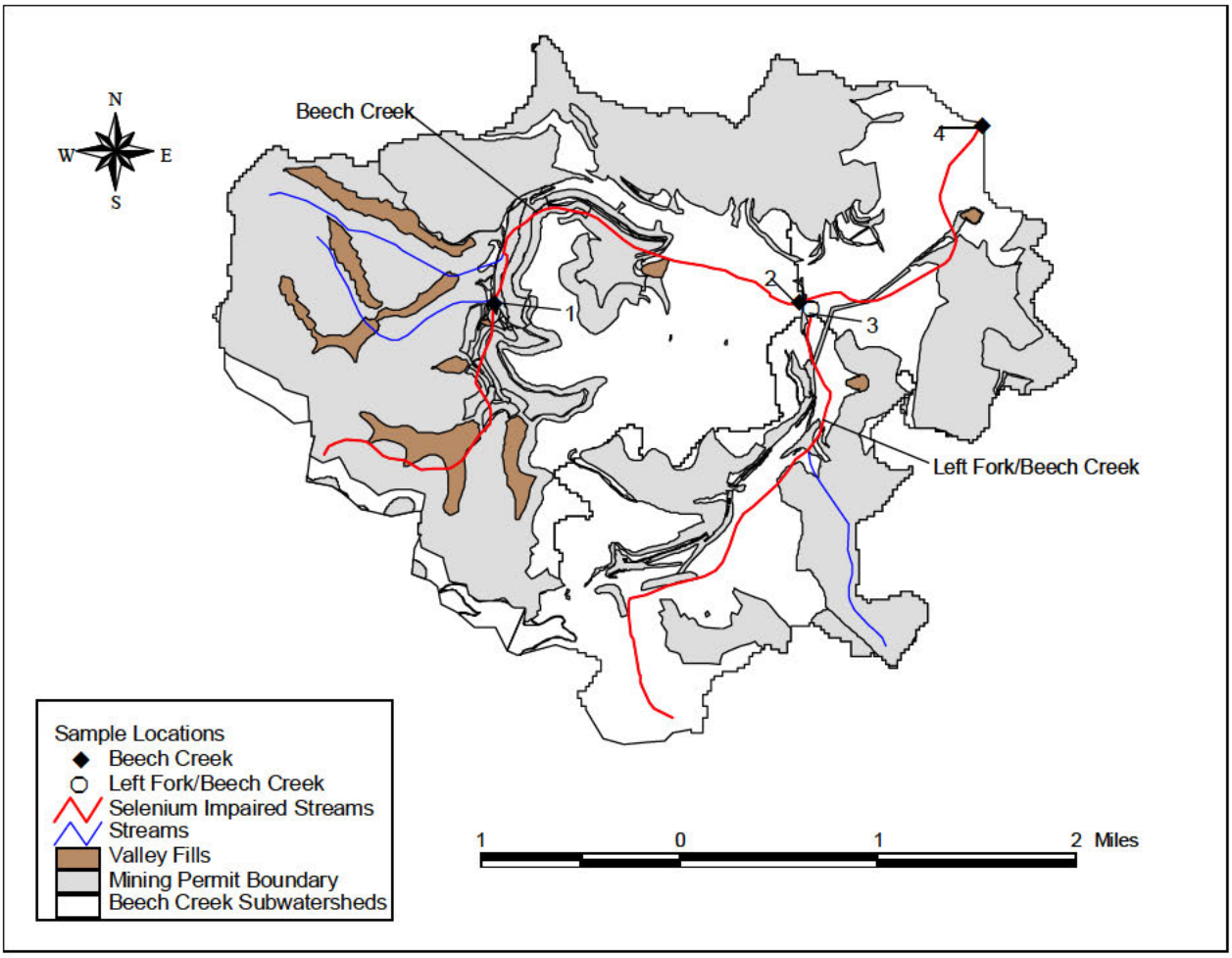


Figure 4-4. Selenium sampling stations in the Beech Creek watershed

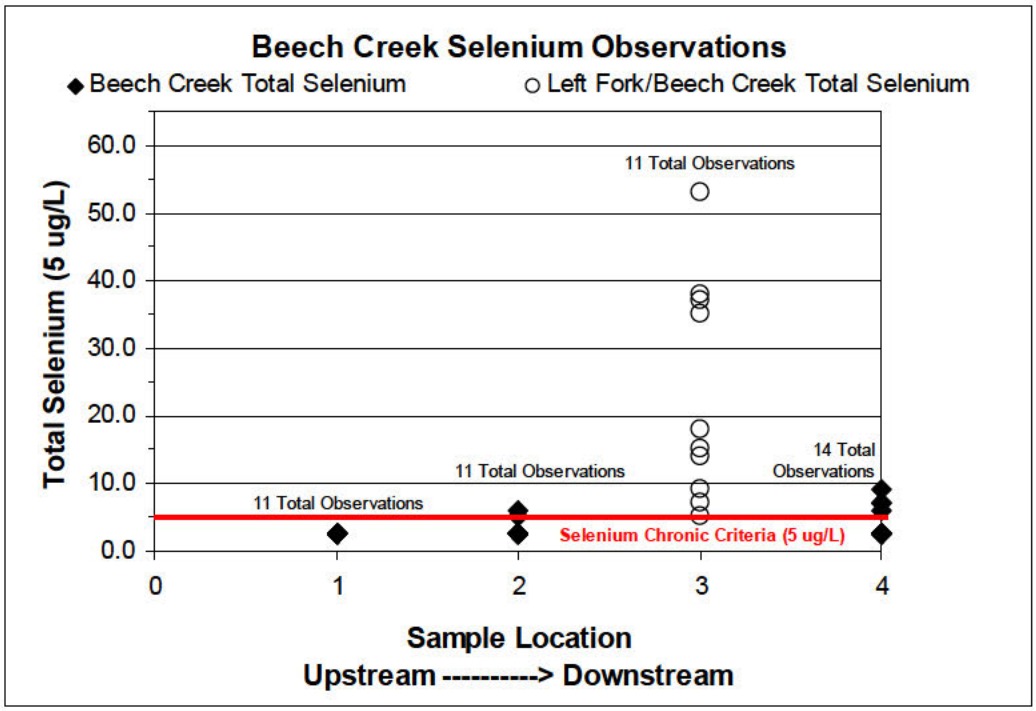


Figure 4-5. Selenium water quality data for Beech Creek watershed

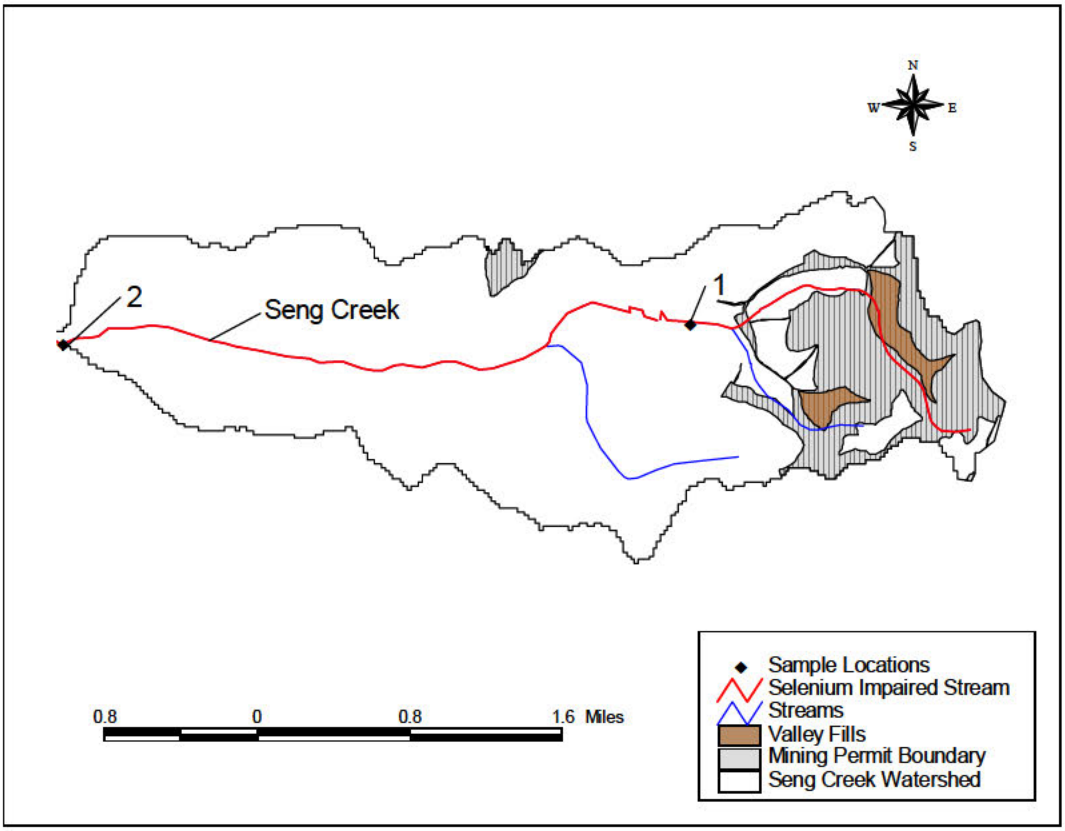


Figure 4-6. Selenium sampling stations in the Seng Creek watershed

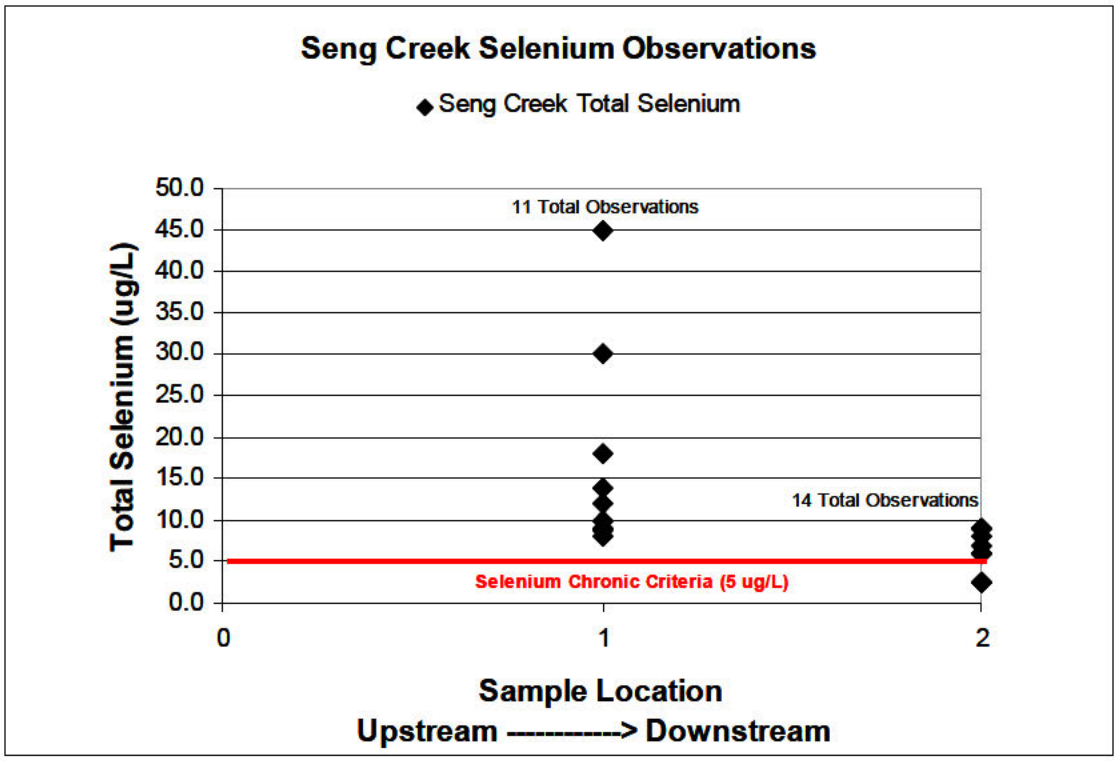


Figure 4-7. Selenium water quality data for Seng Creek watershed

5. FECAL COLIFORM SOURCE ASSESSMENT

5.1 Fecal Coliform Point Sources

The most significant fecal coliform point sources are the permitted discharges from sewage treatment plants. These facilities (including publicly and privately owned treatment works, combined sewer overflows, and home aeration units) are regulated by NPDES permits. Permits require effluent disinfection and compliance with strict fecal coliform limitations (200 counts/100 milliliters [average monthly] and 400 counts/100 mL [maximum daily]). However, noncompliant discharges and collection system overflows can contribute loadings of fecal coliform bacteria to receiving streams. The following sections discuss the specific types of fecal coliform point sources that were identified in the Coal River watershed.

5.1.1 Individual NPDES Permits

WVDEP issues individual NPDES permits to both publicly owned and privately owned wastewater treatment facilities. Publicly owned treatment works (POTWs) are relatively large facilities with extensive wastewater collection systems, whereas private facilities are usually used in smaller applications such as subdivisions and shopping centers.

Two POTWs discharge treated effluent into the fecal coliform-impaired waters of the Coal River watershed. POTWs include those operated by Boone County PSD under WV/NPDES Permit number WV0035939 and Boone-Raleigh PSD under WV/NPDES Permit number WV0086525. POTW effluents are not a significant source of fecal coliform bacteria because they are permitted to discharge only at limits more stringent than water quality criterion.

5.1.2 Overflows

Combined sewer overflows (CSOs) are outfalls from POTW sewer systems that were designed to carry untreated domestic waste and surface runoff. CSOs contain fecal coliform bacteria and are permitted to discharge only during precipitation events. Sanitary sewer overflows (SSOs) are unpermitted overflows that occur as a result of excessive infiltration and/or inflow to POTW separate sanitary collection systems.

There are five CSOs associated with permit number WV0035939 that discharge into the Little Coal River and one SSO associated with permit number WV0086525 that discharges into the Coal River.

5.1.3 Municipal Separate Storm Sewer Systems

USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for all stormwater discharges from municipal separate storm sewer systems (MS4s). There is one designated MS4 municipality, the City of Saint Albans, in the watershed. Saint Albans' MS4 has discharges in the Coal River watershed, and the City has filed a Notice of Intent for MS4 permit issuance. The area within the corporate limits is assumed to be subject to MS4 stormwater permitting.

5.1.4 General Sewage Permits

General sewage permits are designed to cover similar discharges from numerous individual owners and facilities throughout the state. General Permit WV0103110 regulates small, privately owned sewage treatment plants ("package plants") that have a design flow of less than 50,000 gallons per day (gpd). General Permit WV0107000 regulates Home Aeration Units (HAUs). HAUs are small sewage treatment plants primarily used by individual residences where site considerations preclude typical septic tank and leach field installation. Both general permits contain fecal coliform effluent limitations identical to those in individual NPDES permits for sewage treatment facilities. Within the watersheds addressed by this report, 56 facilities are registered under the "package plant" general permit and 217 are registered under the "HAU" general permit.

5.2 Fecal Coliform Non-point Sources

5.2.1 On-site Treatment Systems

Overall, failing septic systems and straight pipes represent the most significant non-point source of fecal coliform bacteria in the Coal River watershed. According to the West Virginia Bureau for Public Health, the failure rate for septic systems in the watershed is estimated to be 70

percent during the first 10 years after installation. Information collected during source-tracking efforts by WVDEP yielded an estimate of 32,783 persons in the watershed that are not served by centralized sewage collection and treatment systems.

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as failing septic systems and straight pipes, are considered non-point sources. The decision to assign load allocations to those sources does not reflect a determination by WVDEP or USEPA as to whether they are, in fact, nonpermitted point source discharges. In addition, by establishing these TMDLs with failing septic systems and straight pipes treated as non-point sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.

5.2.2 Stormwater Runoff

Stormwater runoff represents another non-point source of fecal coliform bacteria in residential and urbanized areas. Runoff from residential and urbanized areas during storm events can be a significant source, delivering bacteria from the waste of pets and wildlife to the waterbody. GAP2000 landuse was used to determine the number of acres of residential and urbanized areas in the Coal River watershed. Reference numbers were used to determine fecal accumulation rates for these areas.

Stormwater runoff from rural areas can transport significant loads of bacteria from livestock pastures, livestock and poultry feeding facilities, and manure storage and application. Natural background sources such as wildlife can also contribute bacteria loadings through runoff during storm events.

5.2.3 Agriculture

Agricultural activities can contribute fecal coliform bacteria to receiving streams through surface runoff or direct deposition. Grazing livestock and land application of manure result in the deposition and accumulation of bacteria on land surfaces. Then, bacteria are available for wash-off and transport during rain events. In addition, livestock with unrestricted access can deposit feces directly into streams.

Based on GAP 2000 landuse data, it was determined that agriculture is not prevalent in the impaired portions of the Coal River watershed. Although agriculture is not widespread, source-tracking efforts identified isolated instances of pastures and feedlots near impaired segments that potentially have significant localized impacts on in-stream bacteria levels. Livestock counts from the 1997 Census of Agriculture (USDA, 1997) were used to develop accumulation rates for agricultural sources of fecal coliform bacteria.

5.2.4 Natural Background (Wildlife)

A certain “natural background” contribution of fecal coliform bacteria can be attributed to deposition by wildlife in forested areas. Accumulation rates for fecal coliform bacteria in forested areas were developed using reference numbers from past TMDLs, incorporating wildlife estimates obtained from West Virginia’s Division of Natural Resources (DNR). On the basis of

the low fecal accumulation rates for forested areas, wildlife is not considered to be a significant non-point source of fecal coliform bacteria in the Coal River watershed.

6. BIOLOGICAL IMPAIRMENT AND STRESSOR IDENTIFICATION

Initially, TMDL development in biologically impaired waters requires identification of the pollutants that cause the stress to the biological community. Sources of those pollutants are often analogous to those already described: mine drainage, untreated sewage, and sediment. The Technical Report discusses biological impairment and the stressor identification (SI) process in detail.

6.1 Introduction

Assessment of the biological integrity of a stream is based on a survey of the stream's benthic macroinvertebrate community. Benthic macroinvertebrate communities are rated using a multimetric index developed for use in wadeable streams of West Virginia. The West Virginia Stream Condition Index (WVSCI; Gerritsen et al., 2000) is composed of six metrics that were selected to maximize discrimination between streams with known impairments and reference streams. In general, streams with WVSCI scores of less than 60.6 points, on a normalized 0–100 scale, are considered biologically impaired.

Biological assessments are useful in detecting impairment, but they might not clearly identify the causes of impairment, which must be determined before TMDL development can proceed. USEPA developed *Stressor Identification: Technical Guidance Document* (Cormier et al. 2000) to assist water resource managers in identifying stressors and stressor combinations that cause biological impairment. Elements of the stressor identification process were used to evaluate and identify the primary stressors to the impaired benthic communities. In addition, custom analyses of biological data were performed to supplement the framework recommended by the guidance document.

The general stressor identification process entailed reviewing available information, forming and analyzing possible stressor scenarios, and implicating causative stressors. The stressor identification method provides a consistent process for evaluating available information. TMDLs were established for the responsible pollutants at the conclusion of the stressor identification process. As a result, the TMDL process established a link between the impairment and benthic community stressors.

6.2 Data Review

WVDEP generated the primary data used in stressor identification through its pre-TMDL monitoring program. The program included water quality monitoring, benthic sampling, and habitat assessment. In addition, the biologists' comments regarding stream condition and potential stressors and sources were captured and considered. Other data sources were: source-tracking data, WVDEP mining activities data, GAP2000 landuse information, Natural Resources

Conservation Service (NRCS) STATSGO soils data, NPDES point source data, and literature sources.

6.3 Candidate Causes/Pathways

The first step in the stressor identification process was to develop a list of candidate causes, or stressors. The candidate causes responsible for biological impairments are listed below:

- Metals contamination (including metals contributed through soil erosion) causes toxicity.
- Acidity (low pH) causes toxicity.
- High sulfates and increased ionic strength cause toxicity.
- Increased total suspended solids (TSS)/erosion and altered hydrology cause sedimentation and other habitat alterations.
- Altered hydrology causes higher water temperature, resulting in direct impacts.
- Altered hydrology, nutrient enrichment, and increased biochemical oxygen demand (BOD) cause reduced dissolved oxygen (DO).
- Algal growth causes food supply shift.
- High levels of ammonia cause toxicity (including increased toxicity due to algal growth).
- Chemical spills cause toxicity.

A conceptual model was developed to examine the relationship between candidate causes and potential biological effects. The conceptual model (Figure 6-1) depicts the sources, stressors, and pathways that affect the biological community.

6.4 Stressor Identification Results

The stressor identification process determined the primary causes of biological impairment. Biological impairment was linked to a single stressor in some cases and multiple stressors in others. The stressor identification process identified the following stressors for the biologically impaired waters of the Coal River watershed:

- Metals toxicity
- pH toxicity
- Sedimentation

- Organic enrichment (the combined effects of oxygen-demanding pollutants, nutrients, and the resultant algal and habitat alteration)
- Ionic toxicity

After stressors were identified, WVDEP determined the pollutants for which TMDLs were required to address the impairment.

The stressor identification process identified metals toxicity and pH toxicity as biological stressors in waters that also demonstrated violations of the iron, aluminum, or pH water quality criteria for protection of aquatic life. WVDEP determined that implementation of those pollutant-specific TMDLs would address the biological impairment.

Where organic enrichment was identified as the biological stressor, the waters also demonstrated violations of the numeric criteria for fecal coliform bacteria. The predominant source of fecal coliform bacteria in the watershed is inadequately treated sewage. WVDEP determined that implementation of fecal coliform TMDLs would remove untreated sewage and thereby reduce the organic and nutrient loading causing the biological impairment. Therefore, fecal coliform TMDLs will serve as a surrogate where organic enrichment was identified as a stressor.

Where the stressor identification process indicated sedimentation as a causative stressor, WVDEP developed sediment TMDLs.

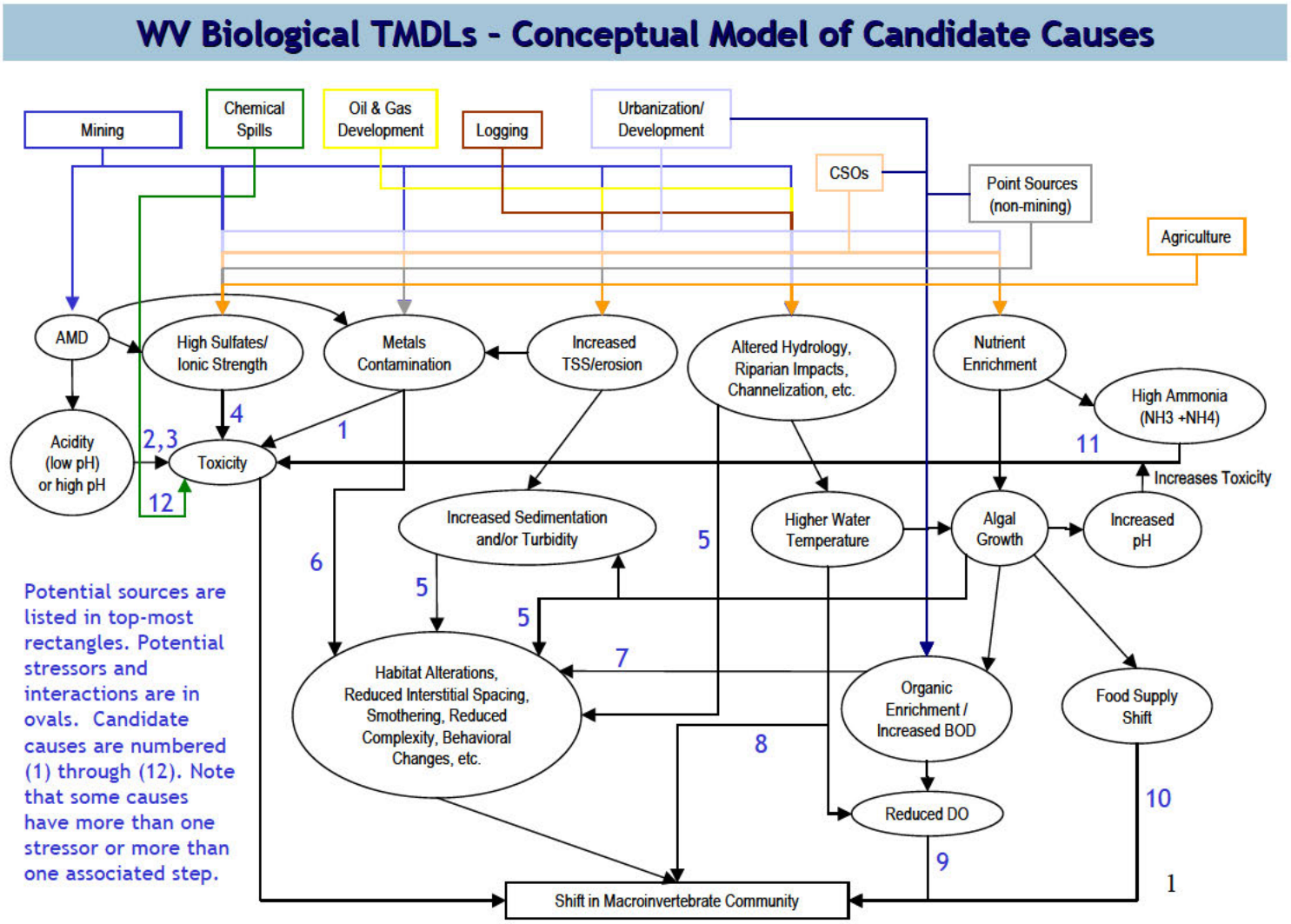


Figure 6-1. Conceptual model of candidate causes and potential biological effects.

In certain waters (James Branch, Ellis Creek, Rockhouse Creek, Toney Fork, Buffalo Fork, Left Fork/Beach Creek, and Seng Creek), the stressor identification process determined ionic toxicity as the primary stressor. Information available regarding the causative pollutants and their associated impairment thresholds is insufficient for biological TMDL development at this time. Therefore, WVDEP is deferring biological TMDL development and retaining those waters on the Section 303(d) list. Table 6-1 summarizes the primary stressors' contributions to biological impairment in the Coal River watershed.

Table 6-1. Primary stressors of biologically impaired streams in the Coal River watershed

Major Watershed	Stream	Biological Stressors	TMDLs Developed
Marsh Fork	Sandlick Creek	Metal toxicity (iron) Sedimentation	Iron Sediment
	Right Fork/Sandlick Creek	Organic enrichment Sedimentation	Fecal coliform Sediment
	Maple Meadow Creek	Metal toxicity (iron) Organic enrichment	Iron Fecal coliform
	Surveyor Creek	Organic enrichment Sedimentation	Fecal coliform Sediment
	Millers Camp Branch	Sedimentation	Sediment
Clear Fork	Clear Fork	Organic enrichment	Fecal coliform
	Stonecoal Branch	Metals toxicity (iron) pH toxicity (acidity) Sedimentation	Iron pH Sediment
	White Oak Creek	Organic enrichment	Fecal coliform
	Lick Run	Metal toxicity (iron) Sedimentation	Iron Sediment
Pond Fork	Pond Fork	Organic enrichment Sedimentation	Fecal coliform Sediment
	West Fork	Sedimentation	Sediment
	Casey Creek	Sedimentation	Sediment
Spruce Fork	Bias Branch	Organic enrichment	Fecal coliform
	Missouri Fork	Organic enrichment	Fecal coliform
	Baldwin Fork	Organic enrichment Sedimentation	Fecal coliform Sediment
	Spruce Laurel Fork	Metals toxicity (iron) Sedimentation	Iron Sediment
Little Coal River	Big Horse Creek	Sedimentation	Sediment
	Dodson Fork	Organic enrichment Sedimentation	Fecal coliform Sediment
	Little Horse Creek	Organic enrichment Sedimentation	Fecal coliform Sediment
	Rock Creek	Organic enrichment	Fecal coliform
	Hubbard Fork	Organic enrichment	Fecal coliform
	Right Fork/Rock Creek	Organic enrichment	Fecal coliform
	Left Fork/Rock Creek	Organic enrichment	Fecal coliform
	Lick Creek	Organic enrichment	Fecal coliform
	Turtle Creek	Organic enrichment	Fecal coliform

Major Watershed	Stream	Biological Stressors	TMDLs Developed
Coal River	Browns Creek	Organic enrichment Sedimentation	Fecal coliform Sediment
	Smith Creek	Organic enrichment Sedimentation	Fecal coliform Sediment
	Little Smith Creek	Organic enrichment	Fecal coliform
	Crooked Creek	Organic enrichment	Fecal coliform
	Lick Creek	Organic enrichment	Fecal coliform
	Brush Creek	Organic enrichment Sedimentation	Fecal coliform Sediment
	Ridgeview Hollow	Organic enrichment Sedimentation	Fecal coliform Sediment
	Sandlick Creek	Organic enrichment Sedimentation	Fecal coliform Sediment

7. MODELING PROCESS

Establishing the relationship between the in-stream water quality targets and source loadings is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses with flow and loading conditions. This section presents the approach taken to develop the linkage between sources and in-stream response for TMDL development in the Coal River watershed.

7.1 Modeling Technique for Metals, pH, and Fecal Coliform Bacteria

Selection of the appropriate analytical technique for TMDL development was based on an evaluation of technical and regulatory criteria. The following key technical factors were considered in the selection process:

- Scale of analysis.
- Point and non-point sources.
- Metals, pH, and fecal coliform bacterial impairments are temporally variable and occur at low, average, and high flow conditions.
- Time-variable aspects of land practices have a large effect on in-stream metals and bacteria concentrations.
- Metals and bacteria transport mechanisms are highly variable and often weather-dependent.

The primary regulatory factor that initiated the selection process was West Virginia's water quality criteria. According to 40 CFR Part 130, TMDLs must be designed to implement applicable water quality standards. The applicable water quality standards for metals, pH, and fecal coliform bacteria in West Virginia are presented in Section 2, Table 2-1. Compliance with the criteria requires attaining conditions that protect against both short-term (acute) effects and long-term (chronic) effects. West Virginia water quality criteria are applicable at all stream flows greater than the 7-day, 10-year low flow (7Q10). The approach or modeling technique must permit representation of in-stream concentrations under a variety of flow conditions to evaluate critical flow periods for comparison to chronic and acute criteria.

The TMDL development approach must also consider the dominant processes affecting pollutant loadings and in-stream fate. For the Coal River watershed, primary sources contributing to metals, pH, and fecal coliform impairments include an array of point and non-point sources. Non-point sources are typically rainfall-driven with pollutant loadings primarily related to surface runoff. Point source discharges might or might not be induced by rainfall.

A variety of modeling tools were used to develop the TMDLs, including the Mining Data Analysis System (MDAS), the Dynamic Equilibrium In-stream Chemical Reactions model (DESC-R), and the Fecal Coliform Loading Estimation Spreadsheet (FCLES).

MDAS is a system designed to support TMDL development for areas affected by non-point and point sources. The MDAS component most critical to TMDL development is the dynamic watershed model because it provides the linkage between source contributions and in-stream response. MDAS is used to simulate watershed hydrology and pollutant transport as well as stream hydraulics and in-stream water quality. It is capable of simulating different flow regimes and pollutant loading variations. Metals and fecal coliform bacteria were modeled using MDAS.

Metals are modeled in MDAS in the total recoverable form. Therefore, it was necessary to link MDAS with DESC-R to appropriately address dissolved aluminum TMDLs for the Coal River watershed. DESC-R was also used to represent the source-response linkage for pH. The model selection process, modeling methodologies, and technical approaches are discussed further in the Technical Report.

FCLES (Fecal Tool) is a spreadsheet tool used to quantify non-point source bacteria accumulation rates based on watershed-specific information. FCLES is a Microsoft Excel spreadsheet tool that estimates the fecal coliform bacteria contribution from multiple sources. Inputs to the Fecal Tool can be generated manually or by using various functions of the Watershed Characterization System. Output from the Fecal Tool is used as input to MDAS. The tool estimates the monthly accumulation rate of fecal coliform bacteria on four landuses (cropland, forest, residential, and pastureland), as well as the asymptotic limit for that accumulation should no washoff occur. The tool also estimates the direct input of fecal coliform bacteria to streams from grazing agricultural animals and failing septic systems. The Fecal Tool provides starting values for model input; however, a thorough calibration of the model is still necessary.

7.1.1 MDAS Setup

Configuration of the MDAS model involved subdivision of the Coal River watershed into modeling units. Flow and water quality for those units were continuously simulated using meteorological, landuse, point source loading, and stream data.

The watershed was broken into six separate watershed units based on the watershed groupings of impaired streams shown in Figure 3-2. These subwatersheds were further subdivided to allow evaluation of water quality and flow at pre-TMDL monitoring stations**.** This subdivision process also ensures a proper stream network configuration within the basin. The 299 total subwatershed delineations across all of the six watersheds are shown in Figure 7-1.

Modeled landuses contributing to metals loads include forest, cropland, pasture, urban/ residential pervious lands, urban/residential impervious lands, barren areas, roads, harvested forest, and abandoned mines. These sources were represented explicitly by consolidating existing GAP2000 landuse categories to create model landuse groupings. Several additional landuse categories were created to account for recent land disturbance activities (e.g., harvested forest, oil and gas operations, unpaved roads, and active mining) that are not represented in the GAP2000 landuse coverage. The process of consolidating and updating the modeled landuses is explained in further detail in the Technical Report. Other sources, such as AML seeps identified by WVDEP's source-tracking efforts, were modeled as direct, continuous-flow sources in the model.

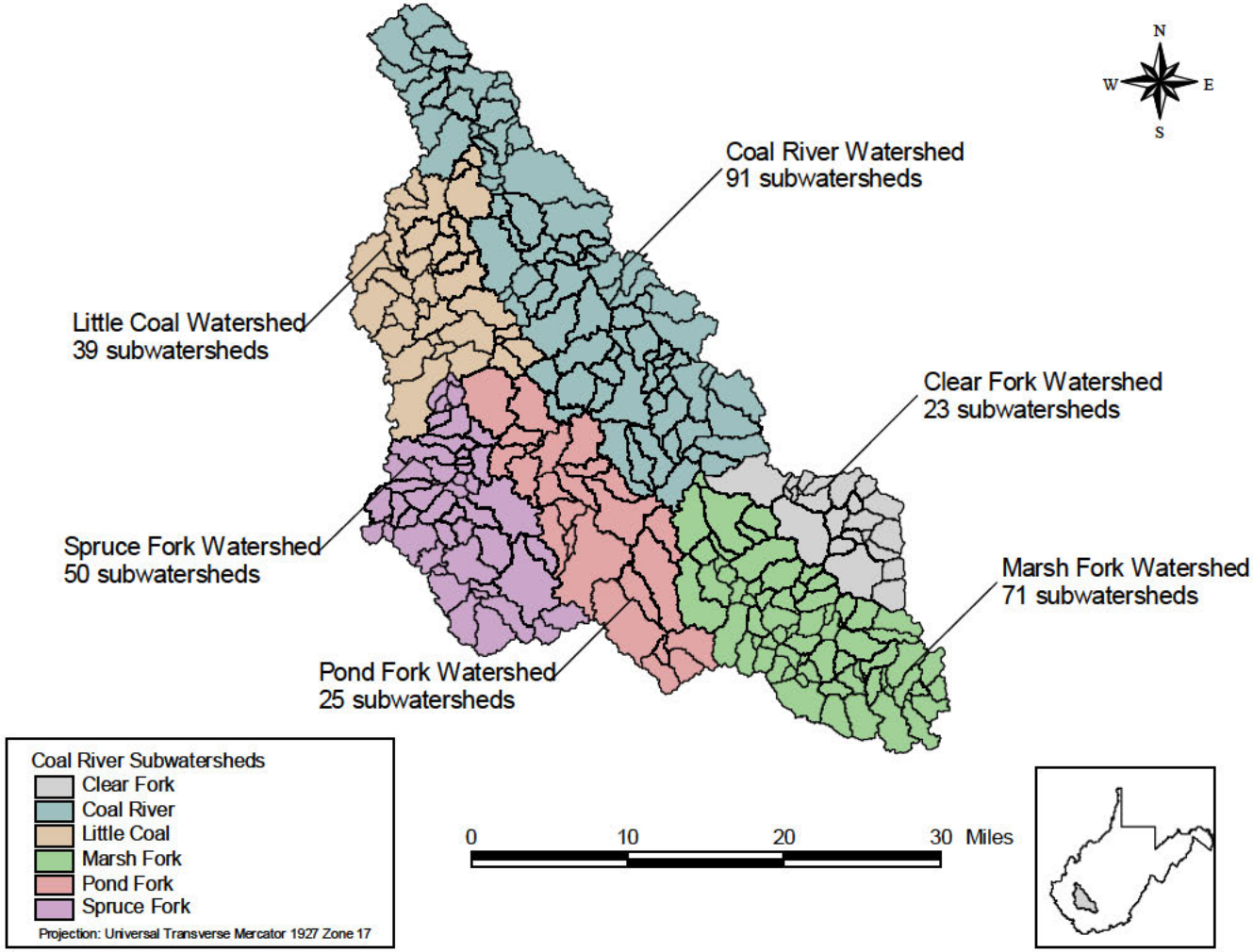


Figure 7-1. Coal River subwatershed delineation.

Modeled landuses contributing bacteria loads include pasture, cropland, urban/residential pervious lands, urban/residential impervious lands, and forest (including barren and wetlands). Other sources, such as failing septic systems, straight pipes, and permitted sources, were modeled as direct, continuous-flow sources in the model. The basis for the initial loading rates for landuses and direct sources are described in the Technical Report. The initial estimates were further refined during the model testing (calibration).

7.1.2 Hydrology Calibration

Hydrology and water quality calibration were performed in sequence because water quality modeling is dependent on an accurate hydrology simulation. Typically, hydrology calibration involves a comparison of model results to in-stream flow observations from USGS flow gauging stations throughout the watershed. There is one USGS flow gauging station in the Coal River watershed with adequate data records for hydrology calibration. A USGS gauging station operated on Rock Creek from 1979 to 1984. Hydrology calibration was based on observed data from that station and the landuses present in the watershed at that time. Key considerations for hydrology calibration included the overall water balance, the high-flow/low-flow distribution, storm flows, and seasonal variation. The model was calibrated to the observed data recorded on the Rock Creek watershed from March 1, 1979, to February 28, 1980. The hydrology was validated for the longer time period of October 1, 1979, to September 30, 1984. Final adjustments to model hydrology were based on flow measurements obtained during WVDEP's pre-TMDL monitoring in the Coal River watershed. Further description and a summary of the results of the hydrology calibration and validation are presented in the Technical Report.

7.1.3 Water Quality Calibration

Following hydrology calibration, the water quality was calibrated by comparing modeled versus observed in-stream metals and fecal coliform bacteria concentrations. The water quality calibration consisted of executing the MDAS model, comparing the model results to available observations, and adjusting water quality parameters within reasonable ranges. Ranges were based on previous watershed modeling experience in West Virginia (*pH and Metals TMDLs for the Tug Fork River Watershed* [USEPA 2002] and *Metals, pH, and Fecal Coliform TMDLs for the Upper Kanawha River Watershed, West Virginia* [WVDEP 2005]). Parameters for background conditions were established using observations from undisturbed areas.

As stated in Section 7.1, it was necessary to link MDAS with DESC-R to appropriately address dissolved aluminum TMDLs in the Coal River watershed. DESC-R was calibrated by adjusting water quality parameters to match the observed in-stream water quality data. Further description and a summary of the results of the DESC-R water quality calibration and validation are presented in the Technical Report.

7.2 Modeling Technique for Sediment

Stressor identification results indicated a need to reduce the contribution of excess sediment to certain biologically impaired streams in the Coal River watershed, as discussed in Section 6. As a result, sediment TMDLs were developed by integrating a watershed loading model that

quantified land-based loads and a stream routing model that examined stream bank erosion and depositional processes.

Selection of this modeling system for the development of sediment TMDLs was based on the evaluation of available technical and regulatory criteria. The key technical factors listed in Section 7.1 were also considerations in the model selection process for sediment TMDL development. Adequately representing erosion processes and non-point source loads in the watershed was a primary concern in selecting the appropriate modeling system.

Narrative criteria are included in West Virginia's water quality standards (Title 47 CSR 2–3.2.i), as discussed in Section 2 of this report. The narrative water quality criterion prohibits the presence of wastes in state waters that cause or contribute to significant adverse impacts on the chemical, physical, hydrologic, and biological components of aquatic ecosystems. This provision is the basis for "biological impairment" determinations. WVDEP assesses compliance with the narrative criteria by monitoring the benthic macroinvertebrate community. Sediment reductions are required to restore water quality and habitat conditions in many of the biologically impaired streams in the Coal River watershed.

A reference watershed approach was used to establish the acceptable level of sediment loading for each impaired stream on a watershed-specific basis. This approach was based on selecting a non-impaired watershed that shares similar landuse, ecoregion, and geomorphologic characteristics with the impaired watershed. Stream conditions in the reference watershed are assumed to be representative of the conditions needed for the impaired stream to attain its designated uses. Given these parameters and a non-impaired WVSCI score, the Spicelick Fork watershed in the Left Fork/Joes Creek subwatershed was selected as the reference watershed. The location of the Spicelick Fork watershed is shown in Figure 7-2.

Sediment loading rates were determined for impaired and reference watersheds. Both point and non-point sources were considered in the analysis, and numeric endpoints were based on the calculated sediment loading from the reference watershed. Sediment load reductions necessary to meet these endpoints and TMDL allocations were then determined. TMDL allocation scenarios were based on an analysis of the degree to which contributing sources could be reasonably reduced.

TMDLs were developed using BasinSim 1.0 (Dai et al., 2000), the Generalized Water Loading Functions (GWLF) model (Haith and Shoemaker, 1997), and the Stream Module (Tetra Tech, 2003). A variety of GIS tools, local watershed data, and observations were used to develop the input data needed for modeling and TMDL development.

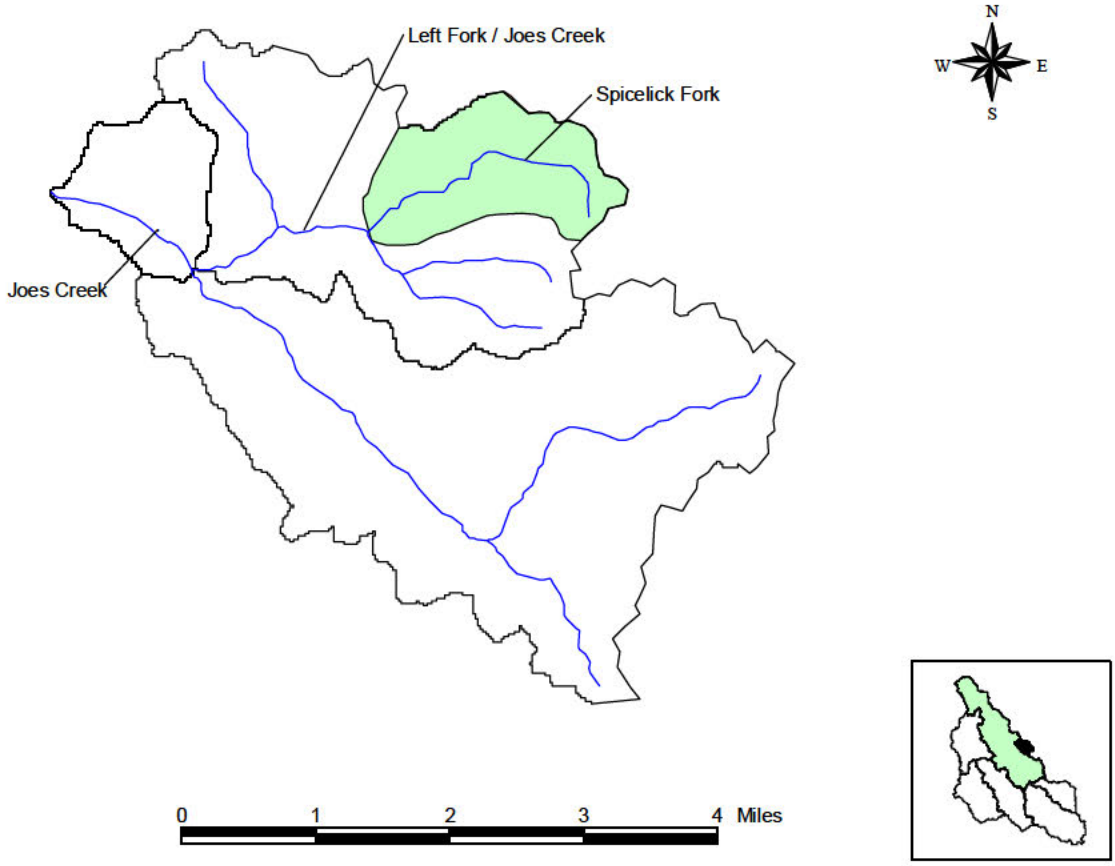


Figure 7-2. Location of the reference stream, Spicelick Fork watershed.

The GWLF model was used to estimate the sediment loads contributed by each modeled watershed. GWLF is a continuous-simulation model that simulates runoff, sediment, and nutrient loadings. GWLF modeling was accomplished using the BasinSim 1.0 watershed simulation program. BasinSim 1.0 is a Windows-based GIS platform that facilitates the execution of the GWLF model and development of model input data.

The Stream Module was used to model sediment transport/routing and stream bank erosion/deposition processes. The stream bank erosion simulation module employed the algorithm used in the Annualized Agricultural Non-point Source (AnnAGNPS) model (Bingner and Theurer 2000). Subwatershed loads calculated by GWLF and point source loads were input into the Stream Module to calculate the sediment loading to each stream channel and the load routed downstream. The Technical Report provides more detailed discussions on the technical approaches used for sediment modeling.

7.2.1 GWLF/Stream Module Setup

The GWLF/Stream Module was configured for each impaired and reference stream in the Coal River watershed. Modeled watersheds were subdivided to simulate hydrologic and sediment loading characteristics using available meteorological, landuse, point source loading, and stream data. Stream channel observational data provided by WVDEP were used to set up the Stream Module for the simulation of stream routing and erosion/deposition processes.

A continuous simulation period of 10 years (January 1, 1991 to September 30, 2001) is used in the hydrologic simulation analysis. An important factor driving model simulations is precipitation data. The pattern and intensity of rainfall affects erosion and the contribution of sediment from the land to the stream. In the GWLF model, the non-point source load calculation is affected by terrain conditions, such as the amount of forested land, land slope, soil erosion potential, and land disturbance activities, used in each modeled watershed. Various parameters can be adjusted in the model to account for these conditions and practices.

Modeled landuses include forest (including wetlands), cropland, pasture, urban/residential pervious lands, urban/residential impervious lands, barren areas, roads, oil and gas operations, harvested forest, surface mines, deep mines, and abandoned mines.

7.2.2 Hydrology Calibration

Hydrology calibration and water quality calibration were performed in sequence because water quality modeling was dependent on an accurate hydrology simulation. The modeling period was determined on the basis of the availability of weather and flow data that were collected during the same period. The USGS flow gauge (03198500) on Coal River at Ashford was used for hydrology calibration. Further description, and a summary of the results of the hydrology calibration and validation are presented in the Technical Report. The model was calibrated to the observed data recorded on the Coal River watershed from January 1, 1991, to July 31, 2001.

7.2.3 Water Quality Calibration

GWLF is an empirical model that was developed based on established relationships between rainfall, erosion, and sediment transport. The Universal Soil Loss Equation (USLE) and runoff curve numbers developed by the NRCS form the basis of the GWLF model. Given proper model setup and sediment source representation, water quality calibration is usually not required for this empirically based model. Water quality calibration was performed, however, to verify the accurate representation of landuses in each watershed and the parameter values used in model simulations. GWLF predicted average annual and monthly sediment loads for each modeled watershed. Those results were compared to available water quality data (TSS and turbidity data) and habitat data collected by WVDEP for each stream.

7.3 Selenium TMDL Approach

As discussed in Section 7-1, the TMDL approach must consider the dominant processes regarding pollutant loadings and in-stream fate. A pollutant flow analysis was performed using

measured flow data and the observed in-stream concentrations from pre-TMDL monitoring in order to evaluate critical flow periods for comparison to water quality criteria for selenium. Figures 7-3 and 7-4 show measured in-stream selenium concentrations with corresponding flow data that were collected from selenium impaired streams and the entire Coal River watershed, respectively. Corresponding flow data were available for only 26 % of the total selenium observations in the entire Coal River watershed and 25% for the selenium impaired streams. Furthermore, a large percentage of these samples (43% for selenium impaired streams and 90% for all data in the Coal River watershed), selenium concentrations were measured below the method detection limits of 5.0 ug/L. For the purposes of this analysis, all non-detect samples were represented at 2.5 ug/L. Using this limited dataset of detectable selenium concentrations with corresponding observed flow data, it was concluded that selenium concentration decreases with increased stream flow.

For the impaired tributaries in the Coal River watershed, the primary sources contributing to selenium impairments are assumed to be the point sources associated with mining activity. To address the perceived low-flow critical condition, WLAs for all mining point sources have been assigned equal to the value of water quality criteria. “Criteria end-of-pipe” allocations are also protective at higher flow conditions.

Nonpoint sources associated with surface disturbances (i.e., barren areas, unpaved roads, harvested forest, and oil and gas well operations) were considered to be negligible sources of selenium because these land disturbances typically do not disturb subsurface strata that contain selenium and because they were not significantly present in the selenium impaired watersheds. Furthermore, in other parts of the Coal River where such land uses are extremely prevalent, selenium impairment was not identified.

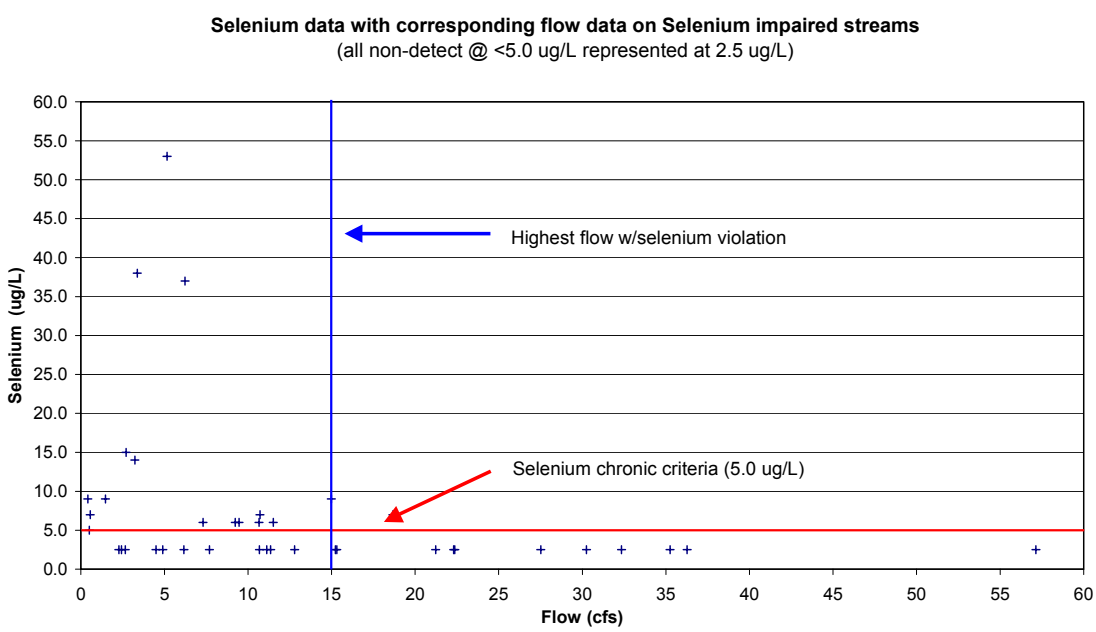


Figure 7-3. Selenium data with corresponding flow data on Selenium impaired streams

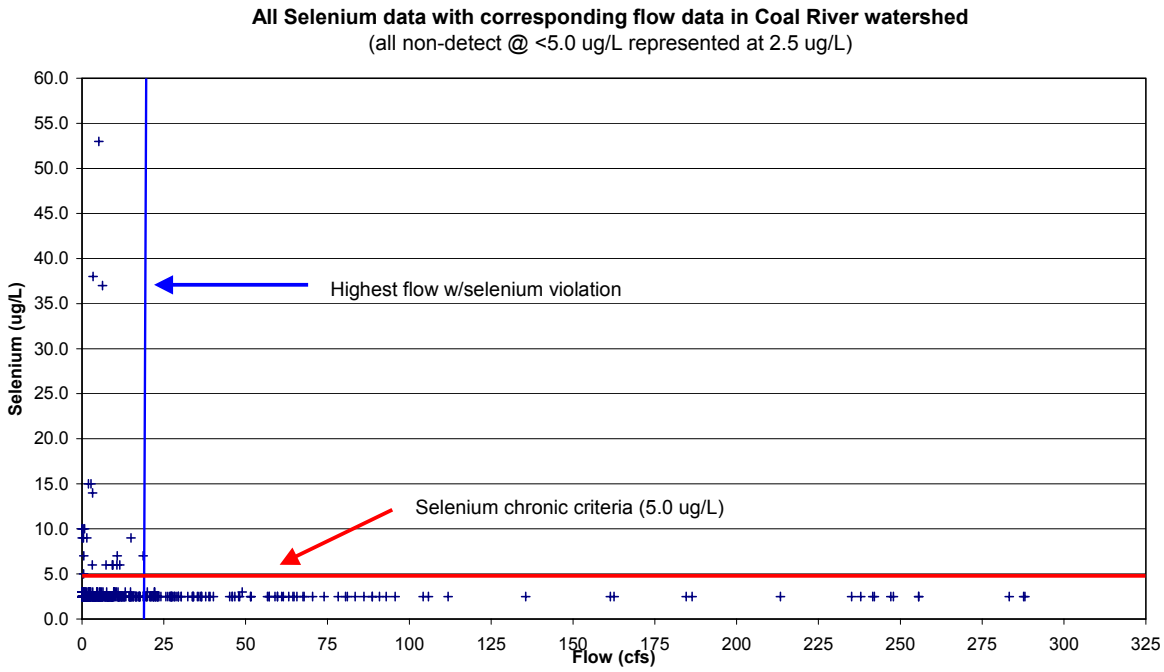


Figure 7-4. All Selenium data with corresponding flow data in Coal River watershed

7.4 Allocation Analysis

As explained in Section 2, a TMDL is composed of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for non-point sources, and natural background levels. In addition, the TMDL must include a margin of safety (MOS), implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. TMDLs can be expressed in terms of mass per time or other appropriate units. Conceptually, this definition is denoted by the equation:

$$\text{TMDL} = \text{sum of WLAs} + \text{sum of LAs} + \text{MOS}$$

To develop aluminum, iron, manganese, selenium, pH, fecal coliform bacteria, and sediment TMDLs for each of the waterbodies listed in Table 3-3 of this report, the following approach was taken:

- Define TMDL endpoints.
- Simulate baseline conditions.

- Assess source loading alternatives.
- Determine the TMDL and source allocations.

7.4.1 TMDL Endpoints

TMDL endpoints represent the water quality targets used to quantify TMDLs and their individual components. Different TMDL endpoints are necessary for dissolved aluminum, total iron, total manganese, selenium, pH, fecal coliform bacteria, and sediment. West Virginia's numeric water quality criteria for the subject pollutants (identified in Section 2) and an explicit MOS were used to identify endpoints for TMDL development. The TMDL endpoint for troutwaters (Hopkins Fork, Clear Fork above Dorothy and Marsh Fork above Sundial) is developed with respect to the troutwater iron criterion. Where applicable, TMDLs are presented as average annual loads because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year. Analysis of available data indicated that critical conditions occur during both high- and low-flow events. To appropriately address the low- and high-flow critical conditions, the TMDLs were developed using continuous simulation (modeling over a period of several years that captured precipitation extremes), which inherently considers seasonal hydrologic and source loading variability.

Dissolved Aluminum, Total Iron, Total Manganese, and Total Selenium
The TMDL endpoints for dissolved aluminum were selected as 712.5 micrograms per liter (µg/L; based on the 750 µg/L acute criterion for aquatic life minus a 5 percent MOS) and 82.7 µg/L (based on the 87 µg/L chronic criterion for aquatic life minus a 5 percent MOS). The endpoint for total iron in warmwater fisheries was selected as 1.425 mg/L (based on the 1.5 mg/L criterion for aquatic life in warmwater fisheries minus a 5 percent MOS). The endpoint for total iron in troutwaters was selected as 0.425 mg/L (based on the 0.5 mg/L criterion for aquatic life in troutwaters minus a 5 percent MOS). The endpoint for total manganese was selected as 0.95 mg/L (based on the 1.0 mg/L criterion for human health minus a 5 percent MOS). Components of the TMDLs for aluminum, iron, and manganese are presented as average annual loads in pounds of pollutant per year.

In meeting the West Virginia water quality criterion for selenium at the end-of-pipe for the surface mining point sources, there will be no excessive contribution of selenium to the streams in the Coal River watershed at the low flow 7Q10 conditions where the assimilative capacity is lowest. This results in the inclusion of an implicit margin of safety. Determination of an explicit margin of safety is not necessary for these particular TMDLs because in presenting the allocations as a concentration at the water quality criteria for selenium the sources will comply with the water quality standards and there will be no uncertainty involved.

Fecal Coliform Bacteria
The endpoint for fecal coliform bacteria was selected as the instantaneous endpoint of 380 counts/100 mL (based on the 400 counts/100 mL criterion for human health minus a 5 percent MOS) and the geometric mean endpoint of 190 counts/100 mL (based on the 200 counts/100 mL geometric mean criterion minus a 5 percent MOS). The instantaneous criterion is more stringent and more difficult to obtain; however, both criteria are satisfied in this TMDL. Components of

the TMDLs for fecal coliform bacteria are presented as average annual loads in terms of total counts (fecal coliform colonies) pollutant per year.

pH

The water quality criteria for pH allow no values below 6.0 or above 9.0. With respect to acid mine drainage, pH is not a good indicator of the acidity in a waterbody and can be a misleading characteristic. Water with near-neutral pH (~ 7) but containing elevated concentrations of dissolved ferrous (Fe^{2+}) ions can become acidic after oxidation and precipitation of the iron (PADEP 2000). Therefore, a more practical approach to meeting the water quality criteria for pH is to use the concentration of metal ions as a surrogate for pH. It was assumed that reducing in-stream metals (iron and aluminum) concentrations to meet water quality criteria (or TMDL endpoints) would result in meeting the water quality standard for pH. This assumption was verified by applying DESC-R. By executing DESC-R under TMDL conditions (conditions in which TMDL endpoints for metals were met), the equilibrium pH could be predicted. The Technical Report contains a detailed description of the pH modeling approach. The TMDLs for the pH-impaired streams are presented as the median equilibrium pH that is calculated based on the daily equilibrium pH output (6-year simulation period associated with the design precipitation from January 1, 1987 through December 31, 1992) from DESC-R.

Sediment

The endpoints for the sediment TMDLs were based on the simulated reference watershed sediment loading (from the Spicelick Fork of the Left Fork /Joes Creek watershed). A 5 percent MOS was applied to the reference sediment load, and the sediment load reductions necessary to meet those endpoints were then determined. TMDL allocation scenarios were developed based on an analysis of the degree to which contributing sources could be reasonably reduced. Components of the TMDLs for sediment are presented as average annual loads in tonnes of pollutant per year.

Margin of Safety

A 5 percent explicit MOS was used to counter uncertainty in the modeling process. Long-term water quality monitoring data were used for model calibration. Although these data represented actual conditions, they were not of a continuous time series and might not have captured the full range of in-stream conditions that occurred during the simulation period. The explicit 5 percent MOS also accounts for those cases where monitoring might not have captured the full range of in-stream conditions.

An implicit margin of safety was included in selenium TMDLs where wasteload allocations were prescribed for the surface mining point sources at water quality criteria at the end-of-pipe. Under these conditions, there will be no excessive contribution of selenium to the streams in the Coal River watershed at the low flow 7Q10 conditions where the assimilative capacity is lowest. Determination of an explicit margin of safety is not necessary for these particular TMDLs because in presenting the allocations as a concentration at the water quality criteria for selenium the sources will comply with the water quality standards and there will be no uncertainty involved. As discussed previously, an implicit margin of safety is applied in selenium TMDLs.

7.4.2 Baseline Conditions and Source Loading Alternatives

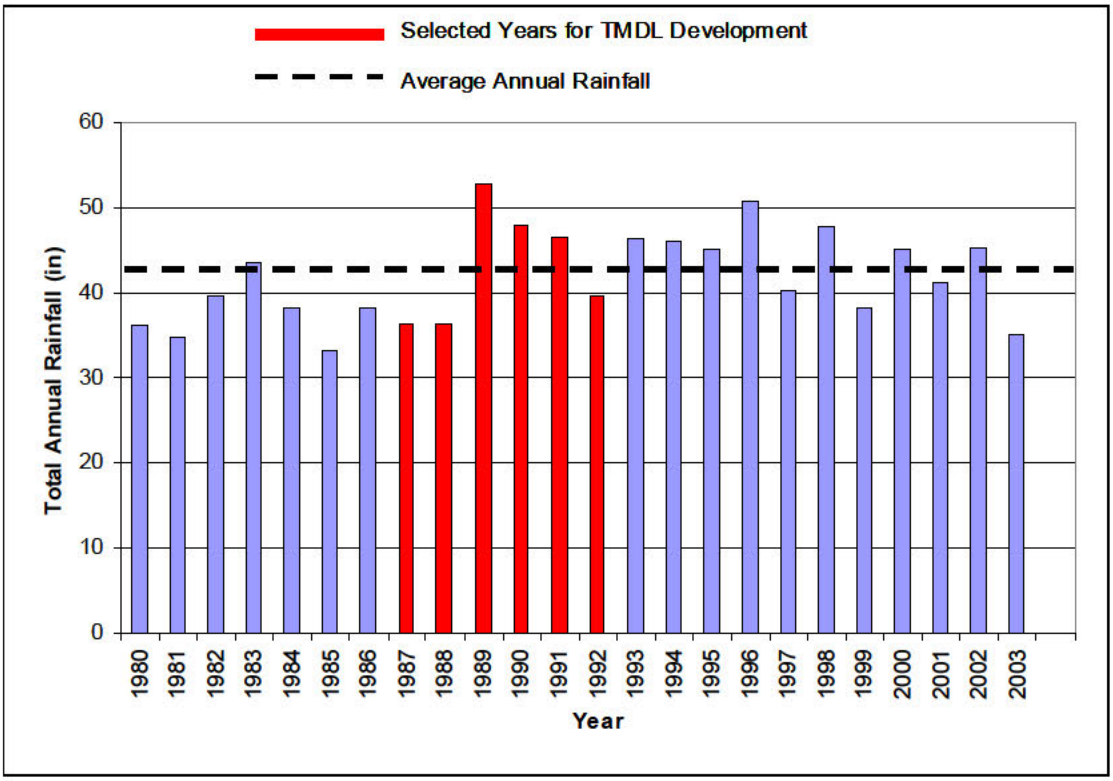
The calibrated model provides the basis for performing the allocation analysis. The first step is to simulate baseline conditions, which represent existing non-point source loadings and point sources loadings at permit limits. Baseline conditions allow for an evaluation of in-stream water quality under the highest expected loading conditions.

Baseline Conditions for MDAS

The MDAS model was run for baseline conditions using hourly precipitation data for a representative 6-year simulation period (January 1, 1987 through December 31, 1992). The precipitation experienced over this period was applied to the landuses and pollutant sources as they existed at the time of TMDL development. Predicted in-stream concentrations were compared directly to the TMDL endpoints. Using the model linkage described in Section 7.1, total aluminum was simulated using MDAS, and DESC-R was used to compare predicted dissolved aluminum concentrations to the TMDL endpoint. This comparison allowed for the evaluation of the magnitude and frequency of exceedances under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods.

Permitted conditions for mining facilities were represented during baseline conditions using precipitation-driven flow estimations and the metals concentrations presented in Table 7-1. Permitted conditions for fecal coliform bacteria point sources were represented during baseline conditions using the design flow for each facility and the monthly average effluent limitation of 200 counts/100 mL.

Figure 7-5 presents the annual rainfall totals for the years 1980 through 2003 at the Charleston Yeager Airport weather station in Charleston, West Virginia. The years 1987 to 1992 are highlighted to indicate that a range of precipitation conditions was used for TMDL development in the Coal River watershed.



Note: Rainfall totals for 2003 are from 1/1/2003 through 7/31/2003

Figure 7-5. Annual precipitation totals and percentile ranks for the Charleston Yeager Airport weather station in Charleston, West Virginia.

Table 7-1. Metals concentrations used in representing permitted conditions for mines

Pollutant	Technology-based Permits	Water Quality-based Permits
Aluminum, total	3.95 mg/L (98th percentile DMR values)	3.95 mg/L (98th percentile DMR values)
Iron, total	3.2 mg/L	1.5 mg/L
Manganese, total	2.0 mg/L	1.0 mg/L

Baseline Conditions for GWLF

The calibrated GWLF model provided the basis for performing the allocation analysis. The first step was to simulate baseline conditions, which allowed for an evaluation of in-stream water quality under the highest expected loading conditions. The pollutant loadings from non-point sources were modeled based on precipitation and runoff; non-mining point sources were represented at design flow and the TSS limits of their permits. The GWLF model was run for baseline conditions using daily precipitation data for the representative period discussed earlier. The precipitation data were applied to the landuses and pollutant sources that existed at the time of TMDL development. The resultant predicted watershed loadings were then compared directly

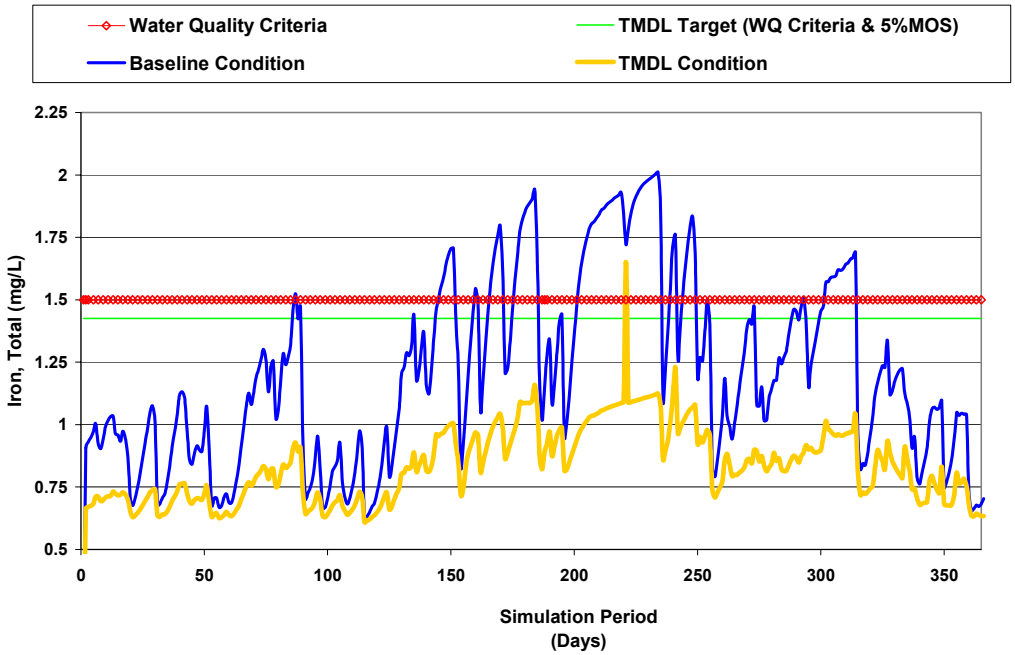


Figure 7-6. Example of baseline and TMDL conditions for total iron.

7.5 TMDLs and Source Allocations

7.5.1 Dissolved Aluminum, Total Iron, Total Manganese, and pH TMDLs

TMDLs and source allocations were developed on a subwatershed basis for each of the six watersheds in the Coal River watershed shown in Figure 3-3. A top-down methodology was followed to develop these TMDLs and allocate loads to sources. Headwaters were analyzed first because their loading affects downstream water quality. Loading contributions were reduced from applicable sources in these waterbodies, and TMDLs were developed. The loading contributions of unimpaired headwaters and the reduced loadings for impaired headwaters were then routed through downstream waterbodies. Using this method, contributions from all sources were weighted equitably. Reductions in sources affecting impaired headwaters ultimately led to improvements downstream and effectively decreased necessary loading reductions from downstream sources. Non-point source reductions did not result in loadings less than natural conditions, and point source allocations were not more stringent than numeric water quality criteria.

The following general methodology was used when allocating to sources for the Coal River watershed TMDLs. In certain subwatershed dominated by permitted discharges, DEP may have altered the general allocation approach to a sensitivity analysis.

to the TMDL endpoint. Similar to MDAS, this comparison allowed evaluation of sediment loadings under a range of hydrologic and environmental conditions, including dry, wet, and average periods.

Source Loading Alternatives

Simulating baseline conditions allowed for the evaluation of each stream's response to variations in source contributions under a variety of hydrologic conditions. This sensitivity analysis gave insight into the dominant sources and the mechanisms by which potential decreases in loads would affect in-stream pollutant concentrations. The loading contributions from abandoned mines and other non-point sources were individually adjusted; the modeled in-stream concentrations were then evaluated.

Multiple allocation scenarios were run for the impaired waterbodies. Successful scenarios were those which achieved the TMDL endpoints under all flow conditions throughout the modeling period. For dissolved aluminum scenario development, the DESC-R output was compared directly to the TMDL endpoint. If the predicted dissolved aluminum concentrations exceeded the TMDL endpoint, the total aluminum sources represented in MDAS were reduced. The averaging period and allowable exceedance frequency associated with West Virginia water quality criteria were considered in these assessments. In general, loads contributed by sources that had the greatest impact on in-stream concentrations were reduced first. If additional load reductions were required to meet the TMDL endpoints, less significant source contributions were subsequently reduced.

Figure 7-6 shows an example of model output for a baseline condition and a successful TMDL scenario.

For watersheds with AMLs but no permitted point sources, AML loads were reduced first, until in-stream water quality criteria were met or until conditions no less than those of undisturbed forest. If further reductions were required, the loads from sediment sources (harvested forest, burned forest, barren land, oil and gas operations, and roads) were reduced until water quality criteria were met.

- For watersheds with AMLs and point sources, point sources were set at the precipitation induced load defined by the permit limits and AML loads were subsequently reduced. Loads from AMLs and revoked-permit mines were reduced (point sources were not reduced) until in-stream water quality criteria were met, if possible. If further reduction was required once loads from AMLs and revoked-permit mines were reduced, sediment sources were reduced. If even further reduction was required, the technology based permitted point source discharge limits were reduced.

- For watersheds where dissolved aluminum TMDLs were developed, source allocations for total iron and manganese were developed first because their total in-stream concentrations (primarily iron) significantly reduce pH and consequently increase dissolved aluminum concentrations. If the dissolved aluminum TMDL endpoint was not attained after source reductions to iron and manganese, the total aluminum source loadings were reduced based on the methodology described above.

Wasteload Allocations

WLAs were calculated for all permitted mining operations. Exceptions to this method were limestone quarries and those with a Completely Released or Phase Two Released SMCRA permit classification. Programmatic reclamation was assumed to have restored those permitted areas. The TMDLs assign WLAs that afford continued operation under those terms and conditions. Loading from revoked-permit facilities was assumed to be a non-point source contribution based on the absence of a permittee.[1]

The WLAs for individual NPDES permits for aluminum, iron, and manganese are shown in the allocation spreadsheets associated with this report. The dissolved aluminum TMDLs were based on a dissolved aluminum TMDL endpoint; however, sources were represented in terms of total aluminum. Wasteload allocations for aluminum are also provided in total metal form. The WLAs are presented as annual loads, in pounds per year and as constant concentrations. The concentration allocations can be converted to monthly averages and daily maximum effluent limitations using USEPA's *Technical Support Document for Water Quality-based Toxics Control* (USEPA 1991). WLA concentration ranges are as follows: aluminum: 0.75–3.72 mg/L, iron: 1.5–3.2 mg/L, manganese: 1.0–2.0 mg/L.

[1] The decision to assign load allocations to abandoned and reclaimed mine lands does not reflect any determination by WVDEP as to whether there are unpermitted point source discharges within these landuses. In addition, in establishing these TMDLs with mine drainage discharges treated as load allocations, WVDEP is not determining that these discharges are exempt from NPDES permitting requirements.

In certain instances, prescribed wasteload allocations may be less stringent than existing effluent limitations. However, the TMDLs are not intended to relax effluent limitations that were developed under alternative bases.

WVDEP's implementation of the antidegradation provisions of the Water Quality Standards may result in more stringent allocations than those resulting from the TMDL process. Whereas TMDLs prescribe allocations that minimally achieve water quality criteria (100 percent use of a stream's assimilative capacity). The antidegradation provisions of the standards are designed to maintain the existing quality of high-quality waters and may result in more stringent allocations that limit the use of remaining assimilative capacity.

TMDL allocations reflect pollutant loadings that are necessary to achieve water quality criteria at distinct locations (i.e., the pour points of delineated subwatersheds). In the permitting process, effluent limitation development is based on the achievement/maintenance of water quality criteria at the point of discharge. Water quality-based effluent limitation development in the permitting process may dictate more stringent effluent limitations for upstream discharge locations.

Load Allocations (LAs)
Load Allocations (LAs) were made for the dominant source categories as follows,

- AMLs, including abandoned mines (surface and deep) and highwalls
- Revoked permits: loading from revoked-permit facilities/bond forfeiture sites
- Sediment sources: metals loading associated with sediment contributions from barren land, harvested forest, burned forest, oil and gas well operations, and roads
- Other non-point sources: urban/residential, agricultural, and forested land contributions (loadings from other non-point sources were not reduced)

The LAs for aluminum, iron, and manganese are presented in the allocation spreadsheets associated with this report. The dissolved aluminum TMDLs are based on a dissolved aluminum TMDL endpoint; however, sources are represented in terms of total aluminum. The LAs for aluminum are also provided in the form of total metal. The LAs are presented as annual loads (pounds per year) because they were developed to meet TMDL endpoints under a range of flow conditions.

The iron, manganese, and aluminum TMDLs are presented in Appendix A for the impaired streams within each of the Coal River watersheds.

As stated in Section 7.4.1, a surrogate approach was used for the pH TMDLs where it was assumed that reducing in-stream metals (iron and aluminum) concentrations to meet water quality criteria (or TMDL endpoints) would result in attainment of the water quality criterion. This assumption was verified by running DESC-R for an extended period (6 years) under conditions where TMDL endpoints for metals were met. A long-term daily average equilibrium

pH was calculated based on the daily equilibrium pH output from DESC-R. These results are shown in Appendix A for the pH-impaired streams within each of the selected Coal River watersheds. Refer to the Technical Report for a detailed description of the pH modeling approach.

Selenium TMDLs

The following general methodology was used in allocating to sources for the selenium TMDLs in the Coal River Watershed:

- Non-point sources in the watershed did not appear to be contributing excessive loads of selenium to the watershed and, therefore, are not required to reduce loadings.

- The WLAs were determined by assigning water quality criteria at the end-of-pipe (5.0 ug/L) to all surface mining operations discharging in the selenium impaired watersheds.

The selenium TMDLs are presented in Appendix A for the impaired streams within Coal River, Pond Fork, and Spruce Fork watersheds. The WLAs for selenium are presented in the allocation spreadsheets associated with this report.

7.5.2 Fecal Coliform Bacteria TMDLs

TMDLs and source allocations were developed for impaired segments of selected steams and their tributaries on a subwatershed basis for each of the six watersheds in the Coal River watershed shown in Figure 3-2. As described in Section 7.5.1, a top-down methodology was followed to develop these TMDLs and allocate loads to sources.

The following general methodology was used when allocating loads to sources for the fecal coliform bacteria TMDLs. All point sources in the watershed were set at the permit limit (200 counts/100 mL monthly average). Because West Virginia Bureau for Public Health regulations prohibit discharge of raw sewage into surface waters, all illicit, non-disinfected discharges of human waste (from failing septic systems and straight pipes) were eliminated.

Sanitary sewer overflows (SSOs) are illegal under NPDES regulations; all such discharges were also eliminated. If further reduction was necessary, combined sewer overflows (CSOs) and non-point source loadings from agricultural lands and residential areas were subsequently reduced until in-stream water quality criteria were met.

Wasteload Allocations (WLAs)

WLAs were developed for all facilities permitted to discharge fecal coliform bacteria, including MS4s, as described below. Applicable fecal coliform effluent limitations are more stringent than water quality criteria; therefore, all permitted fecal coliform sources were represented by the monthly average fecal coliform limit of 200 counts/100 mL and no reductions were applied. The WLAs for individual NPDES permits for fecal coliform bacteria are shown in the Fecal Allocation spreadsheets associated with this report. The fecal coliform bacteria WLAs are presented as annual loads, in counts per year. They are presented on an annual basis (as an average annual load) because they were developed to meet TMDL endpoints under a range of conditions observed throughout the year.

Municipal Separate Storm Sewer System (MS4)
USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for all stormwater discharges from municipal separate storm sewer systems (MS4s). There is one designated MS4 municipality in the six TMDL watersheds within the Coal River watershed: the City of Saint Albans. This municipality has filed a Notice of Intent for MS4 permit issuance; the area within the corporate limits is therefore assumed to be subject to MS4 stormwater permitting. The City of Saint Albans MS4 system was provided a fecal coliform wasteload allocation that is presented in Table 7-2. Stormwater permits and their relationship to TMDLs are discussed further in the appendices of the Technical Report.

Table 7-2. Individual fecal coliform MS4 WLAs for the City of Saint Albans

Town	Parameter	Baseline WLA (counts/yr)	WLA (counts/yr)	% Reduction
City of Saint Albans	Fecal Coliform	1.49E+13	1.46E+13	1.9

Load Allocations (LAs)
LAs were assigned as required to the following the source categories:

- Pasture/Grassland — including pasture, successional grasslands, and croplands
- Onsite Sewage Systems — loading from all illicit, non-disinfected discharges of human waste (including failing septic systems and straight pipes)
- Residential — loading associated with urban/residential runoff
- Background and Other Non-point Sources — loading associated with wildlife sources from forested land (contributions/loadings from wildlife sources were not reduced)

The fecal coliform bacteria LAs are presented as annual loads, in counts per year, in the spreadsheets associated with this report. The fecal coliform bacteria TMDLs are presented in the subwatershed appendices for the impaired streams within each of the Coal subwatersheds.

7.5.3 Sediment TMDLs

When allocating to landuse-based sediment sources, a unit area loading approach was used to establish equitable source allocations. This approach was based on the assumptions that point sources subject to water pollution control permits provide the highest degree of sediment control. Activities that are subject to programmatic BMPs contribute less sediment than do uncontrolled sources. Therefore, sediment sources were reduced systematically in a stepwise fashion until the TMDL endpoint was achieved, as follows:

Step 1: Loads from uncontrolled sediment sources (barren areas, burned forest, and unpaved roads) were reduced to the unit area loading of programmatic BMP sources (harvested forest and oil and gas operations).

Step 2: If further reductions were required, loads from uncontrolled sediment sources and programmatic BMP sources were together reduced to the unit area loading of point sources.

Step 3: If even further reductions were required to meet the TMDL endpoint, loads from all sediment sources were reduced to the extent necessary to achieve the reference watershed loading. These sediment source reductions were based on their relative contribution to the overall sediment load.

After the land-use-based sources were reduced, sediment produced from in-stream processes (bank erosion/deposition) were evaluated for each sediment-impaired stream. The Stream Module predicted bank erosion based upon the soil characteristics and slope of the subwatershed and the rating of bank erosion severity by WVDEP. The Stream Module output displayed the sediment load exiting each subwatershed after accounting for both bank erosion and deposition. This allowed interpretation of the significance of bank erosion at the subwatershed level. If, after reduction of land-use-based sediment loadings to those of the reference watershed, the Stream Module predicted an excess sediment load exiting the modeled subwatershed, then sediment load allocations were prescribed for bank erosion.

Load allocations were not prescribed in other subwatersheds with lesser predicted severity of bank erosion. The lack of load allocations for bank erosion should not be construed to prohibit stream restoration projects that are designed to improve instream or riparian zone habitat, or to mitigate existing sediment bed loads.

Wasteload Allocations (WLAs)

WLAs were made for all permitted mining operations except limestone quarries and those with a Completely Released or Phase Two Released SMCRA permit classification. Programmatic reclamation was assumed to have restored those permitted areas.

Sediment modeling of active mining operations represented the contemporaneous reclamation practices employed by the industry and the removal efficiency associated with treatment structures. WLAs are presented as average annual loads and concentrations in the allocation spreadsheets associated with this report.

Within the sediment-impaired watersheds, there are sources that have sewage permits. Wasteload allocations for sewage treatment facilities recognize the 30 mg/L monthly average TSS effluent limitations contained in permits. Under this TMDL, the wasteload allocations for these sources do not require pollutant reductions and are authorized to continue operation under existing permit conditions. The WLAs are presented as average annual loads, in tonnes per year and are shown in the allocation spreadsheets associated with this report.

At the time of TMDL development, there were three construction stormwater permits in the sediment-impaired watersheds. A provision for future growth related to construction activity is provided and explained in Section 8.

Load Allocations
LAs were assigned as required to the following non-point source categories:

- Pasture/Grassland — including pasture, succession grasslands, and croplands
- Barren land areas — including barren and burned forest areas
- Harvested forest — including skid roads and landing areas
- Residential — sediment loading associated with urban/residential runoff
- Roads — including paved and unpaved roads
- In-stream processes — bank erosion and deposition
- Other non-point sources — forested land (loadings from other non-point sources were not reduced)

The sediment LAs are presented as average annual loads, in tonnes per year, and are shown in the allocation spreadsheets associated with this report.

7.5.4 Seasonal Variation

The TMDL must consider seasonal variation. For the Coal River watershed metals and fecal coliform TMDLs, seasonal variation was considered in the formulation of the modeling analysis. Continuous simulation (modeling over a period of several years that captured precipitation extremes) inherently considers seasonal hydrologic and source loading variability**.** The metals and fecal coliform concentrations simulated on a daily time step by the model were compared to TMDL endpoints. Allocations that met these endpoints throughout the modeling period were developed.

7.5.5 Critical Conditions

TMDL developers must select the environmental conditions that will be used for defining allowable loads. Many TMDLs are designed around the concept of a “critical condition.” The critical condition is the set of environmental conditions, which, if met, will ensure the attainment of objectives for all other conditions. Non-point source loading is typically precipitation-driven. In-stream impacts tend to occur during wet weather and storm events that cause surface runoff to carry pollutants to waterbodies. During dry periods little or no land-based runoff occurs, and elevated in-stream pollutant levels may be due to point sources (Novotny and Olem 1994). Analysis of water quality data for the Coal River watershed shows high pollutant concentrations during both high and low flow, indicating that there are both point and non-point source impacts. Both high-flow and low-flow periods were taken into account during TMDL development by using a long period of weather data that represented wet, dry, and average flow periods.

8. FUTURE GROWTH AND WATER QUALITY TRADING

8.1 Metals and pH

This TMDL does not include specific future growth allocations to each subwatershed. However, the absence of specific future growth allocations does not prohibit new mining in the subwatersheds for which iron, aluminum, manganese, and selenium TMDLs have been developed. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits must be "consistent with the assumptions and requirements of any available wasteload allocation for the discharge...." In addition, the federal regulations generally prohibit issuance of a permit to a new discharger "if the discharge from its construction or operation will cause or contribute to the violation of water quality standards." A discharge permit for a new discharger could be issued under the following scenarios:

1. A new facility could be permitted anywhere in the watershed, provided that effluent limitations are based on the achievement of water quality standards at end-of-pipe for the pollutants of concern in the TMDL.

   NPDES permitting rules mandate effluent limitations for metals to be prescribed in the total recoverable form. For iron, manganese, and selenium, the West Virginia water quality criteria are in total recoverable form and may be directly implemented. Because aluminum water quality criteria are in dissolved form, a dissolved/total pollutant translator is needed to determine effluent limitations. A new facility could be permitted in the watershed of a dissolved aluminum-impaired stream if total aluminum effluent limitations are based on the dissolved aluminum, chronic, aquatic life protection criterion and a dissolved/total aluminum translator equal to 1.0.

2. Remining (under an NPDES permit) could occur without a specific allocation to the new permittee, provided that the requirements of existing State remining regulations are met. Remining activities will not worsen water quality and in some instances may result in improved water quality in abandoned mining areas.

3. Reclamation and release of existing permits could provide an opportunity for future growth provided that permit release is conditioned on achieving discharge quality better than the WLA prescribed by the TMDL.

8.2 Fecal Coliform Bacteria

This TMDL does not include specific future growth allocations to each subwatershed. However, the absence of specific future growth allocations does not prohibit new development in the subwatersheds for which fecal coliform TMDLs have been developed or preclude permitting of new sewage treatment facilities.

In many cases, the implementation of the TMDLs will consist of providing public sewer service to unsewered areas. The NPDES permitting procedures for sewage treatment facilities include technology-based fecal coliform effluent limitations that are more stringent than applicable water

quality criteria. Therefore, a new sewage treatment facility may be permitted anywhere in the watershed, provided that the permit includes monthly average and maximum daily fecal coliform limitations of 200 counts/100 mL and 400 counts/100 mL, respectively. Furthermore, WVDEP will not authorize construction of combined collection systems or permit overflows from newly constructed collection systems.

8.3 Sediment

New mining point sources may be permitted anywhere in the sediment-impaired watersheds provided that the permit contains an annual average TSS effluent limitation of 120 mg/L. This value represents the most stringent WLA assigned to existing mining sources and is comparable to the background sediment loading associated with undisturbed forest. Consequently, WVDEP has concluded that discharges in compliance with this limitation will not cause or contribute to a violation of water quality standards.

Non-mining point source discharges are assigned technology-based TSS effluent limitations that would not cause biological impairment. For example, NPDES permits for sewage treatment and industrial manufacturing facilities contain monthly average TSS effluent limitations between 30 and 60 mg/L. New non-mining point sources may also be permitted in the sediment-impaired watersheds with the implementation of applicable technology-based TSS requirements.

In addition to the three construction stormwater permits in the sediment-impaired watersheds, specific future growth allowances are provided. In general, the successful TMDL allocation scenarios allow for 0.5 percent of the area of sediment-impaired watersheds to be disturbed subject to the terms and conditions of the Construction Stormwater General Permit. At least 10 acres are provided in smaller watersheds. The reserved acreage is expected to accommodate future development in the subject watersheds. If development projects are proposed in excess of the acreage provided, they may be permitted by implementing controls beyond those afforded by the general permit. Larger areas may be permitted if it can be demonstrated that tighter controls will result in a loading condition commensurate with the general permit area allocations provided in Table 8-1.

Table 8-1. Future growth for construction stormwater permits

Subwatershed	Sediment-impaired Stream	Total Watershed Area (acres)	Future Growth Area – 0.5% Total Watershed Area (Acres)
Clear Fork	Lick Run	1,145	10.0
Clear Fork	Stonecoal Branch	356	10.0
Coal River	Browns Creek	7,060	35.3
Coal River	Brush Creek	5,882	29.4
Coal River	Ridgeview Hollow	357	10.0
Coal River	Sandlick Creek (WVKC-31-A)	3,983	19.9
Coal River	Smith Creek	4,465	23.3

Subwatershed	Sediment-impaired Stream	Total Watershed Area (acres)	Future Growth Area – 0.5% Total Watershed Area (Acres)
Little Coal River	Big Horse Creek	18,964	94.8
Little Coal River	Dodson Creek	4,215	21.1
Little Coal River	Little Horse Creek	2,293	11.5
Marsh Fork	Millercamp Branch	11,401	57.0
Marsh Fork	Sandlick Creek (WVKC-46-J)	12,930	64.7
Marsh Fork	Right Fork/Sandlick Creek	2,848	14.2
Marsh Fork	Surveyor Creek	4,223	21.1
Pond Fork	Pond Fork	88,000	440.0
Pond Fork	Casey Creek	3,089	15.4
Pond Fork	West Fork	27,067	139.3
Spruce Fork	Baldwin Fork	1,846	10.0
Spruce Fork	Spruce Laurel Fork	20,442	102.2

8.4 Water Quality Trading

This TMDL neither prohibits nor authorizes trading in the watersheds addressed in the document. WVDEP generally endorses the concept of trading and recognizes that it might become an effective tool for TMDL implementation. However, significant regulatory framework development is necessary before large-scale trading in West Virginia can be realized. Furthermore, WVDEP supports program development assisted by a consensus-based stakeholder process. Before the development of a formal trading program, it is conceivable that the regulation of specific point source-to-point source trading might be feasible under the framework.

9. PUBLIC PARTICIPATION

9.1 Public Meetings

Informational public meetings were held on September 28, 2004 at Sherman High School, Boone County, WV, and on September 30, 2004 at Saint Albans High School, Kanawha County, WV. Detailed information was presented relative to WVDEP's proposed allocation strategies. Three public meetings will be held to present the draft TMDLs: September 27, 2005, at Sherman High School in Seth; September 28, 2005 at Saint Albans High School; and the final public meeting at Scott High School in Madison. All meetings start at 7:00 PM.

9.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised in local newspapers on various dates between September 12, 2005 and September 15, 2005. Interested parties may submit comments during the public comment period, which begins on September 16, 2005 and ends October 17, 2005. The electronic documents are available on the WVDEP's internet site at http://www.dep.state.wv.us/

9.3 Response Summary

Special Note: This Section discusses DEP response to comments received after the public notice of the original Draft Coal River Watershed TMDLs in September 2005. In July 2006, DEP provided public notice of revised, draft dissolved aluminum TMDLs (Coal River Watershed Dissolved Aluminum TMDL Addendum) and an additional public comment period. DEP responses to comments received pursuant to the dissolved aluminum addendum are contained within that document.

The West Virginia Department of Environmental Protection (WVDEP) is pleased to provide this response to comments on the draft TMDLs. The WVDEP appreciates the efforts commenters have put forth to improve the West Virginia TMDL development process. The following entities provided written comments on the draft TMDLs:

- West Virginia Coal Association
- Massey Coal Services, Inc.
- Vernon Haltom
- United States Environmental Protection Agency Region 3

Comments have been compiled and responded to in this response summary. Comments and comment summaries are in boldface and italic. Agency responses appear in plain text.

Comments received from the United States Environmental Protection Agency Region 3 included various suggested typographical /editorial revisions. Although not individually detailed in this summary, WVDEP considered all such comments and revised both the main report and subwatershed appendices, as appropriate.

1) Two commenters expressed concern relative to the presentation of TMDLs for streams/impairments not included on the West Virginia 2004 Section 303(d) list. One contended that the practice constitutes an illegal extension of the 303(d) list and that streams must be "listed" prior to TMDL development. One questioned if DEP has amended or plans to amend the 2004 Section 303(d) list to include the subject waters. Both commenters requested identification of streams not included on the 303(d) list for which TMDLs are presented.

Given the large number of impaired West Virginia waters and the limited resources for TMDL development, DEP's program must focus on efficiency. When working in a specific geographical

area, all impaired waters and all impairments of those waters are attempted to be addressed. Although DEP's pre-TMDL monitoring activities are among the most robust efforts implemented nationally, monitoring frequency, duration and sample location resolution are insufficient to comprehensively assess water quality consistent with the exposure duration and exceedence frequency components of applicable water quality criteria. Water quality modeling is therefore necessary.

DEP has decided to present TMDLs for all named and coded waters where predictive modeling indicates that existing pollutant reductions are needed to ensure compliance with water quality criteria. The majority of the predicted impairments are consistent with impairment decisions based upon the review of monitoring data. In certain instances, the subject waters were not monitored for the pollutants of concern during the pre-TMDL monitoring effort, but receive source loadings (point and/or nonpoint) predicted to cause impairment. In others waters, the modeling predicts impairment at the baseline condition where permitted discharges are represented to contribute loadings authorized by existing permit limits.

The 303(d) list identifies impaired waters for which TMDLs must be developed. There is no prohibition against TMDL development for waters that are not listed. Evaluation of the results of predictive modeling is mandated by 40 CFR 130.7(b)(5)(ii) and the prediction of impairment through modeling is validated by applicable federal guidance for 303(d) listing. Where predictive modeling indicates that discharge in accordance with existing permit limits would cause violation of water quality criteria, water quality is threatened and the water is subject to 303(d) listing and TMDL development pursuant to 40 CFR 130.7(b)(5).

The watershed modeling associated with the Coal River TMDLs incorporates a "top down" approach where headwaters are analyzed first and pollutant loadings are transferred to downstream subwatersheds. The predicted pollutant loads in unimpaired headwater segments are directly transferred downstream. Where the model predicts criterion violations in the headwater segment, problematic pollutant sources are appropriately reduced within that subwatershed and the reduced load is transferred downstream. In this way, DEP can demonstrate criterion compliance in tributary segments and equitably prescribe pollutant reductions throughout the watershed. Under a protocol that prohibits TMDLs and allocations representing pollutant reductions in "unlisted" tributaries, unreduced problematic loadings would have to be transferred downstream. At a minimum, this will place increased burden on existing downstream sources. In some instances, it would preclude criterion compliance in the downstream segment.

Even if the aforementioned allocation obstacles could be rectified, DEP believes it is prudent to recognize the results of the modeling and present the TMDLs now, rather than delay development. Application of our allocation philosophy results in the targeting of the most problematic sources. In the alternative, DEP/EPA permitting protocol (new or reissuance) for discharges into impaired waters where TMDLs are not yet developed requires the imposition of effluent limitations based upon achieving water quality criteria "end-of-pipe". In streams and subwatersheds where both point and nonpoint sources exist, the permitting process would maximize pollutant reduction from point sources, even if abandoned mine lands and other nonpoint sources of metals are the most prevalent problematic pollutant sources.

When the Draft Coal River Watershed TMDLs were initially presented to the public, the West Virginia 2006 Section 303(d) List had not yet been drafted. EPA's approval of the dissolved aluminum criterion revision caused delayed finalization of the TMDLs. The 2006 Section 303(d) List has since been drafted and advertised for public comment. The waters and impairments that are the subject of this comment have been identified on the Draft 2006 Section 303(d) List.

The 303(d) list identifies waters for which TMDLs must be developed. As a general practice, impaired waters are removed from the list upon TMDL development and categorized in the Integrated Report as Category 4A waters. Category 4A waters are those that are impaired or threatened for which TMDLs have been developed. All impaired waters in the Coal River Watershed with approved TMDLs will ultimately be classified in Category 4A of the Integrated Report.

2) Specific objections to the presentation of manganese TMDLs for Little Marsh Fork (WVKC-46-A) and Brushy Fork (WVKC-46-A-4) were received. Commenters stated the streams were not included on the 2004 Section 303(d) list and that water quality monitoring results do not demonstrate violations of the manganese criterion.

After EPA approval of the manganese criterion revision on June 29, 2005, DEP expended considerable effort to identify the locations of water supply intakes and zones of applicability of the criterion, and to review the water quality status relative to manganese within those zones. That review eliminated the need for TMDL development for the vast majority of previously identified manganese-impaired waters within the Coal River watershed.

A zone of manganese criterion applicability extends to Little Marsh Fork and Brushy Fork. Contrary to the comment, Brushy Fork was included on the 2004 Section 303(d) list as manganese-impaired. Little Marsh Fork was not listed in 2004 based upon water quality monitoring results but a manganese TMDL is presented based upon the results of predictive modeling. Predictive modeling results were also used to demonstrate the unimpaired conditions of Big Coal River, Marsh Fork, Clear Fork and Sycamore Creek relative to manganese in this zone of applicability of the criterion.

The water quality standards do not prescribe an averaging period for Category A or C water quality criteria nor an allowable exceedence frequency. This creates a very stringent TMDL condition for manganese in waters where the criterion is applicable. In the Little Marsh watershed, landuse under active mining represents over 73% of the drainage area. Of the active mining area, 82% is subject to technology-based limitations for manganese (2.0 mg/L monthly average, 4.0 mg/L daily maximum). The baseline condition predictions relative to point source impacts in the watershed are reasonable given the high percentage of landuse in active mining and the prevalence of technology-based manganese effluent limitations applicable to existing outlets.

The Draft manganese TMDLs accurately reflect the five-mile zone of criterion applicability above the Boone Raleigh PSD water supply intake. The TMDLs are necessary because manganese reductions from existing sources are needed to ensure attainment of the criterion.

3) The classification and model representation of NPDES permitted discharges as point sources and all others as nonpoint sources were questioned.

The commenters have confused model representation of sources with the prescription of load and wasteload allocations, and incorrectly perceived that all NPDES permitted discharges were represented as continuous flow point sources and all others were represented as precipitation-driven nonpoint sources. In the TMDL process, nonpoint sources are given load allocations and point sources are given wasteload allocations. Functionally, certain point sources are precipitation-induced while others are continuous discharges. Similarly, AML seeps are continuous discharges while runoff from disturbed land is precipitation-induced.

Using "effluent type" information contained in WVDEP's Environmental Resources Information System (ERIS) database, the various NPDES permitted outlets were characterized as precipitation-induced or continuous flow and represented accordingly. For precipitation-induced discharges, the baseline condition incorporated existing effluent limitations, design precipitation, total and disturbed drainage area, treatment pond design, efficiency and clean-out requirements, and the contemporaneous reclamation requirements implemented by the industry. For NPDES outlets categorized as continuous discharges, the baseline condition incorporated effluent limitations and available flow or pump capacity information. Whether represented as precipitation-induced or continuous discharges, all outlets were granted wasteload allocations because they are point source discharges subject to NPDES permitting requirements.

The report portrayal of nonpoint sources is true – most are precipitation-driven, but some are not. Many nonpoint sources were represented based upon surface area and design precipitation. Seeps from abandoned mine lands were represented as continuous sources with flow and pollutant characteristics as determined by DEP source tracking activities.

Discharges from inadequate onsite residential sewage treatment systems were also represented as continuous discharges. Both categories are treated as nonpoint sources and granted load allocations, but are represented as continuous discharges, not directly influenced by precipitation.

4) It was contended that DEP's determination of biological impairment is improper because the West Virginia Stream Condition Index (WVSCI) has not been the subject of formal rulemaking.

DEP's position has not changed relative to its responsibility to identify waters where available data indicates a significant adverse impact to the biological component of an aquatic ecosystem (47CSR2 § 3.2.i). The WVSCI uses metrics that are both validated and widely used nationally when assessing the biologic health of aquatic systems. The rating of observed benthic macroinvertebrate communities using the WVSCI is an appropriate methodology for assessing the narrative criterion and EPA expects its application in West Virginia 303(d) listing and TMDL development processes.

5) Two commenters requested additional insight to the stressor identification process for biological impairment and stated that all relevant data used in the determinations should be made available for review.

A discussion of the stressor identification process is provided in Section 6 of the Main Report. Additional information is presented in Chapter 7 and Appendix J of the Technical Report. The process is based largely upon the application of a strength of evidence approach that considers water quality monitoring data, habitat evaluations, field notes from monitoring and source tracking personnel, and the tolerances and morphology of the benthic organisms collected. In response to the comment, DEP reorganized, and clarified the habitat and biological data presented in Appendix H of the Technical Report. Appendix H, Invertebrate Data tab includes the macroinvertebrate assemblage data for all biological samples collected in the Coal River watershed.

6) Biological impairment stressor identification was questioned in five specific waters. A review of the stressor identification results for all biologically impaired waters was also requested to ensure that identified stressors are reasonable.

The requested comprehensive and stream specific reviews were conducted, and certain revisions were made. DEP reactions to stressor identification comments for specific waters are provided below. Additionally, the stressor identification results for Pond Fork (WVKC-10-U) and Clear Fork (WVKC-47) were also revised, consistent with the rationale described in the response to Comment No. 8. The reevaluation did not result in stressor identification revision to the remaining biologically-impaired waters.

7) The stressor identification results for Rockhouse Creek (WVKC-10-T-13) and Spruce Laurel Fork (WVKC-10-T-11) were questioned. Instream TSS water quality monitoring results at various locations were provided to support a contention that sedimentation is not a significant biological stressor of those waters. Another commenter cautioned that a relationship between water column TSS concentration and excessive sediment accumulation does not always exist.

DEP re-reviewed the physical, chemical, and biological data related to these streams. Following this examination, the DEP agrees that sedimentation is not the primary stressor associated with the biological impairment of Rockhouse Creek. Although increased sedimentation may have secondary impacts on the benthic biota, assemblage composition and field observation do not indicate a macroinvertebrate community that is depressed primarily due to excessive fine sediments. Secondary impacts are also attributed to organic enrichment. However, the available chemical data from Rockhouse Creek exhibits concentrations of ions, known to be detrimental to biological components and indicates that the most likely primary cause of biological impairment is ionic stress. The attributes of the benthic assemblage are also supportive of this conclusion, as the communities representing the two sample locations are composed largely of organisms with known tolerances to increased ions. Therefore, in similarity to other streams where ionic toxicity was identified as the primary stressor to the biological community, the WVDEP will defer TMDL development for biological impairment and retain this stream on the 303(d) list. This is due to insufficient information regarding the causative pollutants of ionic toxicity and their associated impairment.

In regard to the sediment-based biological impairment of Spruce Laurel Fork, it was concluded that elevated sediments are a significant stressor to the benthic community. In particular, three

biological (macroinvertebrate) collections, each having WVSCI scores designating impairment, were indicative of stress due to sedimentation. The samples demonstrated increased numbers of hard-bodied organisms, like Elmid beetles, which have morphologies conducive to excess sediment. In addition, certain ubiquitous organisms, such as Hydropsychid caddisfiles, are conspicuous by their absence at one location, which often indicates a niche vacancy produced by sedimentation. In support of the decision to pursue development of a sediment-related biological TMDL, quantifiable field observations of substrate embeddedness and sediment deposition (via EPA-based RBP protocol) confirm a condition problematic to macroinvertebrate colonization. As such, the WVDEP will retain the sediment TMDL for the purposes of addressing the biological impairment in Spruce Laurel Fork.

Additionally, the commenter argued that in-stream TSS values are consistent with and indicators of sedimentation stress to biological communities, and provided TSS monitoring results as evidence that sedimentation stress is not occurring in the subject waters. WVDEP urges caution with such correlations. Although TSS values are excellent indicators of short-term or acute conditions that may impact resident biota, they are not always consistent with sediment deposition and accumulation, which causes chronic disruption or displacement of sensitive organisms. Benthic macroinvertebrates, as a whole, are well adapted to precipitation-driven pulse perturbations—this is realized through their persistence in harsh or dynamic environments. However, the processes surrounding long-term sedimentation create habitat conditions to which certain species are not able to tolerate. In this scenario, actual measurements of substrate quality, like RBP embeddedness and sediment deposition, are much more reliable in depicting sediment-related stress to the benthic community.

8) The stressor identification conclusions targeting dissolved aluminum as a stressor for the biological impairments of Millers Camp Branch (WVKC-46-Q), West Fork (WVKC-U-7) and Spruce Laurel Fork (WVKC-10-T-11) were questioned. The commenter expressed an opinion that exceedence of the previously applicable 0.087 mg/L dissolved aluminum chronic aquatic life protection criterion is not sufficient evidence of adverse impact to benthic macroinvertebrate communities.

DEP re-reviewed the physical, chemical, and biological data related to these streams, and agrees with the commenter that dissolved aluminum is not the primary cause of biological impairment of the subject waters. In Millers Camp Branch, sedimentation and organic enrichment are considered to be the most significant stressors that must be addressed to facilitate recovery of the benthic macroinvertebrate community. In West Fork/Pond Fork and Spruce Laurel Fork, the communities are most significantly stressed by excess sediment.

Although elevated levels of dissolved aluminum cannot be completely eliminated as a potential stressor, DEP also cannot definitively conclude that instream concentrations greater than 87 µg/L are causing impairment of benthic macroinvertebrate communities. Significant stressor identification is complicated in waters where multiple perturbations are present and where exceedences of numeric water quality criteria for aquatic life protection are co-occurring. In some scenarios, the exceedence of numeric aquatic life protection criteria is completely consistent with adverse impact to benthic organisms, and there is a natural tendency to identify a pollutant as a significant stressor when the numeric aquatic life protection criterion for that pollutant is exceeded. However, there are circumstances where low-level exceedences of

numeric criterion are not necessarily indicative of most significant biological stressor. The draft document identification of dissolved aluminum as a biological stressor erroneously resulted from the need to develop aluminum-specific TMDLs in these waters, pursuant to the 87 µg/L chronic criterion that was effective when the draft TMDLs were developed. After reconsideration, DEP agrees that the magnitudes of dissolved aluminum concentrations in these waters are not severe enough to cause the realized biological impairment. As such, aluminum has been removed from the stressor identification results for Millers Camp Branch, West Fork and Spruce Laurel Fork. Similar scenarios were also identified and rectified in two other waters Pond Fork (WVKC-10-U) and Clear Fork (WVKC-47).

9) The stressor identification conclusion that dissolved aluminum and iron are stressors for the biological impairment of Clear Fork (WVKC-47) was questioned. The commenter contends that sediment is the most likely stressor of Clear Fork.

The biological condition of Clear Fork typifies a multiple stressor scenario. Initially, the stressor identification process assigned the most significant stressors to the benthic fauna of Clear Fork as metals toxicity and organic enrichment. After additional review, it was determined that organic enrichment, acting collectively with other low-level stressors, is the most significant stressor to the stream's benthic macroinvertebrate community.

Organic enrichment, resulting from inadequate or absent sewage treatment in the watershed, affects nearly the entire stream, particularly at downstream monitoring locations; however, of the eight benthic samples collected from Clear Fork during pre-TMDL monitoring, only two exhibited WVSCI scores that indicate biological impairment. These stations are located downstream of problematic tributaries contributing excess dissolved aluminum, iron, and/or low pH to the watershed, and having TMDL-prescribed reductions to those pollutants necessary to achieve both numeric and narrative water quality criteria. In combination with such stressors, organic enrichment can produce a number of biological community attributes, which adds complexity to the stressor identification process. For example, certain Dipterans proliferate in areas of nutrient addition, while other taxa may be entirely displaced by the same degree of perturbation. In this instance, the inclusion of other stressors, like toxic metals, may further suppress the community and result in an assemblage dominated by a few taxa, but having several other organisms in low abundance. Assemblages with attributes typical of this multiple stressor scenario colonize monitoring stations in Clear Fork, downstream of the problematic tributaries. Furthermore, recovery of the benthic community was realized, albeit gradually, with increasing distance from these problematic tributaries; a biological response that typically indicates a dilution of harmful pollutants.
Although levels of dissolved aluminum were elevated, which caused several violations of the 87 µg/L chronic aquatic life protection criterion, it is unlikely that the exceedances, which were of relatively low magnitude, were significantly causative of the biological impairment.

Violations of the State's total iron chronic aquatic life protection criterion were significant and potentially problematic to the benthic community. However, the total iron values were correlated to elevated total suspended solids (TSS), a documentation of the sediment-bound metals relationship, but not necessarily indicative of deposited sediments that are more harmful to

macroinvertebrate assemblages. In high gradient streams like Clear Fork, it is not uncommon for elevated levels of suspended solids to pass though the waterbody with minimal accumulation/deposition. In Clear Fork, this is evidenced by the optimal RBP sediment deposition and embeddedness measurements observed at the impaired stations. Furthermore, the relative low abundance of fines-tolerant organisms (e.g. Elmid 'riffle' beetles) at those stations indicates communities not significantly limited by excessive sediment.

Therefore, the identified stressors relating to Clear Fork's biological impairment have been revised and are now limited to the most significant stressor - organic enrichment. To address this stressor, WVDEP determined that implementation of the Clear Fork fecal coliform TMDL would remove untreated sewage and thereby reduce the organic and nutrient loading causing the biological impairment.

Although not specifically identified as significant stressors of biological impairment, it is important to note that the TMDL process is not forsaking reduction of pollutants that may contribute synergistic biological impacts. It is expected that the prescribed pollutant reductions associated with the independently necessary TMDLs in Stonecoal Branch and Dow Fork will not only ameliorate stress to the benthic communities within the streams themselves, but also facilitate recovery of the macroinvertebrate communities in Clear Fork downstream of the tributaries' influence. Furthermore, implementation of the Clear Fork iron TMDL (again, independently-necessary pursuant to the troutwater numeric iron criterion) would be expected to positively impact the macroinvertebrate community.

10) The implication of point source discharges associated with mining activity as the primary sources of identified selenium impairments was questioned. Clarification was requested regarding the portrayal of selenium impairments as low-flow critical. One commenter stated that six of the nine impaired streams have AML areas in the vicinity of stream monitoring locations.

Selenium impairment is assumed to be associated with the disturbance of subsurface strata containing selenium. In West Virginia, coals that contain the highest selenium concentrations are found in a region of south central West Virginia where the Allegheny and Upper Kanawha Formations of the Middle Pennsylvanian are mined (WVGES 2002). Some of the highest coal selenium concentrations are found in the central portion of the Coal River watershed where significant active mining and the selenium impaired streams are located.

The weight of evidence suggests that the mobilization of selenium is enhanced from crushing of ore and waste materials along with the resulting increase in surface area of material exposed to weathering processes. Division of Mining and Reclamation (DMR) geologists believe that the dark shale strata immediately bracketing coal seams are of particular concern. DMR is implementing new operating requirements to identify non-coal strata with elevated selenium content and to handle such material in a manner that minimizes opportunities for selenium mobilization.

The pre-TMDL monitoring effort included more than 200 sites in the Coal River watershed where selenium was monitored. Selenium impairment has been identified in only nine waters. Land use in those watersheds is dominated by active mining operations. Conversely, nonpoint

sources with associated surface disturbances are much more prevalent in other Coal River subwatersheds where selenium impairment was not identified. As such, there is no current evidence that nonpoint source activities exhibiting surface or near surface disturbances are significant sources of selenium.

DEP reevaluated information for AML areas and seeps in the selenium- impaired watersheds. In the Beech Creek, Left Fork Beech Creek, and Trace Branch watersheds, only small lengths of AML highwall have been identified. AML seeps were identified present only in the White Oak watershed. No AML areas or seeps were identified in the Beaver Pond Branch, Casey Creek and James Creek watersheds. Moderate amounts of AML area and highwall were identified in the Seng Creek watershed. As a part of the reevaluation, DEP resampled the AML seeps in the White Oak watershed for selenium. The selenium concentration in one seep, located in tributary Little White Oak, was < 1 µg/L. The selenium concentration in the other, located in Moccasin Hollow of Left Fork, was 1 µg/L. In contrast, selenium Discharge Monitoring Reports for permitted outlets in the White Oak watershed consistently show average monthly selenium concentrations well in excess of the criteria, and maximum daily values as high as 40 µg/L. Discharge Monitoring Reports demonstrating elevated selenium concentrations in permitted discharges are also available in Seng Creek, Trace Branch, James Creek, Beech Creek and Left Fork Beech watersheds.

Section 7.3 accurately identifies the paucity of monitoring results with matched flow observations and detectable selenium concentrations, and Figures 7-3 and 7-4 reflect this very limited dataset. The lack of a more robust dataset does not negatively influence selenium TMDL development. For the reasons discussed above, DEP is confidant that the proper sources are targeted, and that the level of control necessary to achieve criteria during low flow conditions (i.e. criteria end-of-pipe for active mining point sources) is also protective during higher flow periods.

The prescribed allocations for point source discharges in the selenium-impaired watersheds are based upon the achievement of the chronic aquatic life protection selenium criterion “end-of-pipe”. The permitted discharges from instream treatment structures are waters of the state where numeric water quality criteria are applicable. As such, selenium “criteria end-of-pipe” limitations for such discharges are appropriate regardless of receiving water impairment status, and many discharges in the impaired watersheds already have final effluent limitations equal to the wasteload allocations prescribed by the TMDLs. DEP is confident that the prescribed wasteload allocations are necessary to ensure compliance with the existing criterion.

11) One commenter noted that pre-TMDL selenium monitoring results were not presented for review.

This oversight has been corrected by including all selenium pre-TMDL monitoring results in Appendix H of the Technical Report.

12) Clarification of the basis for presentation of a selenium wasteload allocation for permitted discharges in the Threemile Branch watershed was requested.

The selenium WLA for permit WV0093050 is displayed in the TMDL Allocation Spreadsheet because the Threemile Branch subwatershed (3502) is an upstream tributary of Whiteoak Creek (WVKC-35), which is selenium impaired.

13) A commenter requested that Selenium TMDLs be displayed on the "TMDLs_Metals" page in the "Coal Metals TMDL Allocations" spreadsheet.

The "Coal Metals TMDL Allocations" spreadsheet has been updated as requested.

14) One commenter questioned the presentation of TMDLs as average annual loads in light of concentration-based TMDL endpoints and requested implementation direction for point sources in the NPDES permitting process.

Except for selenium, metal TMDLs and load allocations for nonpoint sources are presented as annual average loadings. For consistency and comparability, wasteload allocations for permitted point sources are similarly presented. In addition, wasteload allocations are also presented as equivalent concentrations. This convention has been used in all West Virginia metals TMDLs developed to date. Point source implementation is to be based upon the concentration-based wasteload allocations and the effluent limitation derivation procedures of EPA's Technical Support Document for Water Quality Based Toxics Control. For iron, aluminum and manganese, applicable concentration-based wasteload allocations are expressed on the "Mining WLAs Metals" and "Mining Pumped WLAs Metals" tabs of the "Coal Metals TMDL Allocation Spreadsheet". For selenium, all point source discharges in selenium-impaired watersheds are subject to a 5.0 µg/L wasteload allocation as depicted on the "Mining Selenium WLAs" tab of the spreadsheet.

15) It was contended that the baseline conditions predicted by modeling are not presented for review.

The Coal River Watershed TMDL modeling generated baseline and TMDL model outputs for 299 subwatersheds for multiple pollutants. The baseline condition predictions are presented throughout the allocation spreadsheets. The TMDL tab summarizes baseline and TMDL loadings for impaired streams for point and nonpoint sources. The LA tab presents baseline and allocation loadings for categories of nonpoint sources for each model subwatershed. The various WLA tabs display baseline and wasteload allocation loadings and concentrations for all NPDES permit/model subwatershed combinations.

16) A complete description of alternative, evaluated TMDL scenarios was requested, as well as the rationale for final scenario selection.

TMDL allocation was not accomplished by selection from multiple scenarios. Instead, the allocation methodologies described in Section 7 of the report were pursued. Deviation occurred only when application of the methodology resulted in the prescription of pollutant reduction of sources or categories of sources that had negligible effect on water quality improvement.

Allocation methodologies were presented at two public meetings in the Coal River watershed in Fall 2004. During those meetings, the agency heard comments that all TMDL pollutant reduction should be directed toward active mining because precipitation-induced discharges and spills are

causing the most significant adverse impacts to water quality. DEP did not alter its allocation philosophy/methodology in response to those comments for a variety of reasons:

- Water quality impacts related to spills are noncompliance events that are to be addressed by NPDES permit enforcement. The role of the TMDL is to prescribe wasteload allocations that are protective of water quality standards.

- TMDLs eliminate the applicability of technology-based, alternative precipitation limitations. Consistent compliance with wasteload allocations will minimize precipitation-induced adverse impacts to water quality.

- Abandoned mine lands, bond forfeiture sites and surface disturbing nonpoint sources are often a significant cause of impairment. Pollutant reductions from those sources are needed to protect water quality, exclusive of the loading contribution from active mining operations.

17) Concern was expressed relative to the high percentage total aluminum reductions determined necessary for attainment of the 87 µg/L dissolved aluminum water quality criterion. The attainability and necessity of such reductions were questioned. DEP was urged to continue to work toward a scientifically sound aluminum criterion. One commenter expressed an opinion that aluminum TMDLs should be based upon a 750 µg/L dissolved aluminum endpoint instead of the 87 µg/L.

TMDLs must be based upon the applicable water quality standards at the time of development. Throughout the development process, and at the time of preparation of the draft TMDLs, the effective dissolved aluminum, chronic, warmwater and troutwater, aquatic life protection criteria were 87 µg/L. The revision of the warmwater dissolved aluminum criterion was pending EPA approval and was not effective for Clean Water Act purpose. As such, the draft TMDLs and the resultant stringent allocations that were presented were appropriate.

On January 9, 2006, EPA approved a revision to the dissolved aluminum criteria. The warmwater chronic aquatic life protection criterion is changed from 87 µg/L to 750 µg/L from the date of approval until July 4, 2007. During that period, the 750 µg/L criterion is effective for Clean Water Act purposes in warmwater fisheries. In response, DEP recalled draft TMDLs in the North Branch Potomac, Lower Kanawha and Coal River watersheds that were pending EPA approval. DEP reevaluated the impairment status of streams and developed alternative TMDLs, load allocations and wasteload allocations pursuant to the 750 µg/L warmwater dissolved aluminum criterion. The revised draft documents contain dissolved aluminum TMDLs and allocations pursuant to both the 87 µg/L and the 750 µg/L criteria. The revised documents allow TMDL implementation to occur now, based upon the approved criteria revision, and also retain the previously advertised TMDLs and allocations that would be effective if criterion reverts to the 87 µg/L value in the future.

18) The basis of the 120 mg/L, annual average, Total Suspended Solids future growth provision was questioned. The commenter mentioned the 40 CFR 434 technology-based TSS limitations (35 mg/L average monthly, 70 mg/L maximum daily), and the

associated alternative precipitation limitations for settleable solids that are applicable to certain discharges from surface mines and asked if alternative precipitation limitations will continue to be available under the TMDL. Also included was an assumption that dischargers would be allowed to include zero discharge days in calculating the annual average concentration.

The 120 mg/L allocation is the most stringent given to existing active mining operations in TMDLs developed by DEP to date. WVDEP has concluded that discharges in compliance with this limitation will not cause or contribute to a violation of water quality standards. The future growth provision is identical to that contained in the Upper Kanawha River Watershed sediment TMDLs that have been approved by EPA. In the absence of this provision, new facilities could be permitted only via the recycling of allocations from existing facilities, after reclamation and permit release.

Implementation of the TSS wasteload allocation for mining point sources in sediment-impaired watersheds will be accomplished by the addition of an annual average TSS effluent limitation in the NPDES permit. Permits will continue to contain the average monthly and maximum daily TSS technology-based limitations and the authorization of alternative settleable solids limitations during qualifying precipitation events. But TSS self-monitoring will always be required, with the results to be used in an annual assessment of compliance with the TSS wasteload allocation of the TMDL. “Zero discharge” days cannot be factored into the annual assessment.

19) Additional information was requested concerning the modeling approach used to address pH impairments.

The selected modeling approach was developed to represent the dynamic and diverse watershed conditions affecting pH and dissolved metal concentrations. pH is an intensity factor that describes free hydrogen concentrations produced by many different processes. Factors that influence pH in natural streams unaffected by high metals loading include redox reactions of nutrients, organic acid/base reactions caused by decaying natural organic matter, CO2 fluctuations by respiratory activity of microbes and plants (including algae and macrophytes), and inflow of alkalinity and CO2 from groundwater/interflow. In mining impacted streams, pH is additionally influenced by acid and metal loadings from surface and subsurface sources.

In order to represent these complex chemical conditions in the model, alkalinity was assigned to characterize the cumulative effect of the chemical constituents and buffer the acidity generated by metal hydrolysis and hydrogen generating reactions. Alkalinity can be generated by many different chemical species including calcite dissolution, dissolved CO2 gas, nitrogen species, phosphorus species, organic acid and many others. However, most alkalinity is generated by bicarbonate and carbonate ions that occur naturally. Alkalinity values were selected during model calibration process based on the range (minimum and maximum) of observed alkalinity measured throughout the watershed. This alkalinity selection methodology was a key component in the sensitivity analysis during the model calibration process where the best representative alkalinity value was selected based on the daily simulation of in-stream metals concentrations in MDAS. The observed in-stream alkalinity was assumed to include any additional alkalinity added during treatment processes.

Highly oxygenated streams, such as shallow mountain streams, can effectively change a redox status of a metal and cause the metal to precipitate. Oxidation and hydrolysis reactions can generate acidity when metals are discharged to streams from subsurface sources. Oxidation reaction of iron is represented by assigning various ratios of ferric and ferrous iron during the iterative model calibration process to determine the best-fit ratio of incoming ferric and ferrous iron. The model counteracts the generated acidity from these incoming sources by utilizing the representative alkalinity (described above) as a buffer attempting to maintain pH conditions that existed prior to the hydrolysis and oxidation reactions.

Furthermore, pH TMDLs were developed using a surrogate approach where it was assumed that reducing in-stream metals (iron and aluminum) to meet water quality criteria (or TMDL endpoints) would result in meeting the water quality standard for pH. This assumption was verified by applying the modeling approach described above. By executing the model under TMDL conditions (conditions in which TMDL endpoints for metals were met), the resulting equilibrium pH was predicted. In all cases, this equilibrium pH was compliant with pH water quality criteria and further reductions to metals sources were not necessary.

20) General comments were provided indicating disappointment in the level of effort that was given to data analysis, model development, and model calibration, and concern that the models used do not accurately predict instream water chemistry.

Contrary to the opinion of the commenter, TMDL development for the Coal River watershed consisted of a very substantial effort over a duration of 2 years. The technical work was completed by a team of highly qualified scientists and engineers that possess a breadth of experience in watershed/water quality modeling with a high level of TMDL development experience. Extreme care and diligence were taken to thoroughly examine and analyze the myriad of available data that included many types and formats originating from various sources (including data collected and submitted by industry).

The sophisticated modeling efforts were supported by carefully crafted technical approaches designed to utilize the best available data while incorporating sound scientific principles to establish representative conditions throughout the Coal River watershed.

The goal of the modeling calibration was to determine a set of parameters to best describe the hydrologic and water quality processes in the Coal River watershed. The hydrology and water quality calibration process first objective is not to match every sampled point, but to adequately replicate processes occurring in the watershed and streams. The purpose of directly comparing modeled results with data is to assess that the model is simulating low flow, mean flow, and storm peaks within observed ranges.

Composite analysis of the available in-stream data (pre-TMDL monitoring data, in-stream Discharge Monitoring Report data, WVDEP DMR trend station data, etc.) from all monitoring stations was performed to establish low-flow, high-flow and seasonal trends. Background values were established by using a composite of samples from watersheds that were minimally disturbed, according to the landuse coverage. In addition, the sediment-metals relationship was determined, and applied to those watersheds where metals-sediment correlation was observed.

For the abandoned mine lands, the concentrations were based on the source tracking monitoring. Values for permitted mines used for calibration were based on DMR data, although it is important to note that those were changed to represent permitted conditions during the allocation process (Baseline Conditions). From these composite analyses, 16 separate water quality parameter groups representing more than 720 landuse/pollutant-specific parameter combinations were developed for the 299 subwatersheds.

Graphical results of model performance were evaluated at many different locations throughout the Coal River watershed following each water quality simulation. Model parameters were further adjusted following iterations to improve model performance. Graphical results for each location were too numerous to display in the Technical report. Therefore, representative examples were displayed in Appendix G of the Technical report. The commenter noted inconsistencies with labeling of the graphical result that have been corrected.

Although error statistics are often used in evaluating model calibration, their use, particularly for water quality calibration, is not recommended for this modeling effort. Making a "point-by-point" comparison (i.e. a comparison of a water quality observation for a given date and time versus the modeled value for the same date and time) will likely result in poor statistical results, because the precise timing of all physical, chemical, and biological phenomenon are likely not perfect in a model. Most of the available data for calibration were instantaneous grab samples, not continuous or composite sampling. Instantaneous grab sample data only permits comparison during a snapshot in time, and this snapshot is representative of only a single condition. Although multiple water quality data are available at many locations, they are not necessarily representative of all conditions (which are, in fact, simulated by the model because it is continuous). The lack of local weather gages increases model error in terms of amount and timing of water flowing through the system. The sparse weather gage network particularly increases model error during storm events. Modeled continuous flow discharges (i.e. point sources, AML seeps) are simplifications that also increase model error, since they have the potential to have variable flow and water quality.

Looking at a time series plot of modeled versus observed data provides more insight into the nature of the system and is more useful in water quality calibration, in particular, than a statistical comparison. Trends in the observed data and cause-effect relationships between various parameters can be replicated with a model, although precise values at each and every point in time may not be. As long as the trends, relationships, and magnitudes are well represented, and thus the underlying physics and kinetics are also being represented, a model is successful and can be used for simulating management alternatives. It is important to note that only EPA approved public domain models were applied during this effort. All models are openly coded and available to anyone who is interested.

21) Additional information was requested regarding modeling considerations relative to metals/sediment correlation. Based upon statements contained in Section 4.2.3, the commenter also questioned the transfer of information from the Elk River and Upper Kanawha River TMDLs to the Coal River, without a demonstration of similar geomorphology.

Section 4.2.3 points out that West Virginia soils can contain metals and that sources of sediment are potential sources of iron, aluminum and manganese. The reference to the Elk and Upper Kanawha TMDLs are examples of past TMDL development efforts where metals/sediment relationships were evaluated. The relationships determined in those TMDLs were not applied in the Coal River watershed. The metals/sediment relationships for this effort were determined directly from available Coal River watershed monitoring data (See Technical Report Appendix C) and resulted in the creation of sixteen different default groups that were applied at the subwatershed level.

22) Identification of the point sources that were modeled as subject to technology-based effluent limitations and those that were modeled as subject to water quality-based effluent limitation was requested. The commenter also asked if any "credit" was given for existing discharges with more stringent antidegradation-based effluent limitations.

Model representations of point sources under baseline and TMDL conditions were based upon permit information contained DEP's ERIS database. Effluent limitation data are presented in Appendix D of the Technical Report. Using the limitation information, outlets were represented as either "Technology-based" (existing iron and manganese effluent limitations consistent with 40CFR434 guidelines) or "Water Quality-based" (existing iron and manganese effluent limitations based upon achieving 47CSR2 water quality criteria end-of-pipe). This categorization methodology accurately represents 95% of the permitted discharges, and the magnitude of the modeling effort precludes representation of permitted discharges exactly equal to every possible existing limitation set. If existing limitations were more stringent than "criteria end-of-pipe" the discharges were represented under the "Water Quality-based" format. If existing limitations fell between "criteria end-of-pipe" and effluent guidelines, the discharges were represented under the "Technology-based" format. It is important to note that "credit" for discharges with antidegradation-based effluent limitations is directly provided in model calibration through the use of Discharge Monitoring Report data.

The discussion presented in Section 7.5.1 recognizes the limited instances where existing effluent limitations are more stringent than TMDL allocations. In the TMDL process, specified pollutant reductions are not greater than necessary to comply with criteria (i.e 100% assimilative capacity use) and prescribed wasteload allocations cannot be more stringent than effluent limitations reflecting the achievement of water quality criteria end-of-pipe. Section 7.5.1 cautions against using TMDL allocations to relax alternatively-based (e.g. antidegradation) existing effluent limitations.

10. REASONABLE ASSURANCE

Reasonable assurance for maintenance and improvement of water quality in the affected watershed rests primarily with three separate programs. Two of these programs are wholly within WVDEP, and the third program is a cooperative effort involving many state and federal agencies. Within WVDEP, the programs involved in the effort include the NPDES Permitting Program and the Abandoned Mine Lands Program. In addition, WVDEP is involved with the West Virginia Watershed Management Framework, which includes many state and federal agencies dealing with the protection and restoration of water resources. The Framework process allows the resources of many entities to focus on the protection and/or restoration of water quality in selected streams.

Historically, mine drainage research has been a conducted by scientists at West Virginia University, the West Virginia Division of Natural Resources, the United States Office of Surface Mining, the National Mine Land Reclamation Center, the National Environmental Training Laboratory, and other agencies and individuals within West Virginia. In addition, USEPA 319 Grant funding has been used to address issues resulting from acid mine drainage.

10.1 Permit Reissuance

WVDEP's Division of Water and Waste Management is responsible for issuing non-mining NPDES permits within the State. The Division of Mining and Reclamation develops NPDES permits for mining activities. As part of the permit review process, permit writers have the responsibility to incorporate the required TMDL wasteload allocations into new or reissued permits. Both the permitting and TMDL development processes have been synchronized with the Watershed Management Framework cycle, such that TMDLs are completed just before the permit expiration/reissuance time frames. Existing permit reissuance in the Coal River watershed is scheduled to begin in July 2006 for non-mining facilities and in January 2007 for mining facilities. Therefore, the wasteload allocations for existing activities will be promptly implemented. New facilities will be permitted in accordance with future growth provisions.

Existing sewage treatment facilities already have permit limitations for fecal coliform bacteria that satisfy the wasteload allocations of the TMDLs. A new MS4 permitting program is being implemented to address stormwater impacts from urbanized areas. DWWM also oversees a program to control discharges from combined sewer overflows (CSOs). The CSO pollutant reductions specified will be implemented at the time of reissuance of the NPDES permit for the affected POTW.

10.2 Watershed Management Framework Process

The Watershed Management Framework consists of a group of state and federal agencies whose goal is to develop and implement watershed management strategies through a cooperative, long-range planning effort. The Framework is incorporated by reference into West Virginia's Continuing Planning Process. The Framework consists of representatives from the following partner agencies:

Bureau for Public Health
Department of Highways
Department of Environmental Protection
State Conservation Agency
Division of Forestry
Division of Natural Resources
West Virginia University Extension Services
ORSANCO (Ohio River Valley Water Sanitation Commission)
U.S. Geological Survey
U.S. Office of Surface Mining
Monongahela National Forest
U.S. Environmental Protection Agency
Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Department of Agriculture

The principal area of focus for the Framework is correcting problems related to non-point source pollution. Each of the partner agencies has placed a greater emphasis on identification and correction of non-point source pollution. The combined resources of these agencies are used to address all different types of non-point source pollution through both public education and on-the-ground projects. The Framework also incorporates as part of its priority selection criteria, the state's list of impaired waters under Section 303(d).

Among other things, the Framework includes a management schedule for integration and implementation of TMDLs. In 2000, the schedule for TMDL development under Section 303(d) was merged with the Framework process. Chapter 3.2.2 of the Framework, entitled "Developing and Implementing Integrated Management Strategies," identifies a six-step process for developing integrated management strategies and action plans for achieving the state's water quality goals. Step 3 of that process includes "identifying point source and/or non-point source management strategies - or Total Maximum Daily Loads - predicted to best meet the needed [pollutant] reduction." Following development of the TMDL, Steps 5 and 6 provide for preparation, finalization, and implementation of an "action plan" that implements the TMDL and any other appropriate water quality improvement strategy.

The Framework uses the 5-year Watershed Cycle to identify watersheds where restoration efforts will be focused. Each year Framework agencies meet to prioritize watersheds within a certain Hydrologic Group. Development of "action plans" for priority watersheds is based on the efforts of local project teams. These teams are composed of Framework members and stakeholders having interest in or residing in the watershed. Team formation is based on the type of impairments occurring or protections needed within the watershed. In addition, teams have the ability to use the TMDL recommendations to help plan future activities. The team's goal is to develop a project plan that allows the most efficient use of resources from all involved parties.

10.3 Public Sewer Projects

Within WVDEP's Division of Water and Waste Management, the Engineering and Permitting Branch's Engineering Section is charged with the responsibility of evaluating sewer projects and providing funding, where available, for those projects. All municipal wastewater loans issued through the State Revolving Fund (SRF) program are subject to a detailed engineering review of the engineering report, design report, construction plans, specifications, and bidding documents. The staff performs periodic on-site inspections during construction to ascertain the progress of the project and compliance with the plans and specifications. Where the community does not use SRF funds to undertake a project, the staff still performs engineering reviews for the agency on all POTWs prior to permit issuance or modification. A list of funded and pending water and wastewater projects in West Virginia can be found at http://www.wvinfrastructure.com/projects/index.html.

10.4 AML Projects

Within WVDEP, the primary entity that deals with abandoned mine drainage issues is the Division of Land Restoration. Within the Division, the Office of Abandoned Mine Lands and Reclamation was created in 1981 to manage the reclamation of lands and waters affected by mining prior to passage of the Surface Mining Control and Reclamation Act (SMCRA) in 1977. A fee placed on coal mined in West Virginia funds the Office of AML&R's budget. Allocations from the AML fund are made to state and tribal agencies through the congressional budgetary process. AML&R has recently increased its emphasis on correcting water quality problems at sites that were primarily chosen for protection of public health, safety, and property. This new emphasis on improving water quality, in conjunction with Framework participation, will aid in the cleanup of sites already selected for remediation activities.

10.5 Special Reclamation Projects

The Office of Special Reclamation is part of the Division of Land Restoration. Since August 1997 Special Reclamation has been mandated by the State of West Virginia to protect public health, safety, and property by reclaiming and treating water on all bond-forfeited coal mining sites in an expeditious and cost-effective manner. Funding for this program is obtained from collection of forfeited bonds, civil penalties, and the Special Reclamation Tax placed on mined coal. Table 10-1 displays six bond forfeiture sites in the watersheds addressed in this report.

Table 10-1. Coal River watershed bond forfeiture sites with water treatment needs

Original Permittee	Permit No.	TMDL Watershed	Subwatershed ID	Stream
Bickford Mining Inc.	U-44-83	Marsh Fork	4612	Horse Creek
Bickford Mining	U-78-85	Marsh Fork	4612	Horse Creek
E.C. Coal Mining Co.	U-207-83	Clear Fork	4718	Toney Fork
Pups Creek Coals, Inc.	S-3006-94	Marsh Fork	4666	Shockley Branch
J & N Processing Company, LLC	O-58-83	Marsh Fork	4654	Maple Meadow Creek
Lodestar Energy, Inc.	S-3016-92	Clear Fork	4717	Buffalo Fork

11. MONITORING PLAN

The following monitoring activities are recommended:

11.1 NPDES Compliance

WVDEP's Division of Water and Waste Management has the responsibility to ensure that NPDES permits contain effluent limitations as prescribed by the TMDL wasteload allocations and to assess and compel compliance. Permits contain effluent self-monitoring and reporting requirements that are periodically reviewed by WVDEP. WVDEP also inspects treatment facilities and independently monitors NPDES discharges. The combination of these efforts will ensure implementation of the TMDL wasteload allocations.

11.2 Non-point Source Project Monitoring

All non-point source restoration projects should include a monitoring component specifically designed to document resultant local improvements in water quality. These data may also be used to predict expected pollutant reductions from similar future projects.

11.3 TMDL Effectiveness Monitoring

TMDL effectiveness monitoring should be performed to document water quality improvements after significant implementation activity has occurred because little change in water quality would otherwise be expected. Full TMDL implementation will take significant time and resources, particularly with respect to the abatement of non-point source impacts. WVDEP will continue monitoring on the rotating basin cycle and will include a specific TMDL effectiveness component in waters where significant TMDL implementation has occurred.

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01/12/2011 10:53 PM

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(b) (6) [redacted] - 2011-01-13 Spruce Consultation Summary.pdf

Spruce No. 1 Surface Coal Mine Consultation Meeting
Tuesday, November 16, 2010
EPA Headquarters, Washington D.C.

I. Issue: On November 16, 2010, EPA's Assistant Administrator for Water, Peter S. Silva, invited representatives of the Arch Coal Company ("the Company"), the State of West Virginia, the U.S. Army Corps of Engineers, and the United Company to meet with EPA to discuss the Company's suggestions for potential corrective actions to reduce adverse environmental and water quality impacts associated with the Spruce No. 1 Mine. This consultation was conducted as a part of EPA's Clean Water Act (CWA) Section 404(c) review of the Spruce No. 1 mine. EPA Region III staff were also available to answer questions regarding the Region's "Recommended Determination" under CWA Section 404(c). This paper provides a summary of the key topics raised and addressed during the November 16 meeting.

II. Participants:

Name	Affiliation
Chris Hunter	US EPA
Jim Pendergast	US EPA
Palmer Hough	US EPA
Matt Klasen	US EPA
COL Robert Peterson	US Army Corps of Engineers, Huntington District
Ginger Mullins	US Army Corps of Engineers, Huntington District
Robert Jones	Arch Coal, Inc.
Robert Shanks	Arch Coal, Inc.
John McDaniel	Arch Coal, Inc.
Denise Keehner	US EPA
Kevin Minoli	US EPA
Thomas Clarke	West Virginia DEP
Randy Huffman	West Virginia DEP
Gregory Peck	US EPA
Peter Silva	US EPA
Randy Pomponio	US EPA
Brian Frazer	US EPA
Scott Mandirola	West Virginia DEP
Kristin Boggs	West Virginia DEP
Mark Taylor	US Army Corps of Engineers, Huntington District
Debora Tabor	US Army Corps of Engineers, Huntington District
Robert Rolfe	Hunton & Williams, LLP
Deidre Duncan	Hunton & Williams, LLP
B.J. Sturgill	Arch Coal, Inc.
Bob McLusky	Jackson Kelly, PLLC
Brian Sullivan	United Affiliates
Shawn Garvin (on the phone)	US EPA
Bill Early (on the phone)	US EPA
Stefania Shamet (on the phone)	US EPA

III. Meeting Summary – Key Topics Discussed:

1. **Because the environmental and water quality concerns identified by EPA associated with the Spruce Mine are pervasive issues affecting all surface mines, does EPA expect to review all surface coal mining projects under section 404(c)?**

   Arch Coal stated that it believe that most arguments in EPA's Recommended Determination would apply to any surface mine in Appalachia. EPA responded by stating that its Section 404(c) actions are discretionary, but the coal industry can expect EPA Region III to raise similar issues and environmental concerns in the review of other mines. Whether those mines would trigger review under CWA Section 404(c) would be determined by EPA on a case-specific basis. EPA reiterated that it better understands the streams on the project site (Pigeonroost Branch and Oldhouse Branch) as being of high quality, and better understands their context in the Coal River watershed.

2. **On what basis is EPA using its authority to revoke a permit issued by the Corps over three years ago?**

   EPA Region III described that the context for the Spruce No. 1 Mine is better understood now than at the time of permit issuance, and the Region has learned a lot more as the project has progressed. United Affiliates noted during the introduction to the meeting that they believe that EPA's action is in the realm of a regulatory taking.

3. **How can EPA put its judgment above that of the U.S. Army Corps of Engineers or the State of West Virginia?**

   WVDEP and Arch Coal were especially interested in the extent to which EPA's action is superseding the decision-making of the Corps or the State. The Corps noted that it was approaching the consultation meeting in a "receiving mode." WVDEP noted its belief that the determination of "impairment" with respect to water quality standards is a policy decision. EPA reiterated that Section 404(c) provides EPA with an independent standard for decision-making based on "unacceptable adverse effects," and that this determination is not dependent upon a determination that water quality standards would be violated (in this case, West Virginia's water quality standards).

4. **What standard does EPA apply under Section 404(c) in deciding whether or not to prohibit or restrict a particular project?**

   WVDEP and Arch Coal expressed concern with respect to the concept EPA has developed regarding Section 404(c) and narrative water quality standards. EPA clarified that decision-making under Section 404(c) is an independent determination based on "unacceptable adverse effects" to wildlife, municipal water supplies, fisheries or shellfisheries, or

recreation. It is also based on "significant degradation." Several participants were unfamiliar with these standards. EPA stated that making an "unacceptable adverse effects" determination does not depend upon a violation of water quality standards. Arch Coal and WVDEP expressed concern that "unacceptable adverse effects" depended upon EPA's perspective and did not include clear threshold standards.

5. **Can EPA and the company agree upon an alternative mine plan that might reconfigure the mine to reduce anticipated adverse environmental impacts?**

   EPA clarified that the intent of consultation was for the permittee to propose potential corrective actions for EPA's consideration that might prevent unacceptable adverse effects. Arch Coal stated that it had previously proposed enhanced monitoring, additional mitigation, operational changes, redesign of a sediment pond, an adaptive mining process, and elimination of two small fills. EPA expressed that some of its concerns relate to the direct impacts of the fill and that additional fill minimization might be an option to address concerns stated in the Recommended Determination. Arch Coal expressed concern over options that EPA previously raised for minimizing spoil placement in streams because they do not account for the cost of spoil storage and disposal. Arch expressed concerns with a "sequenced" fill construction approach because it would introduce uncertainty into the mining process. EPA stated that it was also concerned about uncertainty; in its case, the uncertainty regarding the entire project moving forward given the likelihood of impacts outlined in the Recommended Determination.

6. **What role does EPA's April 1, 2010, mining guidance have in the Region III determination that the project will violate water quality standards, including narrative standards?**

   Arch and WVDEP expressed concern regarding EPA's April 1 guidance and State narrative water quality standards. In particular, concerns were raised regarding specific levels of conductivity as outlined in the guidance (300 and 500 uS/cm). EPA clarified that the Recommended Determination references and discusses water quality standards but that a determination of unacceptable adverse effects was not dependent upon a violation of State water quality standards.

7. **On what basis has EPA concluded that impacts are likely to be unacceptable?**

   EPA Region III described the key conclusions of its Recommended Determination. As outlined, Region III described that the Region views Pigeonroost Branch and Oldhouse Branch as being of superior water quality and wildlife habitat value. EPA detailed concerns regarding downstream water quality impacts of total dissolved solids, and stated that the basis for the determination was that the project would be likely to result in unacceptable adverse impacts on wildlife, specifically macroinvertebrates, birds, and fish. Arch Coal

stated its concerns that most of EPA's arguments would apply to any surface mine in Appalachia.

8. **Is the Company prepared to propose new corrective actions that would reduce anticipated environmental and water quality impacts of the Spruce No. 1 mine? If so, under what conditions?**

   During the meeting, Arch Coal reiterated corrective actions that it had previously proposed to EPA, including enhanced monitoring, additional mitigation, redesigning of the Pigeonroost Branch sediment pond, best management practices, and elimination of two small fills. Arch noted that it had previously proposed such actions to EPA. EPA described that minimizing the volume of physical fill might be an option to address concerns presented in the Recommended Determination, but Arch Coal suggested that such concepts do not acknowledge the cost of managing spoil material during mining. EPA stated that given the high quality of streams affected in this case, EPA would like the company to make certain that significant degradation does not occur before mining is completed. Arch Coal stated that a precondition on future meetings is dependent upon EPA removing the discussion of a sequential approach and being willing to consider ideas on the table already. EPA concluded the meeting by stating that EPA would follow up with the company by the end of the week.

Matthew Klasen/DC/USEPA/US

01/13/2011 12:31 AM

To Christopher Hunter, Marcel Tchaou, Julia McCarthy, Ross Geredien

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Subject Add this PDF to admin record

Not sure who the best is to add this, but see attached. It's referenced in one of the H&W comments but we don't cite it (nevertheless, should be in the AR to show we have it).

Thanks,
Matt

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A STREAM CONDITION INDEX FOR WEST VIRGINIA WADEABLE STREAMS

Prepared for:

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ACRONYMS AND ABBREVIATIONS

ATV	All terrain vehicle
B-IBI	Benthic Index of Biotic Integrity
BPJ	Best professional judgement
DE	Discrimination efficiency
DEP	Division of Environmental Protection (West Virginia); also WVDEP
EDAS	Ecological Data Application System
EMAP	Environmental Monitoring and Assessment Program (USEPA); also EMAP-MAHA
EMAP-MAHA	Environmental Monitoring and Assessment Program—Mid-Atlantic Highlands Assessment (USEPA)
EPA	Environmental Protection Agency (U.S.); also USEPA
IBI	Index of Biotic Integrity
ICI	Invertebrate Condition Index
IQR	Interquartile range
NMDS	Non-metric multidimensional scaling
OWR	Office of Water Resources (West Virginia)
RBP	Rapid Bioassessment Protocol
SCI	Stream Condition Index
SWRB	State Water Resources Board (West Virginia)
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency; also EPA
WAP	Watershed Assessment Program (West Virginia)
WQ	Water quality
WVDEP	West Virginia Division of Environmental Protection; also DEP

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1. EXECUTIVE SUMMARY

Over the past century, land use activities such as mining, agriculture, urbanization, and industrialization have seriously threatened the quality of surface waters by contributing to nonpoint-source pollution. In West Virginia, the investigation of these nonpoint sources of water pollution has become a priority. It is the responsibility of West Virginia Division of Environmental Protection (DEP) to maintain and protect the ecosystem health of the state's waters. In keeping with the Clean Water Act and technical guidance from USEPA, DEP developed water quality standards for the protection of ecosystem health. In support of the state's water quality standards, which mandate the implementation of biological and chemical criteria and a strict antidegradation policy, the ambient monitoring program has established an assessment "toolbox" that includes physical, chemical, and biological techniques.

West Virginia DEP uses a rotating basin network of monitoring, scheduled on a 5-year rotation. A core team of biologists, naturalists, and chemists provides the technical resources to conduct the monitoring. Biological data (e.g., the diversity of organisms) are necessary to assess the health of West Virginia's surface waters and to measure the attainment of biological integrity goals as directed by USEPA and characterized by the state of West Virginia. DEP established a Biological Assessment Program patterned after the Rapid Bioassessment Protocols of EPA (Plafkin et al. 1989). The results presented in this report establish a framework for the assessment and monitoring of West Virginia's streams using rapid bioassessment procedures.

Bioassessment consists of comparing the biological condition of a stream to a reference condition, which is an aggregate of conditions in unimpaired streams of a region. Reference conditions are "best available" conditions where biological potential is at its highest for the particular region or area. These reference conditions are representative of sustainable ecosystem health. For West Virginia, the Mountain State, a single region appears sufficient for statewide and rotating basin assessments. Partitioning the streams and watersheds into Level 3 ecoregions does not appear to improve biological assessment. The information derived from a survey is aggregated into a Stream Condition Index (SCI) for West Virginia. This SCI is used as a primary

Biocriteria: *under the Clean Water Act, numerical values or narrative statements that define a desired biological condition for a waterbody and are part of the WQ standards.*

Bioassessments: *evaluations of the biological condition of a waterbody that use biological surveys of the resident biota.*

Biosurveys: *the collection, processing, and analysis of representative portions of a resident biotic community or assemblage.*

indicator of ecosystem health and can identify impairment with respect to the reference (or natural) condition. The index includes six biological attributes, called metrics, that represent elements of the structure and function of the bottom-dwelling macroinvertebrate assemblage. Metrics are specific measures of diversity, composition, and tolerance to pollution, that include ecological information.

The SCI is to be used as the basis for bioassessment in West Virginia and has been calibrated for a long-term biological index period extending from April through October. A data analysis application has been developed to ensure consistency in data management and analysis throughout the state as DEP biologists conduct biological monitoring.

CORE METRICS

- EPT taxa
- Total taxa
- % EPT
- % Chironomidae
- % Top 2 Dominant Taxa
- HBI (Family biotic index)

See definitions in Table A-2.

Benefits expected from the implementation of the WV SCI will apply to a broad spectrum of management programs, including:

- characterizing the existence and severity of point and nonpoint source impairment;
- targeting and prioritizing watersheds and ecosystem management areas for remedial or preventive programs;
- evaluating the effectiveness of nonpoint source best management programs;
- screening ecosystems for use attainability; and
- developing a basis for establishing biocriteria that relate to regional water quality goals, an EPA priority.

The West Virginia SCI was tested with independent data collected in 1998 and was able to correctly identify the majority of the stream sites stressed in some way by human disturbance or pollution. Index scores were divided into 5 proposed rating categories for reporting on the condition of West Virginia streams.

2. THE APPLICATION OF STREAM BIOASSESSMENT IN WEST VIRGINIA

The West Virginia Division of Environmental Protection (DEP) is developing biological criteria for use in assessing the quality of streams as part of the state's Watershed Assessment Program. Through the 303(d) and Total Maximum Daily Load (TMDL) framework outlined in the Clean Water Act of 1972 (and revisions of 1977, 1987), those waters considered to be impaired and threatened must be identified and improved to meet their designated uses. The definition of impairment by natural resource management or regulatory agencies is typically based on attainment or non-attainment of numerical water quality standards associated with a waterbody's designated use. If those standards are not met (or attained), then the waterbody is considered to be impaired. Resident biota in a watershed function as continual natural monitors of environmental quality, responding to the effects of both episodic as well as cumulative pollution and habitat alteration. Conducting ambient biological surveys is one of the primary approaches to biomonitoring. These surveys, in turn, are used to measure the attainment of biological integrity. The assessment of ecosystem health cannot be done without measuring the attainment of biological integrity goals as directed by USEPA and characterized by the state of West Virginia.

The Clean Water Act of 1972 (PL-92-500) has as one of its primary goals the maintenance and restoration of biological integrity, which incorporates biological, physical, and chemical quality. This concept refers to the natural assemblage of indigenous organisms that would inhabit a particular area if it had not been affected by human activities. This integrity or naturally occurring structure and function of the aquatic community becomes the primary reference condition used to measure and assess waterbodies in a particular region.

> ***Biological integrity*** is commonly defined as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of the regions" (Karr and Dudley 1981, Gibson et al. 1996).

Careful measurement of the natural aquatic ecosystem and its constituent biological communities can determine the condition of biological integrity. Several key attributes are measured to indicate the quality of the aquatic resources. Biological surveys establish the attributes or measures used to summarize several community characteristics, such as taxa richness, number of individuals, sensitive or insensitive species, observed pathologies, and the presence or absence of essential habitat elements.

Multimetric, invertebrate indices of biotic integrity, variously called RBP (Rapid Bioassessment Protocol; Plafkin et al. 1989; Barbour et al. 1999), ICI (Invertebrate Condition Index; Ohio EPA 1989), B-IBI (Benthic IBI; Kerans and Karr 1994) and SCI (Stream Condition Index; Barbour et al. 1996) have been developed for many regions of North America and are generally accepted for biological assessment of aquatic resource quality (e.g., Gibson et al. 1996, Southerland and Stribling 1995, Karr 1991). The framework of bioassessment consists of characterizing reference conditions upon which comparisons can be made and identifying appropriate biological attributes with which to measure the condition. Reference conditions are "best available" conditions where biological potential is at its highest for the particular region or area. These reference conditions are representative of sustainable ecosystem health.

Biological measurements, called metrics, represent elements of the structure and function of the bottom-dwelling macroinvertebrate assemblage. Metrics change in some predictable way with increased human influence (Barbour et al. 1996). They include specific measures of diversity, composition, and functional feeding group representation and include ecological information on tolerance to pollution. Multimetric indices, such as the IBI, incorporate multiple biological community characteristics and measure the overall response of the community to environmental stressors (Karr et al. 1986, Barbour et al. 1995). Such a measure of the structure and function of the biota (using a regionally-calibrated multimetric index) is an appropriate indicator of ecological quality, reflecting biological responses to changes in physical habitat quality, the integrity of soil and water chemistry, geologic processes, and land use changes (to the degree that they affect the sampled habitat).

The purpose of this study was to develop a multimetric biological index for West Virginia streams. State Watershed Assessment Program (WAP) stream assessment data from 1996 and 1997 were used for developing an index, and 1998 data were used to test and validate the index. Results of the analysis were used to make recommendations for improving the state's biological sampling program to achieve more reliable assessments of West Virginia streams.

This study was designed to address the following questions:

- What is the most appropriate site classification for assessment of ecosystem health?
- What are the seasonal differences in biological metrics? (Are two index periods required for monitoring?)
- What are the appropriate metrics for a West Virginia Stream Condition Index (SCI)?
- What are thresholds that indicate the degree of comparability of West Virginia streams to reference condition?

3. ESTABLISHING BIOREGIONS AS A BASIS FOR BIOASSESSMENT

Biological systems naturally vary in composition and diversity of the fauna, depending on the physical characteristics and geomorphology of the waterbodies (in this case, streams) in which they reside. Partitioning this natural variability into relatively homogenous classes, or bioregions, can aid in establishing reference conditions, or benchmarks, from which to assess biological condition. The purpose of this classification analysis is to evaluate Level 3 ecoregions as a means of establishing bioregions for West Virginia streams. Sites sampled in 1996-1997 were located in three Level 3 ecoregions: the Ridge and Valley (No. 67), Central Appalachians (No. 69), and Western Allegheny Plateau (No. 70).

Identification of reference sites (i.e., those having the expected composition and diversity of biota for a region or class of sites) provides the basis for evaluating bioregions. Out of 720 sites sampled by West Virginia DEP in 1996-1997, there were 67 identified as reference (see Appendix A, Table A-1, for criteria). The relative geographic clustering of the benthic data from the West Virginia data set suggested that testing an ecoregional classification might not be reliable with this data set alone. Therefore, similar benthic data were obtained from EPA's Environmental Monitoring and Assessment Program (EMAP) in the Mid-Atlantic Highlands for this analysis. From the EMAP database, 79 reference sites (using same criteria as for West Virginia) were identified that were geographically distributed within the same 3 ecoregions and encompassed a broader pattern than the clustered distribution of the West Virginia database (Figure 3-1).

Methods of Analysis

- *Non-metric Multidimensional Scaling (NMDS) Ordination* — Spatial array of sites based on similarity/difference of benthic composition and abundance.
- *Similarity Analysis* — Tests for statistical significance and the strength of the classification.
- *Box-and-Whisker Plots* — Display of ranges of values for the biological data oriented by spatial and temporal groupings.
- *Scatterplots by date* — Tests for correlation of biological attributes (metrics) with sampling date.

See Appendix A for full discussion of methods.

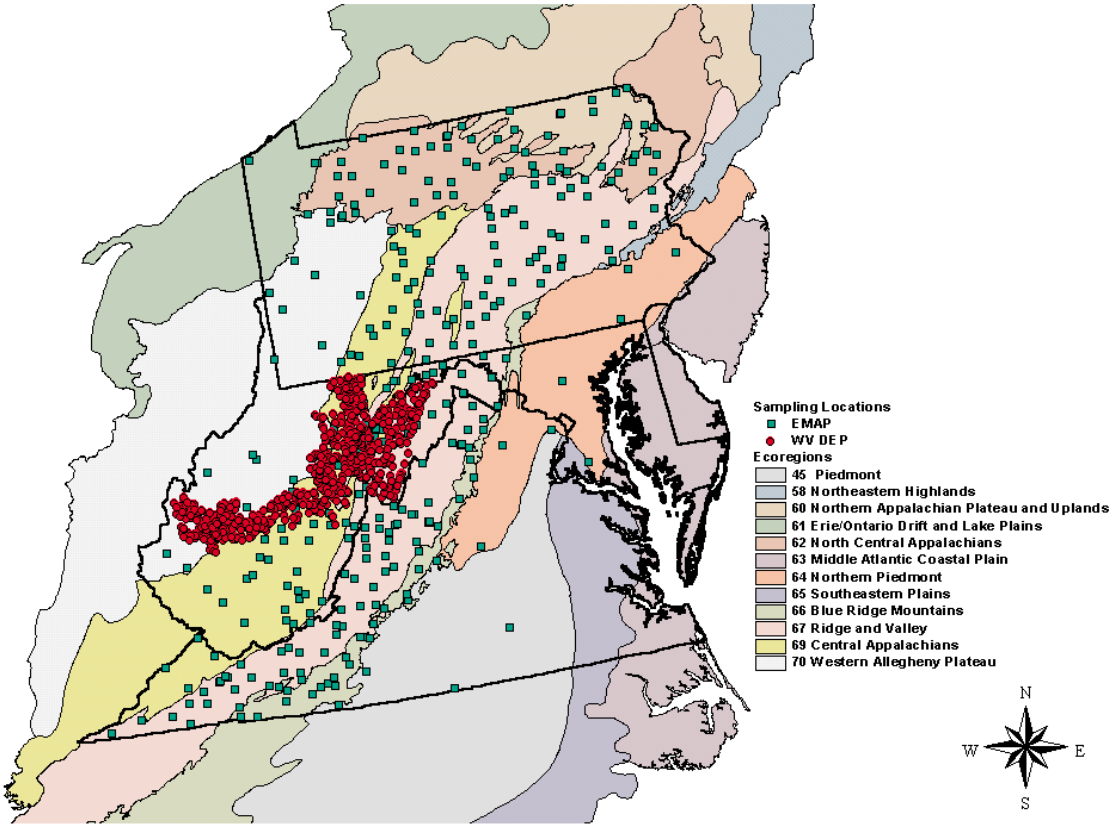


Figure 3-1. Geographic distribution of benthic macroinvertebrate sampling sites by data source and ecoregion.

The development of an appropriate classification for bioassessment was confounded by a broad temporal range of collections (May - September). The issue of seasonal differences in the benthic macroinvertebrate assemblage might require grouping the data by narrower date ranges for classification. Therefore, analyses were performed to evaluate both ecoregions and date.

Conclusion for Classification into Bioregions

- Use of ecoregions to serve as bioregions for benthic assessments of cobble habitat in streams of West Virginia is not necessary.
- While the broad collection timeframe of West Virginia DEP introduces variability into the dataset, no clear differentiation of sampling periods was discernable.

Documentation for results are as follows:

- Ordination of the benthic data by ecoregion indicated that a spatial classification was not distinct (Figure 3-2). Neither the EMAP data (based on genus-level taxonomy) nor the West Virginia data (based on family-level taxonomy) were able to distinguish ecoregions adequately to serve as bioregions.

- Ordination of the West Virginia benthic data by date was not distinct enough to partition into separate sampling periods (Figure 3-3). There was a slight indication that the early sampling dates May - June would provide less variability for assessments. The EMAP data were primarily restricted to a July - August time period, and thus not tested for date differences in this analysis.

- The classification into ecoregions did not explain differences among sites (0% difference explained) for EMAP data, and only a weak explanation (6.5% difference explained) for the West Virginia data (Table 3-1).

- By grouping the benthic data into individual months, classification was improved over ecoregions (9.7% difference explained), but still inconsequential to explaining variability (Table 3-1).

- Comparisons of frequencies and relative abundance of taxa did not reveal distinct differences among sites in the 3 ecoregions (Table 3-2).

- Correlation of various biological attributes or metrics with day of the year sampled illustrated a weak relationship only with abundance of Chironomids (Figure 3-4).

- Box-and-whisker plots performed on various benthic attributes illustrated only weak distinction among ecoregions and sampling periods (Appendix D, Figures D1-D2). The lack of distinction supports using a single class structure for assessment of West Virginia streams.

Recommendations From this Analysis

- Classification by some regional physiographic structure (e.g., ecoregions) was not supported by this analysis of the benthic assemblage from cobble substrate in wadeable streams within the Appalachian Mountains. The issue of using bioregions to stratify or partition the aquatic community may still be valid if collecting methods change, level of taxonomy changes, and/or non-cobble habitats are sampled.

- A narrower sampling window of late spring to early summer would improve the assessments by reducing variability.

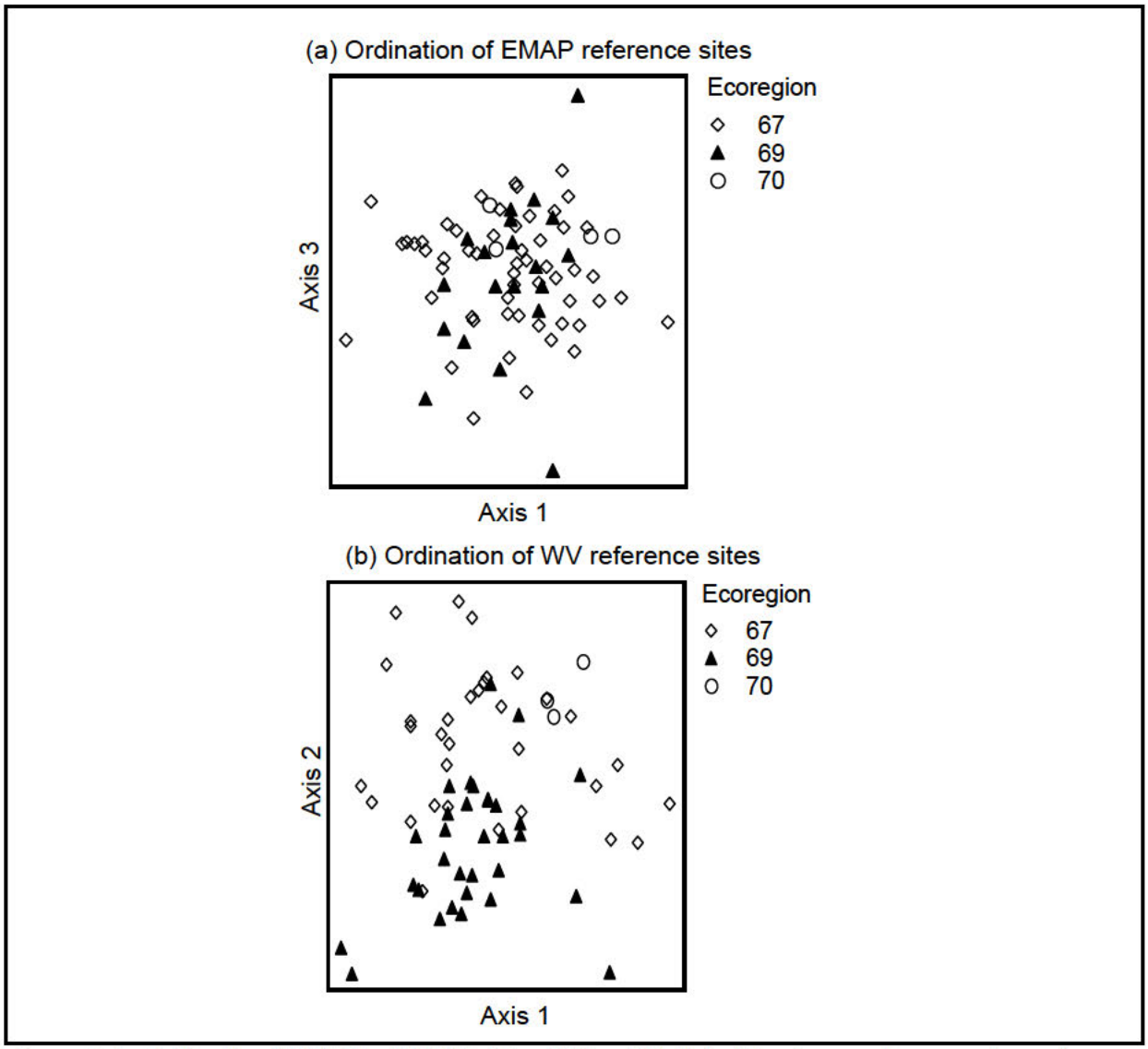


Figure 3-2. Ordination (NMDS) of EMAP (a) and West Virginia (b) reference site macroinvertebrate data by 3 ecoregions: Ridge and Valley (67), Central Appalachians (69) and Western Allegheny Plateau (70). *The ordination plots allow sites to be visualized in "ordination space," such that sites that are similar to each other (i.e., they share a similar species composition) are close together in the plot, while sites that are highly dissimilar are plotted far apart. Ordination of the EMAP macroinvertebrate data (79 sites) from the 3 ecoregions revealed no clear ecoregional pattern, as seen by the overlapping locations of points (Figure a). West Virginia benthic data (67 sites) show a weak but discernible pattern associated with ecoregion (Figure b). Ridge and Valley sites (No. 67) are more abundant in the top half of the plot, Central Appalachian sites (No. 69) are more abundant in the bottom half of the plot, and the 3 Allegheny Plateau sites (No. 70) occur close together in the upper right area. Further similarity analysis is reported in Table 3-1.*

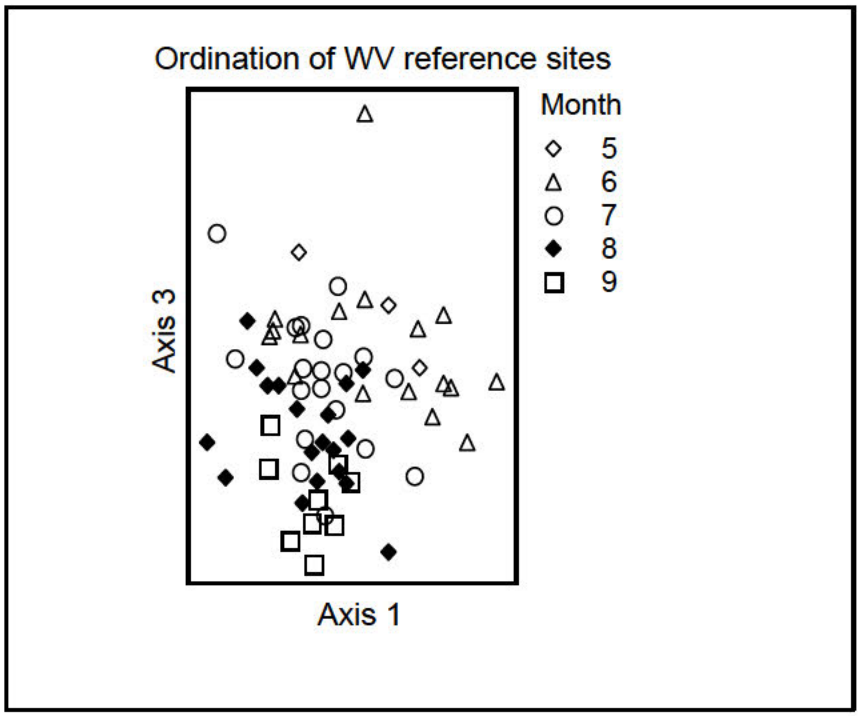


Figure 3-3. Ordination (NMDS) of West Virginia reference site macroinvertebrate data by month of sampling. *The plot shows a slight effect due to time-of-sampling, but as with ordination by ecoregion, there is considerable overlap of data points among the different sampling months.*

Table 3-1. Strength of alternative classifications of macroinvertebrate assemblages in reference sites. *Similarity analysis revealed that the ecoregional classification for West Virginia data accounted for approximately 6.5% of the dissimilarity among sites. Similarly, month of sampling accounted for approximately 9.7% of the total dissimilarity. We found that the effects of ecoregion and date were confounded but that neither gave a particularly strong classification: both were less than 10% of the total average dissimilarity.*

Data Source	Classification	Percent Differences Explained
EMAP data	ecoregions (n=79)	0
WV data	ecoregions (n=67)	6.5%
WV data	month (n=67)	9.7%

Table 3-2. Frequency and relative abundance of top 20 taxa in West Virginia reference sites, by ecoregion. Frequencies of top 10 taxa in each ecoregion are in bold. *Differences among sites in this analysis are caused by differences in taxa composition. Overall, these were relatively minor at the family level. Four families were at least 25% more common and abundant in the Ridge and Valley ecoregion than in the Central Appalachians: the Chloroperlidae, Ephemerellidae, Peltoperlidae, and Gammaridae. Taxa more common in the Central Appalachians were the Tipulidae, Rhyacophilidae, and Cambaridae. There were only 3 sites in the Western Appalachians, so estimates of frequency of occurrence are unreliable (not shown).*

	Ridge and Valley (Region 67) n=32		**Central Appalachians (Region 69) n=32**	
	frequency	**mean rel. abund.**	**frequency**	**mean rel. abund.**
Chironomidae	**94%**	**6.0%**	**97%**	**9.3%**
Heptageniidae	**91%**	**12.6%**	**97%**	**9.0%**
Baetidae	**94%**	**18.0%**	**88%**	**9.1%**
Capniidae	**97%**	**9.8%**	**84%**	**20.2%**
Hydropsychidae	**100%**	**10.4%**	**81%**	**21.2%**
Philopotamidae	**84%**	**5.1%**	**81%**	**6.1%**
Chloroperlidae	**91%**	**5.1%**	**66%**	**6.9%**
Tipulidae	63%	2.5%	**91%**	**4.6%**
Perlidae	66%	4.4%	**69%**	**3.7%**
Perlodidae	**72%**	**3.5%**	50%	3.2%
Leptophlebiidae	63%	5.1%	56%	4.3%
Rhyacophilidae	34%	2.1%	**81%**	**2.6%**
Pteronarcydae	**69%**	**3.8%**	47%	1.8%
Ephemerellidae	63%	2.3%	38%	4.0%
Peltoperlidae	**75%**	**6.7%**	28%	3.2%
Simuliidae	47%	2.5%	41%	2.7%
Cambaridae	31%	2.6%	56%	1.4%
Elmidae	25%	1.8%	47%	2.8%
Oligochaeta	25%	3.1%	44%	3.7%
Nemouridae	31%	5.2%	19%	17.9%

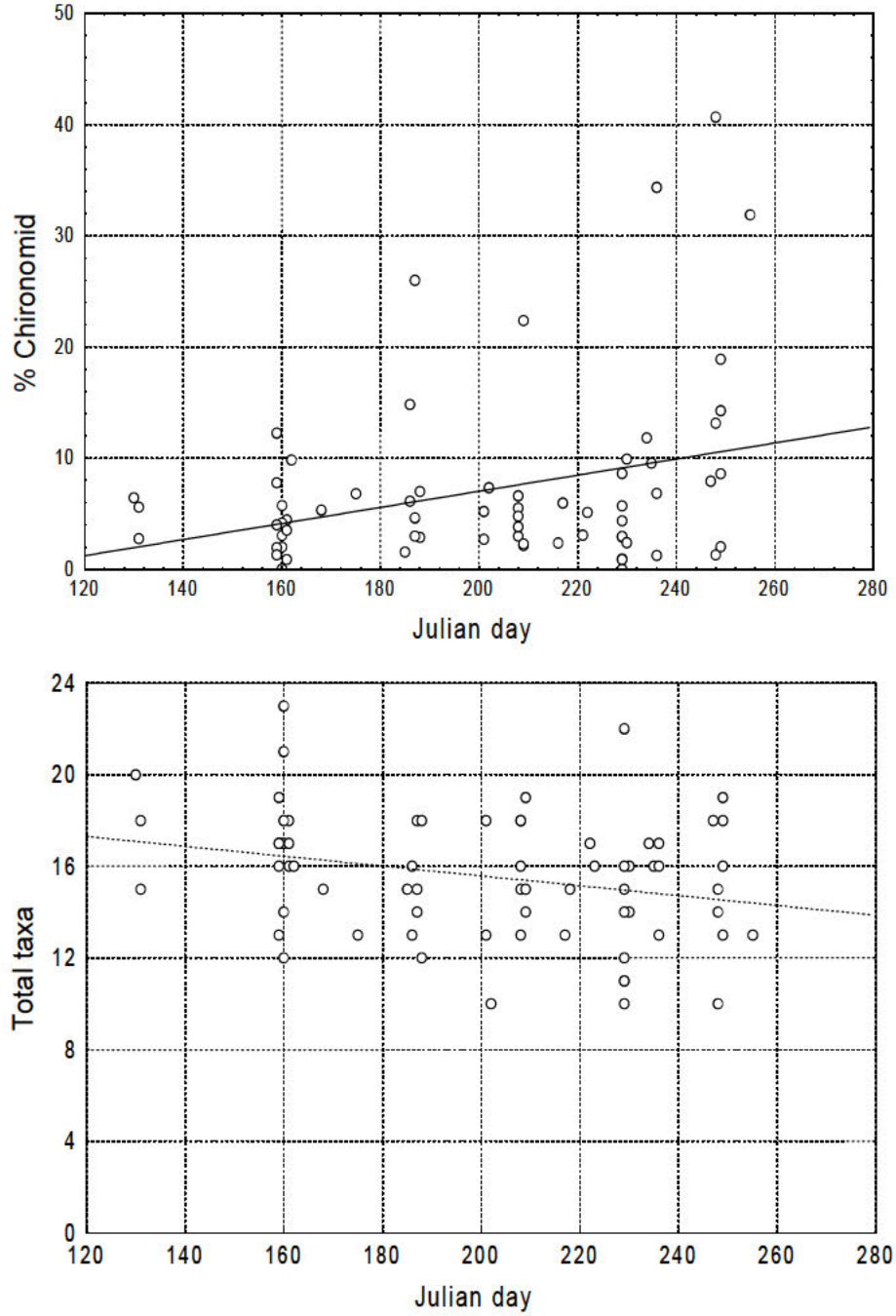


Figure 3-4. Metric values in 67 West Virginia reference sites plotted by Julian day. *This analysis showed a weak relationship in the %Chironomid metric (top), but other candidate metrics, such as Total taxa (bottom), showed no discernible relationship.*

4. TRANSFORMING BIOLOGICAL ATTRIBUTES INTO METRICS

A *metric* is a characteristic of the biota that changes in some predictable way with increased human influence.

Various attributes of the benthic macroinvertebrate community have been characterized in the form of quantitative measures called metrics. The attributes of the community that are measured by these metrics fall into several categories of benthic community characteristics, and the specific metrics within those categories can indicate different aspects of the community condition. For example, metrics dealing with species richness or diversity, such as Total Taxa, can be used as indicators of community health because an ecologically healthy system is generally expected to support a more diverse community of fauna than can be supported in an ecologically impaired area. Multiple metrics evaluated together can give an overall indication of ecological integrity.

West Virginia's benthic macroinvertebrate samples collected in the 1996-1997 seasons were identified to the family taxonomic level, and 100 organisms were counted for each sample. Within each 100-organism sample, the number of individuals of each family were tallied. The identifications and counts of organisms collected at each site provide the information used to calculate a suite of metrics for each benthic sample.

Metrics evaluated for use with the West Virginia 1996-1997 benthic macroinvertebrate data represented four categories: taxonomic richness, taxonomic composition, feeding groups, and tolerance (see metric categories box). Habit metrics were not calculated because they are not useful with family level taxa identification. Since classification analysis did not demonstrate the need for partitioning West Virginia data collection sites into separate bioregions or index periods (Chapter 3), all 720 sampling sites were considered as one site class. Candidate metrics were calculated for each of the 720 benthic samples. Selection of specific metrics for use in a stream condition index was based on several evaluation criteria (see metric evaluation box).

Metric Categories

- *Taxonomic richness* — counts of distinct taxa within selected taxonomic groups.
- *Taxonomic composition* — proportions of individuals belonging to specific selected taxonomic groups.
- *Functional feeding group* — dominant mode of feeding, though not the specific nutritional source or benefits (e.g., suspension feeder, predator, etc.).
- *Habit* — dominant behavior of an animal for moving and maintaining physical position in its habitat (e.g., sprawling, clinging, etc.).
- *Degree of tolerance* — counts, proportions, or weighted scores of taxa based on ability to survive exposure to pollutants.

See Appendix A, A.4.1 for full discussion.

Criteria for identifying stressed sites were established using parameters similar to those used by West Virginia DEP for identifying reference sites (see stressed site criteria box, below). To be categorized as stressed, a site needed to meet only one of the listed conditions. Out of the 720 benthic samples used in this analysis, there were 69 sites identified as meeting at least one of the criteria for stress.

Metric Evaluation. Metrics are included if they:

- are able to differentiate between reference and impaired sites (methods: box plots, discrimination efficiencies [DE]);
- represent at least some different aspects of the community (taxa composition, richness, tolerance, and the like); and
- minimize redundancy among individual component metrics (method: Pearson correlations).

Stressed Site Criteria. 69 sites were deemed stressed by meeting at least one of these criteria:

- Dissolved oxygen < 4.0 mg/l
- pH < 4.0
- Conductivity > 1000 µmhos
- Epifaunal substrate score < 7 and Total habitat score <120
- Channel alteration score < 7 and Total habitat score <120
- Sediment deposition score < 7 and Total habitat score <120
- Bank disruptive pressure score < 7 and Total habitat score <120
- Riparian vegetation zone width score < 4 and Total habitat score <120

- **Discrimination of site impairment**

Box-and-whisker plots for 24 candidate metrics, comparing the distribution of values in 67 reference sites with the distribution of values in 69 impaired sites, are presented in Appendix D (Figures D3-D6). The distributions displayed in these plots were evaluated as described in Appendix A (section A.4.2; Figures A-1 - A-2). Eleven candidate metrics exhibited discrimination efficiencies (as described in Appendix A.4.2) above 60% (Table 4-1).

- **Representation of different community attributes**

Discriminatory metrics, identified on the basis of boxplots and discrimination efficiencies, represent three different categories of benthic community attributes: taxonomic richness, taxonomic composition, and tolerance to environmental stress (Table 4-1).

- **Minimized redundancy**

Pearson correlation coefficients (Table 4-2) identified that EPT taxa and Intolerant taxa had a correlation of 0.92, and that %Chironomidae was highly correlated with %Diptera (0.91) and with %Tolerant (0.88). In addition, with the family-level West Virginia data, individual component metrics involving Ephemeroptera, Plecoptera, and Trichoptera were eliminated in favor of the more highly discriminatory composite metrics of %EPT and EPT taxa.

The process of metric selection is iterative, with the areas of consideration being revisited and weighed throughout the process. Table 4-1 reports the final recommended metrics for use in a stream condition index, along with reasons for including or excluding each metric.

Recommendation for Use of Metrics to Measure Biological Attributes

For scoring West Virginia stream condition based on 1996-1997 data collected in riffle habitats, six recommended metrics are: EPT taxa, Total taxa, %EPT, %Chironomidae, HBI (family level), and % 2 Dominant taxa.

Table 4-1. Candidate metrics: Expected response to stress, discrimination ability, and final recommendation for WV stream condition index

Metric	Expected response ▲ increase ▽ decrease	Discrimination efficiency[1] (DE)	Used in final index	Reason for including or excluding metric in the final index
Taxonomic Richness				
Total taxa	▽	71.0%	✔	Good DE in this category
EPT taxa	▽	82.6%	✔	Good DE in this category
Ephemeroptera taxa	▽	58.0%		Included in EPT taxa with family-level data
Plecoptera taxa	▽	59.4%		Included in EPT taxa with family-level data
Trichoptera taxa	▽	65.2%		Included in EPT taxa with family-level data
Diptera taxa	▽	—		Poor discrimination
Chironomidae taxa	▽	—		Poor discrimination
Taxonomic Composition				
%EPT	▽	78.3%	✔	Good DE in this category
% Ephemeroptera	▽	58.0%		Included in %EPT with family-level data
% Plecoptera	▽	62.3%		Included in %EPT with family-level data
% Trichoptera	▽	68.1%		Included in %EPT with family-level data
% Diptera	▲	72.5%		91% correlated with %Chironomidae
% Chironomidae	▲	73.9%	✔	Good DE in this category
% Oligochaeta	▲	—		Poor discrimination
% Dominant taxon	▲	49.3%		Poor discrimination
% 2 Dominant taxa	▲	55.1%	✔	Acceptable DE; included after ruling out %tolerant and %diptera
Feeding groups				
% Filterers	▲	na		Trend opposite from expected; interpretation unclear
% Scrapers	▽	—		Poor discrimination
% Collectors	▽	na		Trend opposite from expected; interpretation unclear
% Predators	▽	—		Poor discrimination
% Shredders	▽	55.1%		Skewed distribution, high variance; marginal discrimination
Tolerance/Intolerance				
Intolerant taxa	▽	79.7%		92% correlated with EPT taxa
% Tolerant	▲	73.9%		88% correlated with %Chironomidae
HBI (family level)	▲	68.1%	✔	Acceptable DE in this category, after ruling out other tolerance metrics

[1] See Appendix A, section A.4.2

Table 4-2. Pearson Correlation Coefficients among 15 Candidate Metrics. Metrics for all 1996-1997 samples (n=720) were included in the correlation. **Bold** R values are greater than 0.85.

	Total taxa	EPT taxa	Ephem taxa	Plecop taxa	Trichop taxa	% EPT	% Ephem	% Plecop	% Dip	% Chiro	%top 2 dom	Intol.. taxa	% Tolerant
Total taxa	1.00												
EPT taxa	0.85	1.00											
Ephemeroptera	0.72	0.76	1.00										
Plecoptera taxa	0.55	0.78	0.35	1.00									
Trichoptera taxa	0.64	0.66	0.36	0.25	1.00								
% EPT	0.35	0.57	0.34	0.54	0.36	1.00							
% Ephemeroptera	0.33	0.45	0.58	0.29	0.12	0.47	1.00						
% Plecoptera	0.02	0.19	-0.11	0.46	-0.02	0.47	-0.21	1.00					
% Trichoptera	0.07	0.03	-0.08	-0.13	0.38	0.27	-0.27	-0.28					
% Diptera	-0.32	-0.45	-0.26	-0.42	-0.30	-0.79	-0.37	-0.36	1.00				
% Chironomidae	-0.29	-0.39	-0.20	-0.36	-0.30	-0.72	-0.31	-0.35	**0.91**	1.00			
% top 2 dominant	-0.67	-0.66	-0.56	-0.47	-0.43	-0.33	-0.33	-0.05	0.34	0.37	1.00		
Intolerant taxa	0.82	**0.92**	0.62	0.82	0.57	0.55	0.35	0.28	-0.45	-0.41	-0.60	1.00	
% Tolerant	-0.35	-0.46	-0.27	-0.40	-0.35	-0.80	-0.36	-0.36	0.80	**0.88**	0.39	-0.47	1.00
HBI (family)	-0.34	-0.50	-0.22	-0.56	-0.29	-0.76	-0.18	-0.71	0.65	0.67	0.38	-0.56	0.82

5. AGGREGATING METRICS INTO A BIOLOGICAL INDEX

Using the final six selected metrics (Chapter 4), a working index for scoring West Virginia stream condition was determined following the steps summarized in the box to the right. Appendix A describes the entire procedure in detail. The range of reference site values for the working West Virginia stream condition index was compared with the range of values in the impaired sites by means of box-and-whisker plots (Figure 5-1), and these boxplots confirmed that the working index is able to discriminate between reference and stressed sites.

Metrics and Scoring

- *Select metrics* —

Total taxa	% Chironomidae
EPT taxa	% 2 dominant taxa
% EPT	HBI (Family)

- *Calculate metrics* — Calculate values for the 6 selected metrics for all 720 sampling sites.
- *Standardize scores* — Convert all metric values to a standard 0-100 point scale.
- *Calculate index* — Average the 6 standardized metric scores for each benthic sampling site.

See Appendix A, A.5 for full discussion.

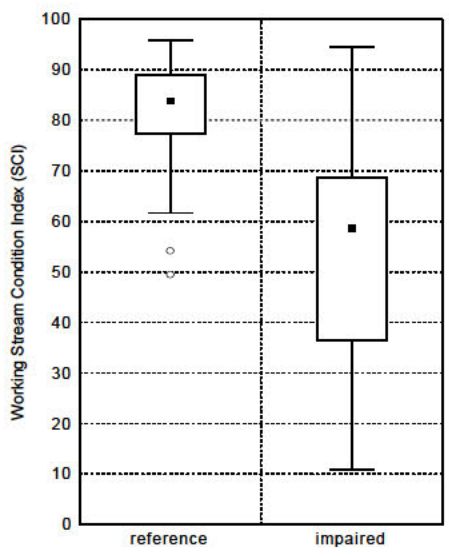


Figure 5-1. Working SCI discriminates between West Virginia reference and impaired sites in the 1996-1997 calibration data.

Though classification analysis (Chapter 3) did not indicate distinct partitioning of sampling into separate index periods, the possible variability of a long sampling period was examined again in the working index. Figure 5-2, showing boxplots of the working index by sampling period and a scatterplot of reference site index scores by Julian day, demonstrates that though the degree of discrimination is slightly better in the May-June period (Figure 5-2[a]), the working index does discriminate between reference and impaired sites in both sampling periods.

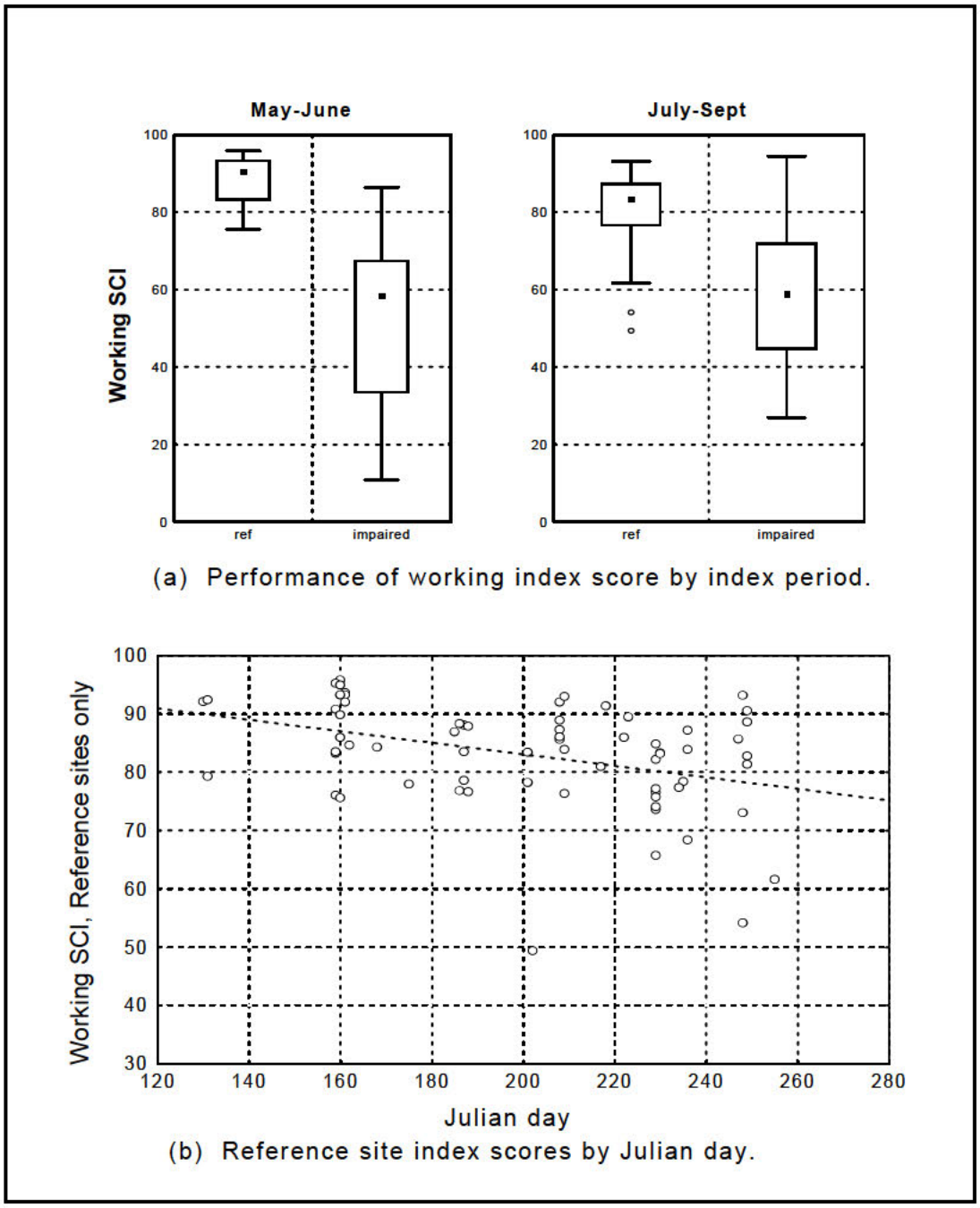
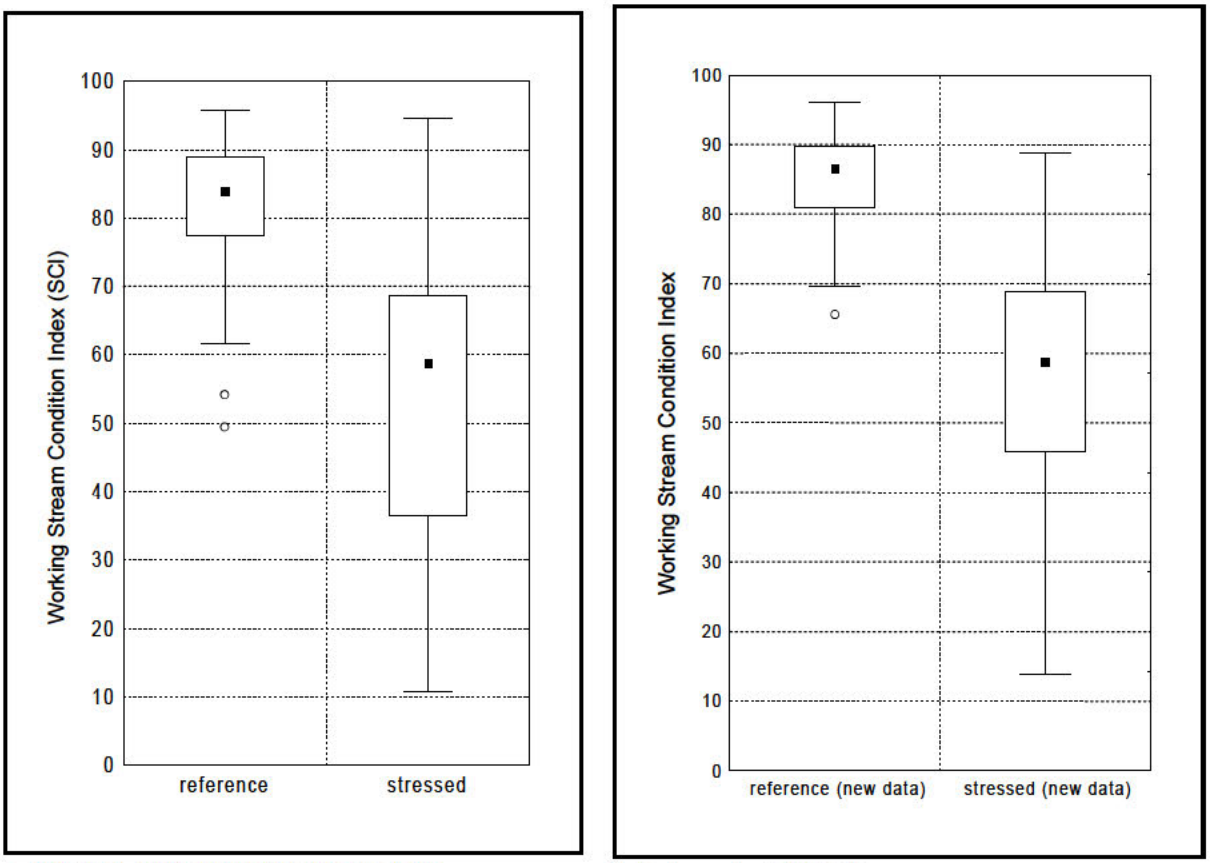


Figure 5-2. Effect of sampling season on working West Virginia stream index (SCI). *This graph shows slight improvement in discrimination between reference and impaired sites in the earlier sampling period (a), though the index does discriminate impairment in the later sampling period as well. A narrower sampling window of late spring to early summer might improve the assessments by reducing overall variability.*

6. TESTING AND REFINING THE INDEX USING INDEPENDENT DATA

New data provided by WV DEP were used (as described in Appendix A.6) to test the discrimination efficiency of the recommended West Virginia multimetric index. A comparison of the working index values in the original data with those in the independent test data shows good agreement (Figure 6-1). Discrimination efficiencies of the test data set were also good: 85% of the 40 test reference sites scored higher than the 25th percentile of the original reference sites. Stressed sites in the test data also were very similar to the original sites: 92% scored below the 25th percentile of the original reference sites.



a. Original 1996-1997 data (Figure 5-1).

b. Independent 1998 data.

Figure 6-1. Working SCI discriminates between West Virginia reference and stressed sites in the new independent data (b) as well as in the original data set (a).

Final Recommended West Virginia Stream Condition Index (SCI):

To refine the working index by making use of the entire set of data provided by WVDEP (1996-1998), all samples were combined. Percentile distributions of each metric's values were determined for the entire set of 1996-1998 data (n=1268 benthic samples). The revised, final Stream Condition Index (SCI) makes use of the 95th or 5th percentile (depending on the metric) standard values determined from this combined set of all samples. Table 6-1 presents metric standard values and standardization formulas for the six metrics that compose the final recommended West Virginia multimetric SCI. Individual metrics in exceptionally high quality streams may score higher than 100, but a maximum metric score of 100 is used when averaging the six metrics to determine the final SCI score; this assures that each metric contributes equally to the multimetric index.

Table 6-1. West Virginia final SCI: Metric standard values and standardization formulas.

Metrics that decrease with stress	Standard (best value) X_{95}	X_{min}	Standardization formula (Appendix A.5, Equation 2; X=metric value)
Total taxa	21	0	score = 100 × (X/21)
EPT taxa	13	0	score = 100 × (X/13)
%EPT	91.9	0	score = 100 × (X/91.9)
Metrics that increase with stress	**Standard (best value) X_5**	**X_{max}**	**Standardization formula (Appendix A.5, Equation 3; X=metric value)**
%Chironomidae	0.98	100	score = 100 × [(100-X)/(100-0.98)]
% 2 dominant	36.0	100	score = 100 × [(100-X)/(100-36.0)]
HBI (family)	2.9	10	score = 100 × [(10-X)/(10-2.9)]
Final index score (SCI) for a site is determined by averaging the site's 6 standardized metric scores, using a maximum metric score of 100 for any metric whose individual score at a site may have exceeded 100.			

Percentile distributions of the final SCI in the 1996-1998 combined set of 107 reference samples are reported in Table 6-2. Metric values, metric standardized scores, and SCI scores for all sites in the original and new data sets are provided in Appendix C.

Table 6-2. Percentile distribution of Index (SCI) values in all 1996-1998 Reference samples.

N	minimum	5th	10th	25th	median	75th	90th	95th	maximum
107	49	68	74	78	86	90	93	94	96

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Rating System

The macroinvertebrate Stream Condition Index (SCI) for West Virginia streams is robust and repeatable and can be used to assess the biological condition of West Virginia streams. The relatively low variability of scores in the reference sites suggests that at least 5 rating classes can be used. A rating of "highly comparable to reference sites" could apply to sites that score greater than the 25th percentile of reference sites. A "comparable" to below-average reference sites could apply to sites scoring greater than the 5th percentile of reference sites (Table 7-1, Figure 7-1). Scores below the 5th percentile of reference sites are increasingly different from the reference condition. Alternatively, the range of scores from 0 to 100 could be divided into 5 equal categories (80-100, 60-80, etc.).

Table 7-1. Example rating system for West Virginia SCI scores.

SCI score	Rating
> 78 - 100	Highly comparable to reference sites (above 25th percentile)
> 68 - 78	Comparable to below-average reference sites (between 5th and 25th percentiles)
> 45 - 68 > 22 - 45 0 - 22	} Increasingly different from reference condition

7.2 Refining the index

The preliminary breakdown of site scores in Table 7-1 could be refined and narrowed by reducing the index period and by examination of outliers:

- The length of the sampling index period (spring to fall) was shown to contribute to index variability, although not fatally. This variability could be reduced by restricting sampling to a smaller window in spring and early summer, for example, May and June.

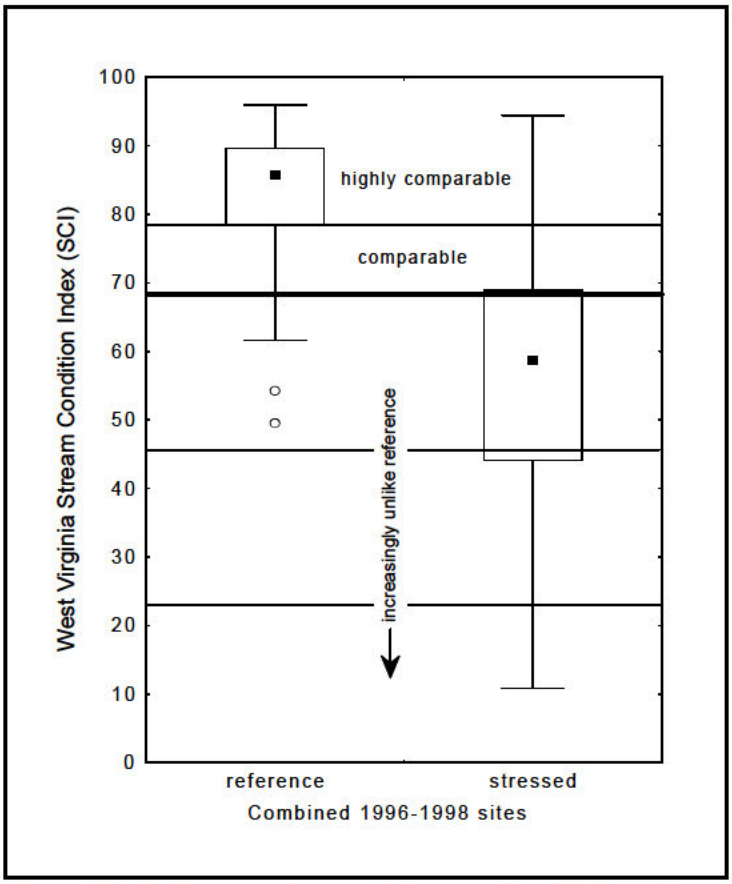


Figure 7-1. Reference and stressed sites, combined 1996-1998 data, and possible rating categories.

- Several reference sites scored low (less than 68) in the original data (and one in the test data). These outliers should be examined in more detail to determine if they were misidentified as reference sites, or if they are not representative of reference sites. They should not be excluded simply because of a low SCI score, but should be excluded if previously undetected human-caused stress or pollution is found at the sites (unknown discharges, erosion, non-point source pollution, habitat disruption).

- The outliers also may be excluded from the reference sites if their physical-chemical habitat is not representative of the other reference sites. For example, there were too few reference sites in limestone valleys to identify valley streams as a separate class. Limestone valley streams may be outliers, unless it can be demonstrated that they are similar to non-limestone streams. Another example of a non-representative outlier is a site where the stream bed is composed entirely of

bedrock. The habitat in all-bedrock sites is impaired and not representative, although it is entirely natural. Such sites should be identified as special cases and removed from the list of reference sites, yet they should not be listed impaired in an assessment only because the (natural) habitat is impaired.

7.3 Maintaining the index

In West Virginia's sampling program, new reference sites will be sampled each year. Confidence in the index will be enhanced if new data are incorporated into the index, especially as more watersheds are sampled and a more representative coverage is obtained of the entire state.

New reference sites can be added to the reference data set, and both the metric standard values (Table 6-1) as well as the distribution of reference scores (Table 6-2) can be recalculated on an annual basis. As the database becomes more representative of the entire state, both the standard values and the distribution should become quite stable.

A larger reference site database will allow WVDEP to revisit the issue of classification, especially with respect to under-represented ecoregions in the current database (e.g., valley streams of the Ridge and Valley; Greenbrier Karst streams). Limestone valley streams are thought to be different from ridge streams, but there were not sufficient reference sites from the valley subregions to make this determination in the current database.

APPENDIX A

ANALYTICAL METHODS AND STEP-BY-STEP PROCESS

A.1 Database development
A.2 Reference site criteria
A.3 Site classification
A.4 Testing of candidate metrics
- **A.4.1 Metric categories**
- **A.4.2 Metric discrimination ability**

A.5 Index development
- **A.5.1 Scoring for metrics whose values are expected to decrease with site degradation**
- **A.5.2 Scoring for metrics whose values are expected to increase with site degradation**
- **A.5.3 Combining scores into an index**

A.6 Index validation and refinement

ANALYTICAL METHODS

The analytical framework used in site classification, final metric selection, biological index development, and development of scoring criteria follows that used in other states and regions (e.g., Barbour et al. 1996, Maxted et al. in press, Stribling et al. 1998), with application to West Virginia's biological sampling and monitoring program. The approach used for development of a regionally-calibrated multimetric biotic index for West Virginia streams (a Stream Condition Index, or SCI) followed these basic steps:

1) Develop database
2) Identify criteria for stream reference sites
3) Determine site classification strata
4) Compile and test candidate metrics
5) Combine metrics into an index
6) Test and validate the index (SCI)

A.1 Database development

Biological, habitat, and water quality data from 1996 and 1997 were received from West Virginia DEP as FoxPro® data files and were transferred into EDAS (Ecological Data Application System, version 1.1c) (Tetra Tech, 1999), for ongoing data management and analysis. In EDAS (a custom application developed for use with Microsoft Access97®), data, metadata, and other information reside in a series of relational tables, including: stations, samples, benthic taxa, chemistry, habitat, and related information. Use of a relational database such as EDAS allows for data elements to be stored in a compact, efficient manner that reduces the redundancy of spreadsheet-style data management systems. EDAS also incorporates pre-designed queries that can be used to calculate and export metrics and other needed information.

West Virginia's 1996-1997 data were collected during the months of May through September from 720 stream sampling sites. Each sample consisted of 100 macroinvertebrates identified to the family taxonomic level. In West Virginia's monitoring program, streams state-wide are sampled on a five-year cycle, with each year's sampling sites consisting of a subset of the entire state. In the 1996-1997 sampling seasons, sample sites were concentrated in an area across the central portion of the state (Figure 3-1).

A.2 Reference site criteria

Reference site selection criteria were developed by West Virginia DEP Watershed Assessment Program personnel to obtain reference conditions for streams that were assessed in the 1996 and 1997 field seasons. Generally, no effort was made to select candidate reference sites before assessments began. Reference site selection criteria are reported in Table A-1. To be classified as reference, a site must have met all of the listed conditions. Based on these criteria, West Virginia DEP identified 67 reference sites out of the 720 benthic sites sampled during the 1996-97 field seasons. Tetra Tech used the 67 reference sites identified by West Virginia to characterize reference conditions.

Table A-1. Reference criteria for West Virginia 1996-1997 Stream Assessment[1]

	Parameter	Criterion	Explanation
1	Dissolved oxygen	≥ 6.0 mg/l	Taken from "WV Water Quality Standards" as developed by the State Water Resources Board (SWRB)
2	pH	≥ 6.0 and ≤ 9.0	Conductivity and pH are based on observations of WAP and OWR data and from BPJ of experienced OWR field personnel
3	Conductivity	<500 umhos/cm	
4	Fecal coliform	<800 colonies/ 100 ml	This limit is double the maximum set by the SWRB (where the standard is no more than 400 colonies/100 ml in more than 10% of all samples taken during the month. Reference criterion value was raised to 800/100ml due to the lengthy holding time of fecal samples (24 hours in many cases). In addition, experienced field personnel have encountered fecal levels exceeding the standard in some streams where no human impacts were possible (possibly due to wildlife populations), so the higher level of 800/100ml would reduce the possibility of excluding some anthropogenically undisturbed streams from reference consideration.
5	No obvious sources of non-point-source pollution (NPS)		
6	Epifaunal substrate score	≥ 11	Criteria 6-11 are adapted from RBP habitat assessment modified for use in the USEPA/EMAP program. These criteria were selected because they are presumably most indicative of anthropogenic perturbation. A value ≥ 11 indicates that stream habitat is at least sub-optimal for that particular parameter. The WV WAP sampling strategy dictates that assessments be conducted at or near the mouths of streams. This strategy tends to bias the habitat scores (many sites are roadside-accessible or below bridges) and in many cases results in relatively low scores for those parameters which are most indicative of human disturbance. It is for this reason that the minimum values are set to 11 (#6-9) and 6 (#10). Otherwise, few streams (if any) would meet the selection criteria.
7	Channel alteration score	≥ 11	
8	Sediment deposition score	≥ 11	
9	Bank disruptive pressure score	≥ 11	
10	Riparian vegetation zone width score	≥ 6 (variable depending on watershed)	
11	Total habitat score	65% of maximum 240 (% is variable depending on watershed)	
12	Evaluation of anthropogenic activities and disturbances	Best professional judgement is employed to make reference site inclusions based on the number and type of disturbance. For example, a surface mine site would generally be considered a greater disturbance than the combination of an ATV trail and a small road and would exclude the site from reference condition consideration. However, impacts from the ATV trail and/or road may be considered so minor that they do not exclude the site from reference consideration.	
13	No known point source discharges upstream of assessment site	(completed after 1-12 are met)	

[1] As provided in "WVDEP Watershed Assessment Program Reference Site Selection Guidance for Riffle/Run Streams" memo dated 2/4/98.

A.3 Site classification

Detection of changes in the biological assemblage due to human effects must take into account inherent differences due to natural factors. Natural variability in the macroinvertebrate assemblage may result from natural variability in the physical and chemical site characteristics across a geographic range. Much of the natural variability can often be accounted for by dividing the area into ecological regions (ecoregions; Omernik 1987). Level 3 ecoregions (Omernik 1987) have been used as an accepted geographic framework for delineating regions of relatively homogeneous natural conditions (e.g., Barbour et al. 1996). West Virginia data in this analysis were collected from sites in three Level 3 ecoregions: Ridge and Valley (No. 67), Western Allegheny Plateau (No. 70), and Central Appalachians (No. 69). We examined whether the Level 3 ecoregions accounted for variability of biota among sites, and whether additional physical and chemical information could account for the variability.

The geographic distribution of West Virginia sampling sites for 1996-1997 was not sufficiently broad to fully address site classification based on ecoregions (see Figure 3-1). Tetra Tech obtained data from EPA's Mid-Atlantic Highlands Assessment of the Environmental Monitoring and Assessment program (EMAP-MAHA) from 1993-1994 to expand the data set to achieve a sufficient geographic distribution of reference sites for analyzing possible site classification. Because of the use of different field collection methods in the two programs, EMAP and West Virginia data were not combined. Instead, West Virginia's reference site criteria (Table A-1) were applied as closely as possible to the EMAP data in order to select substitute reference sites for use in classification analysis. Water chemistry (criteria 1-3; Table A-1) and habitat (criteria 6-11; Table A-1) could b e applied to the EMAP data. Using this procedure, 80 EMAP sites (all riffles) were selected from the three ecoregions of Ridge and Valley (67), Western Allegheny Plateau (70), and Central Appalachians (69). The EMAP reference sites were not required to be located in West Virginia as long as they were located in an ecoregion that extended from an adjacent state into West Virginia. Locations of West Virginia sampling sites, EMAP sites, and EMAP reference sites are shown in Figure 3-1.

Alternative classification schemes were examined with multivariate ordination of the sampling sites based on their species composition, following methods outlined in Jongman et al. (1987) and Ludwig and Reynolds (1988). Ordination is a family of methods for reducing the dimensionality of multivariate information (many species in many sites), by placing sites or species in an order. The ordination method we use is non-metric multidimensional scaling (NMDS) using the Bray-Curtis dissimilarity coefficient. This method has been shown to be robust for ordination of species composition (e.g., Kenkel and Orloci 1986, Ludwig and Reynolds 1988) and has been used successfully for classification of stream communities (e.g., Barbour et al. 1996; Reynoldson et al. 1997).

NMDS is a nonlinear ordination that attempts to place sites in a spatial orientation that agrees with some distance measure between the sites. It is analogous to creating a map using only the distances between cities. In the case of our ordination of biological samples, the "distance" between two samples is their percent similarity, as measured by one of several similarity indexes. The Bray-Curtis index is the percent that two assemblages are similar to each other.

A matrix of Bray-Curtis similarities was calculated from the species-relative abundance data. This matrix was then used in the NMDS procedure. The NMDS ordination (McCune and Mefford 1995) follows the procedure of Kruskal (1964). The final ordination was required to have a stress coefficient (a measure of goodness-of-fit of the ordination to the original data) of less than 20%. This usually required 3 ordination axes. The final NMDS configuration was plotted (as a scatterplot) to determine any obvious groupings and to evaluate alternative classes (Figures 3-2 and 3-3). Candidate classifications were tested with similarity analysis (Van Sickle 1997) to determine the strength of the classification. This procedure calculates the mean similarity of sites within classes, and the mean similarity of sites among classes. The difference between the two is the % of dissimilarity that is explained or accounted for by the classification. Thus, a value of 10% indicates that the classification (say, ecoregions) explains 10% of the total dissimilarity (difference) among all sites (Table 3-1).

A.4 Testing of Candidate Metrics

Various attributes of the benthic macroinvertebrate community have been proposed as metrics to quantitatively characterize aspects of the community condition (e.g., Gibson et al. 1996, Stribling et al. 1998). Twenty-four candidate measures were considered for use with the West Virginia benthic macroinvertebrate data. These metrics were selected based upon their known or suspected ability to discriminate impairment. The 24 candidate metrics fall into five categories of community attributes: taxonomic composition, taxonomic richness or abundance, feeding or trophic groups, life habit, and degree of tolerance to stress in the environment.

A.4.1 Metric Categories

Taxonomic richness. Metrics in this category are counts of the distinct number of taxa within selected taxonomic groups. “Total taxa” and “EPT taxa” are widely used metrics that provide information on overall and group-specific taxonomic variety. “EPT taxa” measures richness in three insect orders known to be generally sensitive to disturbance (Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies]), thereby conferring information both on variety and community tolerance. Other candidate metrics of this category are focused on different orders, families, or non-insect groups of ecological importance.

Taxonomic composition. These metrics are based on the proportion of individuals in a sample belonging to a specified taxonomic group. They are expressed as percentages and reveal the relative abundance of insect and non-insect groups, each of which may respond differently to environmental conditions and community dynamics.

Feeding group. The functional feeding group designation for an organism reflects the dominant mode of feeding, not the specific nutritional source or benefits (Cummins and Klug 1979, Merritt and Cummins 1984, Wallace and Webster 1996). Designations for each taxon include filterers, scrapers, collector-gatherers, predators, shredders, and others. Scrapers are those organisms that remove periphyton or other algal material and the associated microbes from mineral or vegetable substrates. Predators engulf or actively capture living animal tissue or prey. Collector-gatherers feed on organic materials that are

deposited or trapped within episubstrate layers of fine sediments or detritus. Filterers trap, engulf, or strain suspended particulates from the water column that may be plant or animal in origin. Shredders chew and break up woody materials, coarse organic particulates, or living macrophyte tissue.

Habit. The habit description categorizes a benthic organism's behavior with regard to how it maintains its location or moves. Designations for a taxon include skaters, swimmers, divers, climbers, clingers, burrowers, and others. Although habit metrics have been used successfully, they are considered unreliable for family-level data, because there is no assurance that all genera in a family have the same habit. Because of this, habit metrics were not tested.

Tolerance/Intolerance. Tolerance of a taxon is based on its ability to survive short- and long-term exposure to organic pollution. The Hilsenhoff Biotic Index (HBI) weights each taxon in a sample by its proportion of individuals and the taxon's tolerance value. Following the basic framework established by Hilsenhoff (1982), tolerance values were assigned to individual taxa on a scale of 0-10, with 0 identifying those taxa least tolerant (most sensitive) to stressors, and 10 identifying those taxa most tolerant (least sensitive) to stressors. Tolerance values compiled by USEPA (USEPA 1990) and Merritt and Cummins (1984) were used for this analysis.

Specific metrics tested with West Virginia benthic macroinvertebrate data, grouped by the five categories described above, are presented in Table A-2 , along with the expected response of each metric to increasing impairment of the waterbody.

A.4.2 Metric discrimination ability

Metrics are selected for use in the multimetric index on the basis of their ability to differentiate between unimpaired, or reference, sites and sites whose physical and/or chemical quality is impaired. As previously noted, West Virginia DEP identified 67 reference sites according to physical and chemical parameters reported in Table A-1. Tetra Tech used the following criteria, using parameters similar to those used by WVDEP for identifying reference sites, to identify likely impaired sites. To be categorized as impaired, a site needed to meet only one of the listed conditions. Using these criteria, 69 sites were identified.

- Dissolved oxygen < 4.0 mg/l
- pH <4.0
- Conductivity > 1000 µmhos
- Epifaunal substrate score <7 and Total habitat score <120
- Channel alteration score <7 and Total habitat score <120
- Sediment deposition score <7 and Total habitat score <120
- Bank disruptive pressure score <7 and Total habitat score <120
- Riparian vegetation zone width score <4 and Total habitat score <120

Table A-2. Attributes of Benthic Macroinvertebrates used as Candidate Metrics, and Expected Response of Metric to Increasing Disturbance.

Category **Specific Metrics**	**Definition**	**Expected response** **▲ = increase** **▽ = decrease**
Taxonomic richness:	*Number of taxa:*	
Total taxa	in the entire sample; measures the overall variety of the macroinvertebrate assemblage	▽
EPT taxa	that is the sum of taxa in the insect orders Ephemeroptera, Plecoptera, and Trichoptera	▽
Ephemeroptera taxa	in the order Ephemeroptera (mayfly nymphs)	▽
Plecoptera taxa	in the order Plecoptera (stonefly naiads)	▽
Trichoptera taxa	in the order Trichoptera (caddisfly larvae)	▽
Diptera taxa	in the order Diptera (“true” flies)	▽
Chironomidae taxa	in the family Chironomidae (midge larvae)	▽
Taxonomic composition:	*Percent abundance (of individuals in the sample) of:*	
% Dominant taxon	the single most abundant taxon	▲
% 2 Dominant taxa	the 2 most abundant taxa	▲
%EPT	Ephemeroptera (mayfly nymphs), Plecoptera (stonefly naiads), and Trichoptera (caddisfly larvae)	▽
% Ephemeroptera	mayfly nymphs (order Ephemeroptera)	▽
% Plecoptera	stonefly naiads (order Plecoptera)	▽
% Trichoptera	caddisfly larvae (order Trichoptera)	▽
% Diptera	”true” fly larvae and pupae	▲
% Chironomidae	chironomid (midge) larvae pupae	▲
% Oligochaeta	aquatic worms	▲
Feeding groups	*Percent abundance of individuals belonging to the functional feeding group:*	
% Filterers	filterers	▲
% Scrapers	scrapers	▽
% Collectors	collectors	▽
% Predators	predators	▽
% Shredders	shredders	▽
Tolerance/Intolerance		
Intolerant taxa	Number of taxa with a Tolerance Value ≤ 3	▽
% Tolerant	Percent abundance of organisms with a Tolerance value ≥ 7	▲
Hilsenhoff Biotic Index (HBI)	Abundance-weighted average tolerance of assemblage of organisms	▲

Box-and-whisker plots were used to display differences in ranges of values of the metrics between stream-quality categories (reference and impaired sites). This type of plot displays the statistics of median value, minimum value, maximum value, and 25th and 75th percentile values of a population of sites. Figure A-1 illustrates how the statistical values are displayed by the box-and-whisker plots employed in this report (after Statsoft 1998). The box shows the range from the 25th percentile to the 75th percentile of the metric values (the interquartile range, or IQR), and whiskers show the range from the non-outlier minimum (often 0) to non-outlier maximum value. The non-outlier maximum limit is equal to the 75th percentile value plus 1.5 times the interquartile range, and the non-outlier minimum limit is equal to the 25th percentile value minus 1.5 times the interquartile range. The whiskers show the range of data values that are within these limits, not necessarily the actual 1.5*x* limits. *Extremes* are values that are either (1) greater than the 75th percentile value plus 3 times the interquartile range, or (2) less than the 25th percentile value minus 3 times the interquartile range (Figure A-1). *Outliers* are values falling between the 1.5×IQR whisker threshold and the 3×IQR *Extremes* threshold.

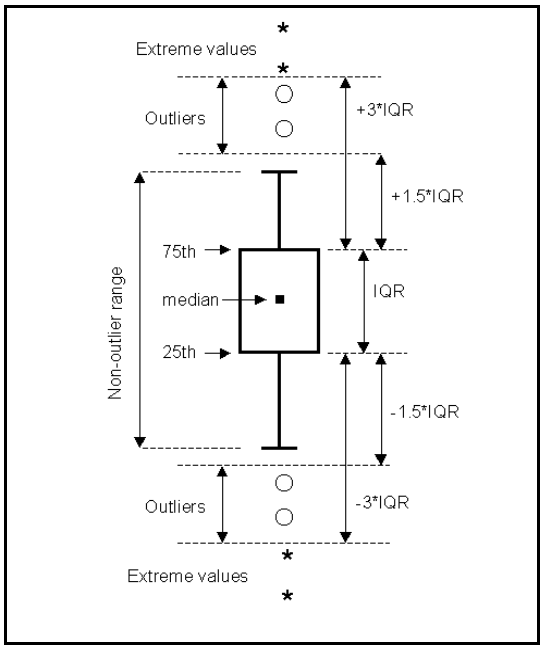


Figure A-1. Ranges of outliers and extremes in box-and-whisker plots (after Statsoft 1998). IQR is the interquartile range.

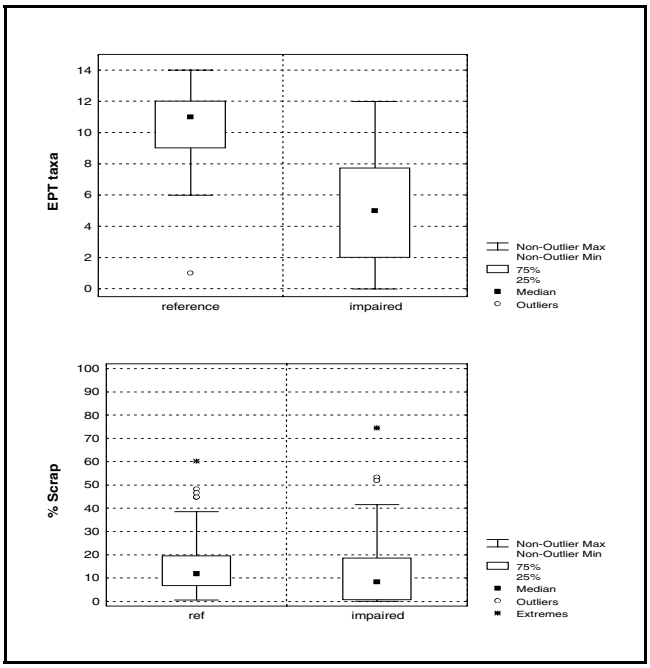


Figure A-2. Use of boxplots to discriminate between West Virginia reference and impaired sites. EPT taxa (top) shows better discrimination ability than does Percent Scrapers (bottom).

Boxplots of the metrics "EPT taxa" and "Percent Scrapers" may be examined to illustrate differences in the ability of the metrics to discriminate between reference and impaired sites. Figure A-2 illustrates these metric values calculated from the 1996-1997 West Virginia data. For the Percent Scrapers metric (Figure A-2, bottom), there is substantial overlap between the interquartile ranges of the reference and impaired populations of sampling sites. This metric does not differentiate well between the two populations of sites. In contrast, the EPT taxa metric (Figure A-2, top) shows no

overlap between the interquartile ranges of the reference and impaired sites. This metric differentiates clearly between the two populations of sites.

For quantitative comparison of the discrimination ability of a metric, each metric's discrimination efficiency (DE) was examined. The DE of a particular metric measures the agreement between metric values and the reference status of a site. The DE is a numerical description of the degree of separation between metric value distributions of reference and impaired sites and is calculated as a percentage according to Equation 1:

(Eq. 1) $$DE = 100 * \frac{a}{b}$$

For metrics that are expected to decrease in value with increasing site impairment, such as Total taxa or %EPT, the values for a and b are:

a = the number of stressed samples scoring below the 25th percentile of the reference distribution
b = the total number of stressed samples

For metrics that are expected to increase in value with increasing site impairment, such as HBI or %Diptera, the value for a is:

a = the number of stressed samples scoring above the 75th percentile of the reference distribution

A higher DE indicated better performance of a metric, or a better ability to distinguish between unstressed and stressed conditions.

A.5 Index development

A multimetric index is a simple additive approach for combining metric value information from different types of biological metrics into a single numeric assessment value. Each metric, as described in Section A.4, is a quantitative measure of some specific attribute of the benthic community structure or composition. In developing a multimetric index, care is taken to include metrics that

- are most able to differentiate between reference and impaired sites,
- represent at least some different aspects of the community (species composition, richness, tolerance, feeding groups, and the like), and
- minimize redundancy among individual component metrics.

The process of multimetric index development involved first scoring the selected metrics and then averaging these scores into a single numerical index value. To score the metrics, the range of values for

each metric was standardized on a 100-point scale, assigning all metric values a score ranging from 0 (worst) to 100 (best). The specific scoring procedure used for achieving the 100-point scoring range differed depending on the direction of expected response by the metric value to disturbance or impairment. For those metrics in which higher values are considered a "better" condition and lower values are considered "worse"(such as, %EPT in Table A-2, where the expected response to increasing perturbation is a decrease in %EPT individuals), the scoring procedure is described in section A.5.1 below. Conversely, for those metrics in which higher values are considered "worse," such as %Diptera in Table A-2, whose expected response to increasing perturbation is for the metric value to increase, the scoring procedure is described in section A.5.2 below. Note: in exceptionally high quality streams, one or more of a site's individual metrics may score greater than 100. The effect of such cases on the site index is addressed in Section A.5.3.

A.5.1 Scoring for metrics whose values are expected to decrease with site degradation

For metrics such as Total Taxa or %EPT, which are expected to decrease in value with increasing site impairment (i.e., higher values represent "better" sites), the 95th percentile metric value was assigned a score of 100. By choosing the 95th percentile value rather than the 100th percentile as the "best" score, we reduce the effect of unusual outlier values that might otherwise skew the ultimate index (Section A.5.3). Values between the minimum ("worst," usually 0) and the 95th percentile value (standard, or best value) were scored proportionally from 0 ("worst") to 100 ("best") according to Equation 2:

(Eq. 2) $$\text{score} = \left(\frac{x}{x_{95} - x_{min}}\right) x100;$$

where,
x = the metric value
x_{95} = the 95th percentile value
x_{min} = the minimum possible value, usually 0.

A.5.2 Scoring for metrics whose values are expected to increase with site degradation

For metrics such as HBI or %Diptera, which are expected to increase in value with increasing site impairment (higher values represent "worse" sites), the 5th percentile metric value was assigned the "best" score of 100. Again, by choosing the 5th percentile value rather than the minimum value as the "best" score, we reduce the effect of unusual outlier values that might skew the ultimate index (Section A.5.3). For these metrics, values between the maximum ("worst") value in the range and the 5th percentile ("best") value were scored proportionally between 0 ("worst") and 100 ("best") according to Equation 3:

(Eq. 3) $$\text{score} = \left(\frac{x_{max} - x}{x_{max} - x_5}\right) x100;$$

where, x = the metric value
x_5 = the 5th percentile value
x_{max} = the maximum possible value; e.g., 100% for percentage metrics; 10 for HBI.

A.5.3 Combining scores into an index

By standardizing the metric values to a common 100-point scale, each of the metrics contributes to the combined index with equal weighting, and all of the metric scores represent increasingly "better" site conditions as scores increase toward 100. Once all metric values for sites were converted to scores on the 100-point scale, a single multimetric site index value was calculated by simply averaging the individual metric values for the site. To assure that each metric did indeed contribute equally to the final index, any individual metrics that may have scored greater than 100 in any exceptionally high quality stream sites were converted to a maximum score of 100 when averaging to calculate the index. An example of metric standardization, showing raw metric values, score standardization, and index scoring is given in Table A-3.

Table A-3. Metric standardization example for site WVMC-60-K (Glady Fork).

Metric	Change with impairment	Percentile for "best" value	Standard (best value)	Measured metric value	Standardized metric score
%EPT	decrease	95th	91.9	83	90
%Chironomidae	increase	5th	0.98	10	91
Total taxa	decrease	95th	21	16	76
EPT taxa	decrease	95th	13	10	77
% 2 dominant taxa	increase	5th	36	43	89
HBI	increase	5th	2.9	4	84
			Final index (SCI) value for the site:		85

A.6 Index validation and refinement

New data were received from West Virginia DEP in August 1999 for use in validating the working index. These data consisted of sampling and taxonomic results from 549 sites, sampled from four major basins during the 1998 field season and from one basin (Coal) during fall 1997 and not included with the previously analyzed data. For the working index to be valid, it should separate reference from stressed sites in the new data just as with the original data used to develop the index.

Reference and stressed sites in the new data set were identified using non-biological criteria as in the original data set. The same parameters used for identifying reference and stressed sites in the original 1996-1997 data were used where possible to identify the new data set's reference and stressed sites. WVDEP habitat data collection procedures differed somewhat in 1998 from earlier years, so that the selection criteria for reference and impaired sites were slightly modified for analysis of the 1998 validation data set. West Virginia DEP personnel identified 40 reference sites in the new data set using criteria similar to those used for the 1996-1997 calibration data set (Table A-1). To identify stressed

sites in the new data, Tetra Tech used parameters similar to those used to identify the original data set's stressed sites, modified according to revised data collection procedures. Table A-4 lists selection criteria that were used to identify 102 stressed sites in the validation data.

To test the effectiveness of the working index, the six recommended metrics (Chapter 4) were calculated for the new data set. These metric values were standardized, and index values were calculated, as described in section A.5. The degree to which the recommended index correctly classified these new test data was examined by calculating the discrimination efficiency (DE) of the working index as applied to the new data. The DE of the working index for classifying the new data's reference sites was found according to Equation 1 (Section A.4.2), where:

a = the number of reference sites from the test data (1998) scoring above the 25th percentile of the original data's reference sites, and,

b = the total number of test data reference sites (n=40).

The DE of the working index for classifying the new data's stressed sites was found according to Equation 1 (Section A.4.2), where:

a = the number of stressed sites from the test data scoring below the 25th percentile of the original data's reference sites, and,

b = the total number of test data stressed sites (n=102).

Table A-4. Selection criteria for stressed sites in the new data set. A site was identified as stressed if it met at least one of the listed criteria.

	Stressed (sites meet at least one of the criteria) n=102
Dissolved oxygen (mg/L)	<4
pH	<4
Conductivity (µmhos)	>1000
Fecal coliform (colonies/100mL)	not used
Channel alteration score	<7 and total habitat score <120
Sediment deposition score	<7 and total habitat score <120
Riparian vegetation zone width:	
• Coal basin (1997); one combined score for both banks (as in original 1996-97 data)	<4 and total habitat score <120
• 1998 basins; reported separately for each bank	<2 for each bank, and total habitat score <120

Table A-4 (cont'd). Selection criteria for stressed sites in the new data set. A site was identified as stressed if it met at least one of the listed criteria.

	Stressed (sites meet at least one of the criteria) n=102
Bank disruptive pressure:	
• Coal basin (1997); one combined score for both banks (as in original 1996-97 data)	<7 and total habitat score <120
• 1998 basins; data not reported; substituted Bank Stability scores, reported separately for each bank	<4 for each bank and total habitat score <120
Epifaunal substrate score:	
• Coal basin (1997)	<7 and total habitat score <120
• 1998 basins, data not reported; no substitute parameter used	

Refinement of standard "best" values

Once the discrimination efficiency of the working index was found to be acceptable, the standard, or "best" values (section A.5) for each metric were re-determined by combining the original 1996-1997 data with the 1998 data. Percentile distributions of each metric's values were determined for the combined data set (n=1268 benthic samples). The standard, or "best" values, for each metric were revised to the 95th or 5th percentile (depending on the metric) of the distribution of this combined data set.

Consideration of the effect of different organism sub-sample sizes

Because WVDEP's benthic macroinvertebrates were sub-sampled to 200 organisms in the 1998 data, rather than 100 organisms as in the earlier data set, there was some concern over whether the difference would cause taxa richness metrics to be over-estimated in the new data (higher numbers of taxa simply because more organisms were counted and identified). Tetra Tech examined the correlation between the number of organisms and number of taxa (Total and EPT) in the reference sites of both data sets (Figure A-3) in order to determine whether it might be appropriate to apply a statistical procedure called rarefaction to the 200-organism data. This procedure would examine the distribution of metric values against sample size and adjust the two taxa richness metrics in larger-sized samples to what the expected values would be at the smaller 100-organism sample size. Although there does appear to be some effect between sample size (number of organisms) and taxa richness (wherein the number of taxa is greater in part simply because more organisms are counted and identified), the effect is not great with the family-level identifications of West Virginia's data. It was decided among Tetra Tech, EPA Region 3, and WVDEP that rarefaction would not be applied to the data, since WVDEP plans to continue the 200-organism subsampling protocol in their future biological monitoring, so that any effect from different sample sizes will be diminished as the bioassessment program progresses. The adjustment to the index, described above, of using distributions from all 1996-1998 data to determine each metric's standard/best value also will help to reduce possible effects from the different sub-sample sizes in the data.

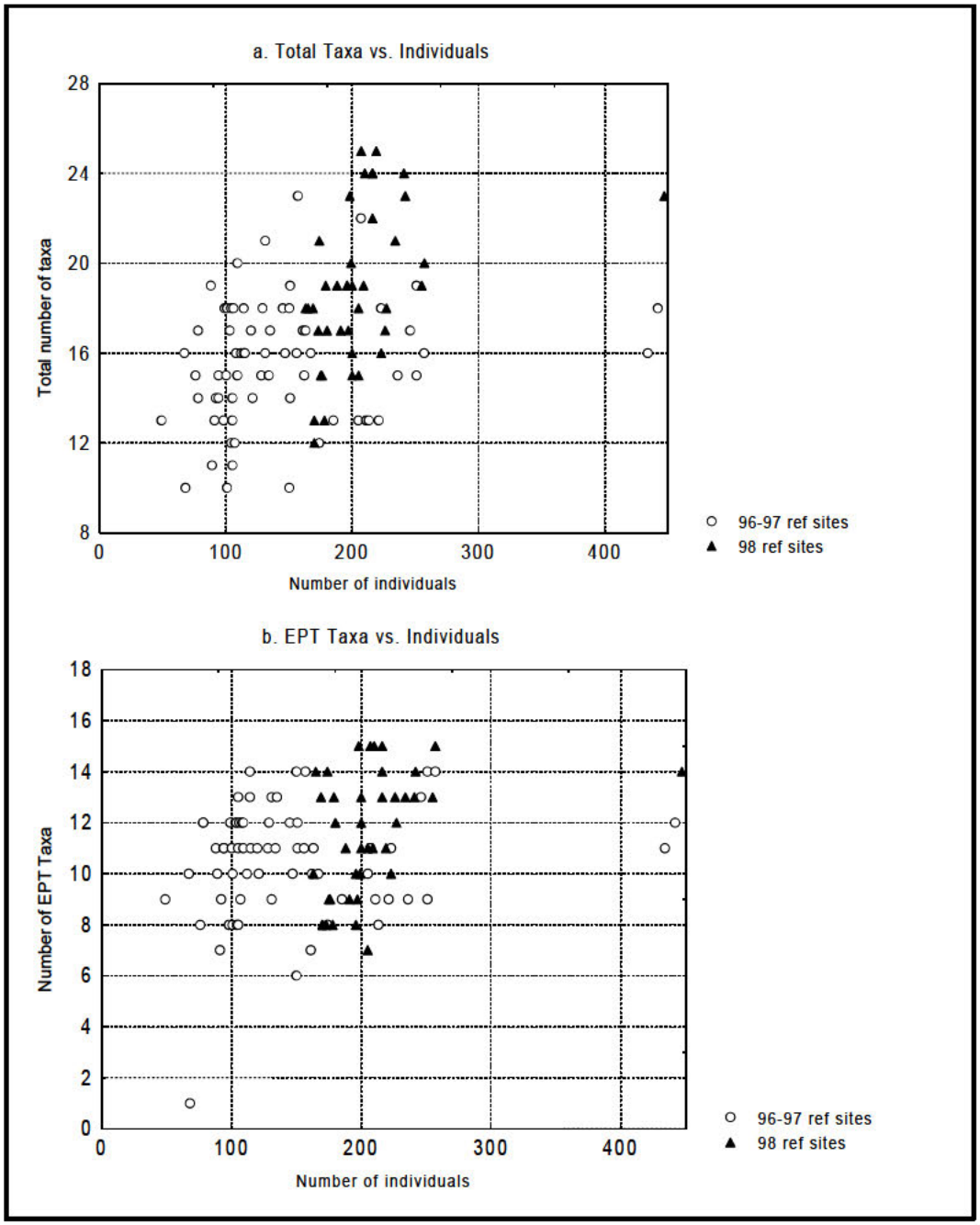


Figure A-3. Number of taxa (Total and EPT) vs. number of individual organisms in West Virginia benthic sampling reference sites.

APPENDIX B

LITERATURE CITED

LITERATURE CITED

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APPENDIX C

SITE METRICS AND METRIC SCORES

Site metrics and metric scores

Stations are grouped by data set (1= 1996-1997 calibration data; 2= 1997-1998 validation data). Within each data set, stations are listed by site type (reference, unlabeled, stressed), then within type by ascending Station ID.

Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
1	WVK-13	LITTLE SIXTEENMILE CREEK	reference	LOKAN B6	5/12/1997	15	71	9	69	91	99	6	95	65	55	4	85	79
1	WVK-14-B-1-97	U.T. OF FIVEFORK BRANCH	reference	LOKAN B10	5/12/1997	18	86	12	92	89	97	3	98	46	84	3	98	92
1	WVK-39-E-3-{0.6}97	BAYS FORK	reference	LOKAN B2	5/11/1997	20	95	12	92	68	74	6	95	33	105	3	95	92
1	WVK-39-M-1-A {1.0}97	HOFFMAN HOLLOW	reference	LOKAN B93	6/12/1997	17	81	13	100	83	90	4	97	43	89	3	95	92
1	WVK-43-{156.2}	ELK RIVER	reference	ELK B143	7/8/1997	18	86	11	85	65	71	26	75	50	78	5	76	78
1	WVKE-102-A	CAMP CREEK	reference	ELK B155	7/9/1997	18	86	12	92	87	94	7	94	54	71	4	89	88
1	WVKE-111-S	FLINT RUN	reference	ELK B156	7/9/1997	12	57	8	62	93	101	3	98	71	46	3	97	77
1	WVKE-117-B	RIGHT FORK/LEATHERWOOD	reference	ELK B151	7/8/1997	14	67	11	85	87	94	5	96	55	70	4	89	84
1	WVKE-136 {0.5}	PROPS RUN	reference	ELK B128	7/6/1997	15	71	11	85	91	99	2	99	51	77	4	90	87
1	WVKE-137	LAUREL RUN	reference	ELK B132	7/7/1997	16	76	12	92	80	87	15	86	36	100	4	89	88
1	WVKE-14-P	PANTHER HOLLOW	reference	ELK B117	6/26/1997	13	62	9	69	86	94	7	94	68	49	3	101	78
1	WVKE-50-B-10	IKE FORK	reference	ELK B225	7/29/1997	16	76	10	77	79	86	3	98	45	86	3	94	86
1	WVKE-76-U-{0.8}	JOHNSON BRANCH	reference	ELK B21	7/22/1997	13	62	9	69	76	83	3	98	62	59	3	99	78
1	WVKE-98-C-1-0.5A	WILSON RUN	reference	ELK B136	7/7/1997	13	62	8	62	84	91	6	95	64	56	3	96	77
1	WVKE-98-C-14-{1.4}	FALL RUN	reference	ELK B20	7/22/1997	18	86	12	92	90	98	5	96	73	43	4	85	83
1	WVKE-98-C-15-{1.0}	BIG RUN/ LEFT FORK HOLLY	reference	ELK B141	7/8/1997	15	71	11	85	90	98	3	98	46	84	3	93	88
1	WVMC-12-A-{03}	LAUREL RN/BIG SANDY CK ABOVE PATTERSON RN	reference	CHEAT B100	6/19/1996	15	71	11	85	81	88	5	96	54	71	3	95	84
1	WVMC-2-A	DARNELL HOLLOW	reference	CHEAT B179	7/29/1996	18	86	12	92	79	86	7	94	42	90	4	85	89
1	WVMC-52-A	ROARING RUN	reference	CHEAT B185	7/29/1996	18	86	12	92	91	99	4	97	52	75	3	105	92
1	WVMC-54-A	MIKE RUN	reference	CHEAT B213	8/7/1996	13	62	9	69	93	102	2	99	57	67	4	90	81
1	WVMC-54-C	MAXWELL RUN	reference	CHEAT B204	7/30/1996	14	67	11	85	95	103	2	99	56	68	4	85	84
1	WVMC-60-C	ELKLICK RUN @ FERNOW EXP. FOREST	reference	CHEAT B17	6/11/1996	18	86	14	108	93	101	2	99	39	95	3	95	96
1	WVMC-60-C-3	JOHN B. HOLLOW	reference	CHEAT B23	6/11/1996	14	67	13	100	99	108	0	101	42	91	3	104	93
1	WVMC-60-C-4	HICKMAN SLIDE HOLLOW	reference	CHEAT B22	6/11/1996	23	110	14	108	57	62	6	95	36	100	4	87	91
1	WVMC-60-E	LAUREL RUN/DRY FORK	reference	CHEAT B25	6/11/1996	12	57	8	62	90	98	0	101	78	35	2	106	75
1	WVMC-60-F	OTTER CREEK	reference	CHEAT B27	6/11/1996	17	81	11	85	76	83	4	97	45	86	4	85	86
1	WVMC-60-I	MILL RUN /DRY FORK	reference	CHEAT B26	6/11/1996	21	100	13	100	74	81	3	98	31	107	3	94	95
1	WVMC-60-K	GLADY FORK	reference	CHEAT B50	6/13/1996	16	76	10	77	83	90	10	91	43	89	4	84	85
1	WVMC-60-K-2-A	HOG RUN/ PANTHER CAMP RUN	reference	CHEAT B180	7/29/1996	15	71	11	85	74	81	6	95	37	99	3	93	87
1	WVMC-60-N-8.5	TINGLER RUN/LAUREL FK	reference	CHEAT B47	6/12/1996	16	76	13	100	97	106	1	100	48	81	3	103	93
1	WVMC-60-T-1	LOWER TWO SPRING RUN	reference	CHEAT B8	6/10/1996	19	90	14	108	79	86	4	97	73	42	4	84	83
1	WVMC-60-T-2	UPPER TWO SPRING RUN	reference	CHEAT B15	6/10/1996	16	76	14	108	70	77	8	93	59	64	4	89	83
1	WVMC-60-T-3	SWALLOW ROCK RUN	reference	CHEAT B207	7/30/1996	15	71	8	62	57	62	22	78	38	97	4	89	76
1	WVMC-60-T-8	BIG RUN/ GANDY CK NEAR LEADING RIDGE MTN	reference	CHEAT B2	6/10/1996	17	81	12	92	90	98	2	99	50	77	3	97	91
1	WVMC-7	SCOTT RUN/CHEAT RIVER	reference	CHEAT B147	7/23/1996	10	48	1	8	35	38	7	94	71	46	5	64	49
1	WVMCS-12	LITTLE LAUREL RUN/SHAVERS FORK	reference	CHEAT B182	7/29/1996	13	62	11	85	94	103	5	96	48	82	4	90	86
1	WVMCS-14	CLIFTON RUN	reference	CHEAT B36	6/12/1996	18	86	14	108	89	97	4	97	42	90	4	91	94
1	WVMCS-28	UPPER PONDLICK RUN	reference	CHEAT B14	6/10/1996	17	81	12	92	92	100	1	100	38	96	3	105	95
1	WVMCS-53	BEAVER CREEK/SHAVERS FORK	reference	CHEAT B189	7/30/1996	19	90	11	85	84	92	2	99	39	96	3	97	93
1	WVMCS-54	SECOND FORK	reference	CHEAT B11	6/10/1996	13	62	8	62	76	82	12	89	61	61	3	103	76
1	WVMCS-8	LAUREL RUN/SHAVERS FK	reference	CHEAT B220	8/8/1996	15	71	11	85	90	98	6	95	37	99	3	101	91
1	WVMT-64-{6.7}	MILL CREEK	reference	TYVAR B377	9/10/1997	16	76	11	85	78	85	19	82	44	87	4	81	83
1	WVMT-64-C	GLADE RUN/MILL CREEK	reference	TYVAR B371	9/10/1997	19	90	12	92	83	90	9	92	47	83	4	83	89
1	WVMTB-31	RIGHT FORK BUCKHANNON RIVER	reference	TYVAR B363	9/9/1997	15	71	9	69	73	80	13	88	63	58	5	72	73
1	WVMTB-32-D	BEAR CAMP RUN	reference	TYVAR B389	9/16/1997	13	62	7	54	59	65	32	69	66	53	5	67	62
1	WVMTM-1	HANGING RUN	reference	TYVAR B287	8/25/1997	17	81	7	54	66	72	12	89	47	82	4	86	77
1	WVMTM-11-{7.6}	RIGHT FORK OF MIDDLE FORK	reference	TYVAR B350	9/8/1997	18	86	10	77	77	84	8	93	42	91	4	83	86
1	WVMTM-11-E	JENKS RUN	reference	TYVAR B296	8/26/1997	16	76	10	77	85	93	10	91	64	56	5	77	78
1	WVMTM-25-{1.5}	SCOOLCRAFT RUN	reference	TYVAR B320	8/27/1997	13	62	10	77	86	93	7	94	45	85	3	93	84
1	WVMTM-25-A	BIRCH FORK	reference	TYVAR B311	8/27/1997	17	81	13	100	96	104	1	100	65	55	4	87	87
1	WVMTM-26-B	ROCKY RUN	reference	TYVAR B364	9/9/1997	10	48	6	46	54	59	41	60	72	44	5	69	54
1	WVPNB-18	DIFFICULT CREEK	reference	NBRPO B264	8/13/1997	16	76	11	85	78	84	5	96	30	109	3	96	89
1	WVPNB-4-EE-7-{0.4}	UT OF NORTH FORK PATTERS ON CREEK	reference	NBRPO B259	8/12/1997	17	81	11	85	83	90	3	98	60	63	3	99	86
1	WVPSB-21-{33.7}	SOUTH FK /SOUTH BR POT @ FT. SEYBERT	reference	SBRPO B257	8/20/1996	22	105	11	85	52	56	3	98	54	72	4	86	83
1	WVPSB-28-D	MOYER FORK	reference	SBRPO B320	9/9/1996	14	67	12	92	96	105	1	100	37	98	2	106	93
1	WVPSB-28-EE-2-A	BACK RUN /BIG RUN	reference	SBRPO B238	8/20/1996	12	57	9	69	97	106	1	100	67	51	4	86	77
1	WVPSB-28-EE-3	TEETER CAMP RUN	reference	SBRPO B261	8/20/1996	15	71	10	77	72	79	9	92	66	53	5	72	74
1	WVPSB-28-EE-3-A	HEMLOCK RUN	reference	SBRPO B246	8/20/1996	11	52	8	62	90	97	6	95	57	67	4	82	76
1	WVPSB-28-EE-3-B	LEONARD SPRING RUN	reference	SBRPO B251	8/20/1996	11	52	10	77	49	54	0	101	58	65	3	94	74
1	WVPSB-28-EE-3-C	MIDDLE RIDGE HOLLOW	reference	SBRPO B253	8/20/1996	10	48	8	62	43	46	3	98	66	53	4	89	66
1	WVPSB-28-EE-3-D	BUD HOLLOW	reference	SBRPO B241	8/20/1996	14	67	9	69	53	58	4	97	48	82	4	88	77
1	WVPSB-28-G	ZEKE RUN	reference	SBRPO B333	9/10/1996	18	86	12	92	91	99	2	99	54	73	3	94	90
1	WVPSB-28-GG-1	VANCE RUN	reference	SBRPO B279	8/21/1996	14	67	10	77	81	88	10	91	43	89	4	88	83

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1	WVPSB-28-GG-1-A	SAMS RUN /VANCE RUN	reference	SBRPO B277	8/21/1996	16	76	10	77	86	93	2	99	53	73	4	82	83
1	WVPSB-28-J.2	SHUCKLEFORD RUN	reference	SBRPO B330	9/10/1996	13	62	9	69	78	84	14	87	39	96	4	91	82
1	WVPSB-28-K-6-A	LOWER GULF RUN	reference	SBRPO B252	8/20/1996	16	76	11	85	91	99	1	100	59	64	4	85	85
1	WVPSB-9-{02.2}	MILL CREEK/SOUTH BR POT @ MOUTH	reference	SBRPO B300	8/27/1996	16	76	9	69	42	46	34	66	46	85	5	68	68
1	WVK-10-A	COOPER CREEK		LOKAN B13	5/13/1997	15	71	9	69	69	75	21	79	48	82	4	80	76
1	WVK-10-F	BARNETT FORK		LOKAN B26	5/14/1997	15	71	9	69	72	79	16	85	44	88	4	78	78
1	WVK-12-{20.7}	THIRTEEN MILE CREEK		LOKAN B52	5/19/1997	10	48	6	46	70	77	11	89	54	71	3	92	71
1	WVK-12-E-{2.4}	MUDLICK FORK		LOKAN B84	6/10/1997	20	95	7	54	24	26	18	82	46	84	6	59	67
1	WVK-12-E-2.5-{4.0}	U.T. OF MUDLICK FORK		LOKAN B90	6/11/1997	13	62	8	62	68	74	23	78	45	86	4	87	75
1	WVK-12-F-{5.0}	POPLAR FORK		LOKAN B100	6/16/1997	16	76	5	38	56	61	10	91	56	69	4	87	70
1	WVK-12-J	BEE RUN		LOKAN B47	5/19/1997	17	81	10	77	89	97	4	97	50	78	4	90	87
1	WVK-14-{2.2}	SIXTEENMILE CREEK		LOKAN B86	6/10/1997	10	48	4	31	70	77	21	80	77	36	3	97	61
1	WVK-14-A.5-{1.6}	U.T. OF SIXTEENMILE CREEK		LOKAN B37	5/14/1997	12	57	8	62	63	69	17	84	69	48	3	98	69
1	WVK-16-{12.8}	EIGHTEEN MILE CREEK		LOKAN B59	5/21/1997	17	81	10	77	72	78	22	79	65	54	3	96	77
1	WVK-16-{33.0}	EIGHTEEN MILE CREEK		LOKAN B97	6/16/1997	13	62	5	38	54	59	24	76	51	76	4	81	65
1	WVK-16-B	JAKES BRANCH		LOKAN B61	5/21/1997	13	62	8	62	42	46	54	46	72	44	6	62	54
1	WVK-16-J-3-{1.0}	SALTLICK CREEK		LOKAN B102	6/19/1997	11	52	3	23	23	25	66	34	82	28	6	53	36
1	WVK-16-L	SULUG CREEK		LOKAN B57	5/20/1997	16	76	9	69	93	101	3	98	61	62	3	96	83
1	WVK-16-Q-{1.0}	HARRIS BRANCH		LOKAN B88	6/11/1997	10	48	7	54	80	87	15	86	55	71	4	85	72
1	WVK-16-S	COTTRELL RUN		LOKAN B54	5/20/1997	18	86	12	92	69	75	4	97	58	66	5	70	81
1	WVK-22-{6.0}	HURRICANE CREEK		LOKAN B89	6/11/1997	12	57	4	31	29	31	47	53	69	49	6	55	46
1	WVK-22-B	POPLAR FORK		LOKAN B76	5/28/1997	15	71	6	46	34	37	48	53	65	55	5	67	55
1	WVK-29-{61.0}	POCATALICO RIVER		LOKAN B85	6/10/1997	10	48	4	31	56	61	35	66	58	66	5	75	58
1	WVK-32-0.1A	VINTROUX HOLLOW		LOKAN B43	5/15/1997	9	43	2	15	4	4	79	21	88	20	7	44	25
1	WVK-32-A	ROCKSTEP RUN		LOKAN B42	5/15/1997	8	38	3	23	1	2	67	33	93	10	7	46	25
1	WVK-36-{2.4}	FINNEY BRANCH		LOKAN B87	6/11/1997	13	62	8	62	88	95	1	100	58	65	4	92	79
1	WVK-39-{03.6}	DAVIS CREEK		LOKAN B14	5/13/1997	13	62	8	62	68	74	26	75	74	41	4	86	67
1	WVK-39-{12.2}	DAVIS CREEK		LOKAN B91	6/12/1997	12	57	8	62	79	86	13	88	62	59	4	89	73
1	WVK-39-A	WARD HOLLOW		LOKAN B25	5/13/1997	7	33	1	8	5	5	43	58	83	26	8	32	27
1	WVK-39-E-3-{0.4}	BAYS FORK		LOKAN B1	5/8/1997	17	81	10	77	68	74	10	91	48	82	4	90	82
1	WVK-39-F	RAYS BRANCH		LOKAN B3	5/11/1997	11	52	6	46	9	9	81	19	89	17	7	45	31
1	WVK-39-J	COAL HOLLOW		LOKAN B12	5/13/1997	7	33	2	15	2	2	93	7	95	8	7	44	18
1	WVK-39-O	SHREWSBURY HOLLOW		LOKAN B21	5/13/1997	17	81	12	92	73	79	19	81	51	77	4	88	83
1	WVK-41	TWOMILE CREEK		LOKAN B22	5/13/1997	4	19	1	8	3	3	85	15	93	12	7	42	16
1	WVK-41-D.5	RICH FORK/TWO MILE		LOKAN B41	5/15/1997	2	10	0	0	0	0	98	2	100	0	7	44	9
1	WVK-41-D.5-B	CRAIGS BRANCH		LOKAN B40	5/15/1997	7	33	3	23	10	11	86	14	91	14	7	47	24
1	WVK-41-D-1	U.T. OF LEFT FORK / KANAWHA TWO MILE		LOKAN B23	5/13/1997	7	33	2	15	1	1	44	57	86	21	8	27	26
1	WVK-41-E-1	EDENS FORK		LOKAN B55	5/20/1997	14	67	7	54	30	33	51	49	62	59	6	59	53
1	WVK-41-E-2-{0.1}	HOLMES BRANCH		LOKAN B31	5/14/1997	7	33	1	8	2	2	22	79	95	7	9	13	24
1	WVK-41-E-2-{1.4}	HOLMES BRANCH		LOKAN B98	6/16/1997	13	62	8	62	3	4	16	85	96	6	9	11	38
1	WVK-41-E-2-{1.7}	HOLMES BRANCH		LOKAN B44	5/16/1997	12	57	7	54	78	85	10	91	54	72	4	86	74
1	WVK-42	JOPLIN BRANCH		LOKAN B18	5/13/1997	5	24	1	8	2	2	95	5	97	5	7	43	14
1	WVK-43-{1.2}	ELK RIVER		ELK B238	8/7/1997	14	67	7	54	75	82	1	100	47	84	5	75	77
1	WVK-43-{63.0}	ELK RIVER		ELK B236	8/5/1997	19	90	13	100	88	95	3	98	46	85	4	88	93
1	WVK-43-{87.4}	ELK RIVER		ELK B237	8/5/1997	16	76	10	77	85	92	1	100	66	53	3	94	82
1	WVK-9-C-{5.4}	LOWER NINEMILE CREEK		LOKAN B80	6/9/1997	14	67	7	54	64	70	9	92	52	74	4	82	73
1	WVKE-102 {14.6}	LAUREL CREEK		ELK B173	7/15/1997	20	95	11	85	82	89	1	100	45	86	4	84	90
1	WVKE-102 {2.83}	LAUREL CREEK		ELK B157	7/9/1997	10	48	6	46	92	100	5	96	76	38	5	73	67
1	WVKE-102-C-1-{0.4}	UT OF BROOKS CREEK		ELK B161	7/9/1997	10	48	4	31	60	66	22	78	71	46	5	69	56
1	WVKE-111 {0.2}	BACK FORK		ELK B153	7/9/1997	15	71	10	77	58	63	36	65	58	66	5	71	69
1	WVKE-111-K	SUGAR CREEK		ELK B160	7/9/1997	17	81	13	100	61	67	23	78	45	85	4	80	82
1	WVKE-111-K-2	LITTLE SUGAR CREEK		ELK B158	7/9/1997	16	76	10	77	79	85	6	95	48	81	3	98	85
1	WVKE-111-Q	BIG RUN/ BACK FORK ELK		ELK B154	7/9/1997	15	71	10	77	87	95	5	96	61	61	4	87	81
1	WVKE-115	STEPS RUN		ELK B152	7/8/1997	12	57	6	46	76	83	4	97	63	58	4	81	70
1	WVKE-117	LEATHERWOOD CREEK		ELK B144	7/8/1997	15	71	11	85	83	90	10	91	42	90	4	88	86
1	WVKE-118	BERGOO CREEK		ELK B139	7/8/1997	15	71	10	77	77	84	14	87	38	97	4	87	84
1	WVKE-124	BIG RUN		ELK B140	7/8/1997	17	81	11	85	85	93	7	94	47	83	3	97	89
1	WVKE-128	HICKORYLICK RUN		ELK B130	7/7/1997	20	95	14	108	79	86	5	96	42	91	4	89	93
1	WVKE-13	NARROW BRANCH		ELK B116	6/26/1997	9	43	6	46	85	92	0	101	57	67	4	78	71
1	WVKE-138	BIG SPRING FORK		ELK B164	7/14/1997	15	71	8	62	42	46	20	81	51	76	5	72	68
1	WVKE-139	OLD FIELD FORK		ELK B134	7/7/1997	14	67	11	85	90	98	6	94	71	45	5	74	77
1	WVKE-139-B	CROOKED FORK		ELK B199	7/22/1997	17	81	12	92	72	78	15	86	57	67	4	78	80
1	WVKE-14-G-1-{0.8}	RIGHT FORK OF SLACK BRANCH		ELK B162	7/13/1997	12	57	6	46	84	92	4	97	76	38	3	102	72

Site metrics and metric scores

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
1	WVKE-14-G-2	WHITE OAK FORK	ELK	B111	6/25/1997	5	24	3	23	94	102	0	101	92	12	2	107	60
1	WVKE-14-K	JOE'S HOLLOW	ELK	B19	6/25/1997	8	38	3	23	78	85	6	95	75	39	4	81	60
1	WVKE-14-M	MORRIS FORK	ELK	B121	6/27/1997	7	33	3	23	91	99	3	98	79	33	3	95	64
1	WVKE-14-M-2	MUDLICK BRANCH	ELK	B110	6/25/1997	6	29	1	8	76	82	0	101	85	24	3	104	57
1	WVKE-14-O {5.2}	MIDDLE FORK	ELK	B174	7/15/1997	16	76	8	62	61	66	8	93	48	81	4	81	76
1	WVKE-14-O-0.5	MCBRIDE HOLLOW	ELK	B115	6/26/1997	16	76	9	69	68	74	7	94	34	103	5	74	81
1	WVKE-19-B	TWO MILE FORK	ELK	B126	7/1/1997	15	71	9	69	64	70	6	95	30	109	4	79	81
1	WVKE-19-H	PETES FORK	ELK	B159	7/9/1997	12	57	6	46	59	64	4	97	49	79	5	77	70
1	WVKE-21	LEATHERWOOD CREEK	ELK	B114	6/26/1997	15	71	8	62	30	33	28	73	68	50	6	59	58
1	WVKE-23 {0.43}	BIG SANDY CREEK	ELK	B193	7/21/1997	13	62	6	46	57	62	4	97	51	76	4	84	71
1	WVKE-23-F-1	DOELICK RUN	ELK	B195	7/21/1997	12	57	5	38	61	66	0	101	44	88	4	88	73
1	WVKE-23-P-3-A	HORSE RUN	ELK	B25	7/23/1997	15	71	8	62	64	70	10	91	38	97	4	79	78
1	WVKE-2-E	GREEN BOTTOM	ELK	B18	6/25/1997	11	52	4	31	7	8	65	35	79	34	7	46	34
1	WVKE-3	NEWHOUSE BRANCH	ELK	B125	7/1/1997	7	33	0	0	0	0	34	66	85	23	8	25	25
1	WVKE-34	CAMP CREEK	ELK	B181	7/16/1997	7	33	3	23	65	71	22	79	55	71	5	65	57
1	WVKE-37-B	LAUREL FORK	ELK	B113	6/26/1997	14	67	4	31	54	58	34	67	60	62	6	61	58
1	WVKE-37-D	SUMMERS FORK	ELK	B120	6/26/1997	15	71	5	38	43	47	46	54	74	40	6	58	51
1	WVKE-4	COONSKIN BRANCH	ELK	B17	6/25/1997	12	57	4	31	35	38	44	56	68	50	6	61	49
1	WVKE-40	LITTLE SYCAMORE CREEK	ELK	B27	7/23/1997	9	43	5	38	90	98	6	95	72	44	3	96	69
1	WVKE-41	SYCAMORE CREEK	ELK	B213	7/24/1997	15	71	6	46	80	87	6	95	50	79	4	82	77
1	WVKE-41-A	CHARLEY BRANCH	ELK	B170	7/15/1997	19	90	12	92	81	88	11	90	45	86	4	88	89
1	WVKE-41-B-{0.2}	ADONIJAH FORK	ELK	B185	7/17/1997	13	62	5	38	86	93	2	99	58	65	5	77	72
1	WVKE-41-B-1.5	LAUREL FORK	ELK	B189	7/17/1997	16	76	6	46	87	95	1	100	75	40	5	75	72
1	WVKE-41-C-1	GRASSY FORK	ELK	B187	7/17/1997	9	43	4	31	57	62	33	68	56	69	5	66	56
1	WVKE-45-B	LICK BRANCH	ELK	B218	7/28/1997	13	62	5	38	64	69	4	97	50	78	5	71	69
1	WVKE-46 {1.2}	LEATHERWOOD CREEK	ELK	B235	7/31/1997	15	71	7	54	55	60	13	88	49	80	5	74	71
1	WVKE-49	PISGAH RUN	ELK	B221	7/28/1997	20	95	11	85	75	81	4	97	54	72	3	98	88
1	WVKE-50 {0.2}	BUFFALO CREEK	ELK	B234	7/31/1997	13	62	7	54	81	88	11	90	56	68	4	85	75
1	WVKE-50-B-{0.1}	LILLY FORK	ELK	B230	7/30/1997	16	76	9	69	80	87	3	98	40	93	4	83	85
1	WVKE-50-B-1-{2.0}	SINNETT BRANCH	ELK	B233	7/30/1997	16	76	10	77	77	84	5	96	56	68	3	102	83
1	WVKE-50-B-7-{0.1}	JIM YOUNG FORK	ELK	B226	7/29/1997	7	33	2	15	50	54	9	92	64	57	5	77	55
1	WVKE-50-B-8	BEECH FORK	ELK	B222	7/29/1997	13	62	8	62	87	94	3	98	49	79	4	87	80
1	WVKE-50-B-9	SYCAMORE RUN	ELK	B228	7/29/1997	14	67	9	69	71	77	11	90	57	67	4	81	75
1	WVKE-50-F-{2.2}	SAND FORK	ELK	B232	7/30/1997	16	76	8	62	71	77	13	88	45	86	4	86	79
1	WVKE-50-I	ROCKCAMP RUN	ELK	B231	7/30/1997	13	62	7	54	78	85	1	100	30	109	3	92	82
1	WVKE-50-I-3	HICKORY FORK	ELK	B224	7/29/1997	3	14	2	15	95	104	0	101	95	7	5	69	51
1	WVKE-50-O	ROBINSON FORK	ELK	B227	7/29/1997	16	76	8	62	64	70	7	94	43	89	4	85	79
1	WVKE-50-P	TAYLOR CREEK	ELK	B229	7/29/1997	2	10	1	8	50	54	50	50	100	0	5	77	33
1	WVKE-50-S	DILLE RUN	ELK	B223	7/29/1997	6	29	3	23	99	108	0	101	99	2	3	101	59
1	WVKE-50-T	PHEASANT RUN	ELK	B220	7/28/1997	6	29	3	23	44	48	3	98	91	13	4	85	49
1	WVKE-56	SPREAD RUN	ELK	B212	7/24/1997	14	67	9	69	92	100	1	100	68	50	4	91	79
1	WVKE-59	TURKEY RUN	ELK	B214	7/24/1997	5	24	1	8	22	24	0	101	56	69	5	74	50
1	WVKE-6 {5.6}	MILL CREEK	ELK	B127	7/3/1997	14	67	6	46	39	42	3	98	49	79	4	81	69
1	WVKE-64	BIG OTTER CREEK	ELK	B192	7/21/1997	13	62	6	46	89	96	7	94	74	40	4	79	70
1	WVKE-69 {5.6}	GROVES CREEK	ELK	B188	7/17/1997	19	90	11	85	82	89	7	94	37	98	4	88	91
1	WVKE-70-A	ROAD FORK	ELK	B183	7/16/1997	11	52	5	38	69	75	8	93	53	73	5	75	68
1	WVKE-74 {10.4}	STRANGE CREEK	ELK	B23	7/22/1997	14	67	9	69	68	74	7	94	44	87	4	89	80
1	WVKE-74-F	BIG RUN	ELK	B198	7/22/1997	21	100	12	92	59	65	13	88	28	113	3	92	89
1	WVKE-76 {0.9}	BIRCH RIVER	ELK	B186	7/17/1997	10	48	5	38	64	70	19	82	49	79	4	81	66
1	WVKE-76-A	LEATHERWOOD RUN	ELK	B26	7/23/1997	13	62	7	54	62	68	4	97	47	83	3	97	77
1	WVKE-76-C	MIDDLE RUN	ELK	B197	7/21/1997	14	67	9	69	85	93	8	93	58	66	3	93	80
1	WVKE-76-D-1	BUCKEYE FORK	ELK	B180	7/16/1997	15	71	9	69	65	70	13	88	37	98	5	76	79
1	WVKE-76-E-{2.6}	LITTLE BIRCH RIVER	ELK	B182	7/16/1997	13	62	6	46	44	48	29	72	54	72	5	67	61
1	WVKE-76-E-5	WINDY RUN	ELK	B178	7/15/1997	13	62	9	69	78	84	6	95	47	84	4	80	79
1	WVKE-76-E-6-A	SENG RUN	ELK	B176	7/15/1997	12	57	7	54	90	98	2	99	75	38	4	81	71
1	WVKE-76-E-7.5	FISHER RUN	ELK	B171	7/15/1997	17	81	9	69	70	76	18	83	52	74	5	70	76
1	WVKE-76-N-{2.4}	ANTHONY CREEK	ELK	B24	7/23/1997	20	95	10	77	87	95	1	100	46	84	3	96	91
1	WVKE-76-N-8	RICH FORK	ELK	B211	7/24/1997	20	95	12	92	75	82	5	95	45	86	4	91	90
1	WVKE-76-O	POPLAR CREEK	ELK	B29	7/23/1997	17	81	10	77	92	101	2	99	63	58	3	95	85
1	WVKE-76-S.3	OTTER HOLE	ELK	B28	7/23/1997	18	86	10	77	72	78	6	95	37	98	4	90	87
1	WVKE-76-W	JACKS RUN	ELK	B172	7/15/1997	7	33	2	15	10	11	23	78	80	31	6	60	38
1	WVKE-7-E	KAUFMAN BRANCH	ELK	B15	6/24/1997	9	43	3	23	32	35	48	53	79	33	6	53	40
1	WVKE-84.5	BEAR RUN	ELK	B191	7/21/1997	10	48	4	31	33	36	48	53	65	55	6	62	47

Site metrics and metric scores

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
1	WVKE-85	LITTLE BUFFALO CREEK	ELK	B196	7/21/1997	16	76	8	62	63	69	27	74	72	44	5	74	67
1	WVKE-87-B	LAUREL FORK	ELK	B217	7/28/1997	16	76	5	38	47	52	16	84	47	82	6	62	66
1	WVKE-88	OLD WOMAN RUN	ELK	B219	7/28/1997	10	48	3	23	10	10	21	79	79	32	8	25	36
1	WVKE-9 {1.5}	LITTLE SANDY CREEK	ELK	B147	7/8/1997	12	57	6	46	48	53	20	81	42	91	5	70	66
1	WVKE-9 {15.0}	LITTLE SANDY CREEK	ELK	B148	7/8/1997	8	38	3	23	79	86	6	95	70	46	4	85	62
1	WVKE-91	WOLF CREEK	ELK	B179	7/15/1997	15	71	6	46	64	70	15	86	36	100	4	82	76
1	WVKE-91-A-1	SPRUCE FORK	ELK	B177	7/15/1997	12	57	9	69	69	75	29	72	61	61	5	67	67
1	WVKE-94	FLATWOODS RUN	ELK	B216	7/28/1997	16	76	7	54	38	41	4	97	43	89	4	86	74
1	WVKE-98-A	KANAWHA RUN	ELK	B131	7/7/1997	12	57	8	62	67	73	28	73	72	44	5	66	62
1	WVKE-98-B	RIGHT FORK HOLLY RIVER	ELK	B168	7/14/1997	20	95	12	92	81	88	5	96	45	86	4	85	90
1	WVKE-98-B-{13.6}	RIGHT FORK/HOLLY RIVER	ELK	B175	7/15/1997	19	90	9	69	69	75	19	82	45	85	4	79	80
1	WVKE-98-B-16	DESERT FORK	ELK	B166	7/14/1997	16	76	10	77	85	93	6	95	41	92	3	94	88
1	WVKE-98-B-16.4	UPPER MUDLICK	ELK	B169	7/14/1997	13	62	9	69	86	93	10	91	70	47	4	79	74
1	WVKE-98-B-3-{0.6}	FALL RUN	ELK	B129	7/7/1997	20	95	12	92	76	82	15	86	58	66	3	92	86
1	WVKE-98-B-8	WEASE RUN	ELK	B135	7/7/1997	14	67	7	54	82	89	4	97	66	53	4	80	73
1	WVKE-98-C-{10.0}	LEFT FORK/HOLLY RIVER	ELK	B145	7/8/1997	15	71	9	69	74	80	21	80	45	85	5	76	77
1	WVKE-98-C-{13.8}	LEFT FORK/HOLLY RIVER	ELK	B146	7/8/1997	16	76	10	77	85	92	4	97	45	85	4	85	85
1	WVKE-98-C-1	LAURELPATCH RUN	ELK	B133	7/7/1997	17	81	8	62	81	88	12	89	58	66	4	80	78
1	WVKE-98-C-11	LAUREL FORK	ELK	B190	7/18/1997	15	71	10	77	62	67	10	91	41	92	4	88	81
1	WVKE-98-C-11-C	RIGHT FORK/LAUREL FORK	ELK	B22	7/22/1997	11	52	7	54	92	100	5	96	89	17	3	105	70
1	WVKE-98-C-2	OLDLICK RUN	ELK	B150	7/8/1997	13	62	6	46	68	74	23	78	48	82	5	74	69
1	WVKE-98-C-2-D	COUGAR FORK	ELK	B165	7/14/1997	13	62	10	77	76	83	5	96	39	96	4	89	84
1	WVKE-98-C-5	LONG RUN	ELK	B149	7/8/1997	12	57	8	62	89	97	4	97	59	65	4	83	77
1	WVKE-98-C-6	BEAR RUN	ELK	B138	7/8/1997	18	86	10	77	77	84	7	94	60	63	4	81	81
1	WVKE-9-B-1	BIG FORK	ELK	B112	6/26/1997	11	52	2	15	13	14	61	40	72	44	6	54	37
1	WVKE-9-C-{0.6}	AARON'S FORK	ELK	B137	7/8/1997	13	62	5	38	65	71	2	99	54	72	5	76	70
1	WVKE-9-E	BULLSKIN BRANCH	ELK	B122	7/1/1997	13	62	7	54	64	70	16	85	42	90	5	77	73
1	WVKE-9-G	RUFFNER BRANCH (DOUGLAS BRANCH)	ELK	B118	6/26/1997	15	71	9	69	53	57	38	63	64	56	5	68	64
1	WVKE-9-I-1-A	HARPER HOLLOW	ELK	B123	7/1/1997	16	76	8	62	81	88	4	97	53	74	4	83	80
1	WVKP-16 {4.5}	GRAPEVINE CREEK	LOKAN	B83	6/10/1997	16	76	9	69	55	60	12	88	44	88	4	81	77
1	WVKP-16-B	BROADTREE RUN	LOKAN	B4	5/12/1997	9	43	2	15	2	2	75	25	87	21	7	41	25
1	WVKP-16-D	VANCE HOLLOW	LOKAN	B11	5/12/1997	18	86	12	92	88	96	7	94	63	57	4	83	85
1	WVKP-17-B-5	FIRST CREEK / MIDDLE FORK	LOKAN	B16	5/13/1997	16	76	10	77	83	91	6	95	56	69	3	93	84
1	WVKP-17-C-1-A	DAN SLATER HOLLOW	LOKAN	B27	5/14/1997	13	62	9	69	76	83	18	83	64	57	4	86	73
1	WVKP-17-C-4	RAILROAD HOLLOW	LOKAN	B34	5/14/1997	12	57	8	62	84	92	13	88	60	62	4	78	73
1	WVKP-17-E-{2.6}	DUDDEN FORK	LOKAN	B92	6/12/1997	10	48	4	31	77	84	2	99	67	52	3	104	69
1	WVKP-17-F-1	LOOM TREE HOLLOW	LOKAN	B19	5/13/1997	11	52	8	62	94	103	4	97	69	49	4	79	73
1	WVKP-17-G	FABER HOLLOW	LOKAN	B15	5/13/1997	19	90	12	92	89	97	9	92	47	83	3	97	92
1	WVKP-1-B	BIGGER BRANCH	LOKAN	B39	5/15/1997	14	67	11	85	68	74	31	69	63	58	5	75	71
1	WVKP-20	RACCOON CREEK	LOKAN	B8	5/12/1997	15	71	9	69	39	43	57	43	74	41	6	63	55
1	WVKP-21	PERNEL BRANCH	LOKAN	B7	5/12/1997	18	86	11	85	83	91	14	87	79	33	5	74	76
1	WVKP-26	CAMP CREEK	LOKAN	B5	5/12/1997	6	29	1	8	4	4	92	8	96	6	7	44	16
1	WVKP-28	GREEN CREEK (REFERENCE)	LOKAN	B74	5/28/1997	17	81	12	92	65	70	21	80	55	70	4	80	79
1	WVKP-28-A-1-{0.7}	HUNT FORK	LOKAN	B94	6/12/1997	13	62	9	69	71	78	17	84	38	97	4	81	78
1	WVKP-28-B-1	BEAR BRANCH	LOKAN	B72	5/28/1997	19	90	13	100	74	81	11	90	48	82	4	79	87
1	WVKP-28-E	ANDERSON LICK RUN	LOKAN	B71	5/28/1997	10	48	5	38	30	33	61	40	72	43	6	59	44
1	WVKP-29	STRAIGHT CREEK	LOKAN	B9	5/12/1997	18	86	11	85	41	45	52	49	67	51	5	69	64
1	WVKP-32-.5A	SUGAR CAMP HOLLOW	LOKAN	B77	5/28/1997	18	86	12	92	87	95	8	93	56	69	4	85	87
1	WVKP-32 {1.0}	WOLF CREEK	LOKAN	B96	6/12/1997	16	76	9	69	60	66	19	82	46	85	4	92	78
1	WVKP-33 {5.8}	TRACE FORK/FLAT FORK	LOKAN	B81	6/9/1997	10	48	7	54	88	96	0	101	74	41	2	107	73
1	WVKP-33-D-{0.8}	COON RUN	LOKAN	B79	6/9/1997	13	62	7	54	67	73	12	89	44	87	4	87	75
1	WVKP-33-G	CABBAGE FORK	LOKAN	B67	5/22/1997	12	57	5	38	70	76	13	88	77	36	5	69	61
1	WVKP-36-B	BONER HOLLOW	LOKAN	B66	5/22/1997	14	67	10	77	94	102	0	101	78	34	4	82	77
1	WVKP-37-A	SNAKE HOLLOW	LOKAN	B70	5/22/1997	14	67	10	77	80	87	0	101	42	91	3	99	87
1	WVKP-38-.8A	GREATHOUSE HOLLOW	LOKAN	B68	5/22/1997	13	62	9	69	94	102	3	98	57	68	3	93	82
1	WVKP-38-D	HOLLYWOOD FORK	LOKAN	B69	5/22/1997	15	71	9	69	61	66	11	90	45	86	4	84	78
1	WVKP-4	HARMOND CREEK	LOKAN	B29	5/14/1997	6	29	1	8	4	4	12	89	65	54	5	77	44
1	WVKP-40	ROUND KNOB RUN	LOKAN	B62	5/21/1997	14	67	9	69	84	91	13	88	50	77	4	86	80
1	WVKP-41-A	SLAB FORK	LOKAN	B63	5/21/1997	15	71	9	69	60	66	33	68	48	81	4	83	73
1	WVKP-43-A	SMITH RUN	LOKAN	B64	5/21/1997	15	71	10	77	78	84	1	100	56	68	4	85	81
1	WVKP-45.5	VINEYARD RUN	LOKAN	B65	5/21/1997	21	100	13	100	58	63	27	74	50	77	5	74	81
1	WVKP-5	ROCKY FORK	LOKAN	B48	5/19/1997	7	33	3	23	13	14	76	24	84	26	7	48	28
1	WVKP-8	SCHOOLHOUSE BRANCH	LOKAN	B49	5/19/1997	8	38	5	38	82	89	8	93	77	36	3	101	66

Site metrics and metric scores

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1	WVKP-9-A	SPRING BRANCH		LOKAN B50	5/19/1997	5	24	3	23	19	21	26	74	81	30	8	32	34
1	WVM-27-{115.0}	TYGART VALLEY RIVER		TYVAR B341	9/3/1997	19	90	8	62	30	33	10	90	49	79	5	75	72
1	WVM-27-{46.2}	TYGART VALLEY RIVER		TYVAR B381	9/11/1997	13	62	10	77	64	70	26	74	44	88	5	71	73
1	WVMC-10	BIG RUN NEAR PISGAH		CHEAT B136	7/23/1996	20	95	8	62	63	68	7	94	34	104	4	80	83
1	WVMC-11-D {10}	LEFT FORK BULL RUN @ HEADWATERS		CHEAT B103	6/19/1996	9	43	6	46	88	96	0	101	82	29	3	103	69
1	WVMC-12-.5A-{0}	SOVERN RUN @ MOUTH		CHEAT B69	6/17/1996	3	14	1	8	79	86	18	82	97	4	3	100	49
1	WVMC-12-.7A	PARKER RUN/BIG SANDY CREEK		CHEAT B159	7/24/1996	16	76	8	62	57	62	13	87	32	106	4	86	79
1	WVMC-12-{10}	BIG SANDY CREEK @ BRUCETON MILLS FALLS		CHEAT B53	6/17/1996	16	76	8	62	61	67	24	77	58	66	5	68	69
1	WVMC-12-{14}	BIG SANDY CREEK ABOVE LITTLE SANDY CREEK		CHEAT B54	6/17/1996	8	38	4	31	53	58	29	71	47	83	5	70	58
1	WVMC-12-A-{02.5}	LAUREL RUN/BIG SANDY CK NEAR MOUTH		CHEAT B101	6/19/1996	15	71	11	85	94	102	1	100	80	32	2	106	81
1	WVMC-12-A-1	LITTLE LAUREL RUN		CHEAT B105	6/19/1996	12	57	5	38	79	86	3	98	74	41	3	96	69
1	WVMC-12-A-2	PATTERSON RUN		CHEAT B160	7/24/1996	8	38	3	23	58	63	0	101	77	36	5	64	54
1	WVMC-12-B-.5 {00}	WEBSTER RUN @ MOUTH		CHEAT B89	6/18/1996	3	14	2	15	80	87	0	101	90	16	5	77	52
1	WVMC-12-B-.5 {02}	WEBSTER RUN @ HEADWATERS		CHEAT B88	6/18/1996	13	62	8	62	70	76	2	99	36	100	4	81	80
1	WVMC-12-B-.5-A	UNNAMED TRIB/WEBSTER RUN		CHEAT B87	6/18/1996	3	14	2	15	50	54	0	101	75	39	3	102	54
1	WVMC-12-B-{01}	LITTLE SANDY CREEK NEAR MOUTH		CHEAT B83	6/18/1996	8	38	5	38	82	89	10	91	64	56	4	88	67
1	WVMC-12-B-{02}	LITTLE SANDY CREEK BELOW BEAVER CREEK		CHEAT B106	6/19/1996	11	52	7	54	87	95	8	93	61	60	4	91	74
1	WVMC-12-B-{06}	LITTLE SANDY CREEK BELOW HOGG RUN		CHEAT B107	6/19/1996	6	29	3	23	20	21	76	25	83	27	6	49	29
1	WVMC-12-B-{11}	LITTLE SANDY CREEK BELOW CHERRY RUN		CHEAT B82	6/18/1996	6	29	2	15	80	87	8	93	88	20	3	103	57
1	WVMC-12-B-1-{01}	BEAVER CREEK NEAR MOUTH		CHEAT B92	6/19/1996	6	29	2	15	84	91	3	98	87	20	2	106	59
1	WVMC-12-B-1-{04}	BEAVER CREEK NEAR HEADWATERS		CHEAT B73	6/18/1996	12	57	6	46	82	89	3	98	74	41	3	101	72
1	WVMC-12-B-3-{02}	HOGG RUN AT HEADWATERS		CHEAT B78	6/18/1996	16	76	9	69	51	56	30	71	52	75	4	78	71
1	WVMC-12-B-4-{02}	ELK RUN NEAR MOUTH		CHEAT B95	6/19/1996	11	52	7	54	84	91	0	101	59	65	3	100	77
1	WVMC-12-B-4-{03}	ELK RUN ABOVE UNNAMED TRIBS		CHEAT B94	6/19/1996	11	52	7	54	65	71	20	81	75	40	3	96	66
1	WVMC-12-B-5-C	THIRD UNNAMED TRIB/CHERRY RUN NEAR HEAD		CHEAT B85	6/18/1996	9	43	3	23	97	105	1	100	96	6	2	110	62
1	WVMC-12-B-6	MILL RUN /LITTLE LAUREL RUN NEAR MOUTH		CHEAT B108	6/19/1996	8	38	4	31	85	93	3	98	82	28	3	96	64
1	WVMC-12-C {01}	HAZEL RUN NEAR MOUTH		CHEAT B98	6/19/1996	11	52	4	31	65	71	4	97	73	42	3	94	64
1	WVMC-12-D	GLADE RUN WEST OF BRUCETON MILLS		CHEAT B96	6/19/1996	13	62	10	77	71	77	25	76	60	63	4	87	74
1	WVMC-12-E	GLADE RUN NORTH OF BRANDONVILLE		CHEAT B62	6/17/1996	11	52	7	54	90	98	6	95	81	29	3	96	71
1	WVMC-12-E.1	U.T./BIG SANDY CK NEAR CLIFTON MILLS		CHEAT B70	6/17/1996	14	67	8	62	64	69	30	71	77	36	5	69	62
1	WVMC-12-F-{00.0}	LITTLE SANDY CREEK @ MOUTH		CHEAT B64	6/17/1996	18	86	10	77	49	53	12	89	35	102	4	82	81
1	WVMC-12-F-{01.0}	LITTLE SANDY CREEK NEAR CLIFTON MILLS		CHEAT B156	7/24/1996	16	76	10	77	63	68	4	97	39	96	4	84	83
1	WVMC-15-{01}	LAUREL RUN/CHEAT RIV. ABOVE HOGBACK RUN		CHEAT B102	6/19/1996	13	62	8	62	90	97	3	98	49	80	3	94	82
1	WVMC-15-A	LONG HOLLOW		CHEAT B183	7/29/1996	16	76	9	69	77	83	1	100	37	99	4	80	85
1	WVMC-16-A-{0.8}	SOUTH FORK GREENS RUN ABOVE MIDDLE FORK		CHEAT B68	6/17/1996	4	19	2	15	40	44	40	61	60	63	6	59	43
1	WVMC-17-.6A	2ND UNNAMED TRIB /MUDDY CREEK		CHEAT B52	6/17/1996	10	48	7	54	94	102	2	99	88	19	2	106	70
1	WVMC-17-.7	CRAB ORCHARD CREEK @ MOUTH		CHEAT B57	6/17/1996	9	43	4	31	3	3	5	96	96	6	4	82	43
1	WVMC-17-{10.2}	MUDDY CREEK ABOVE SUGARCAMP RUN		CHEAT B109	6/19/1996	20	95	14	108	81	88	7	94	48	81	4	82	90
1	WVMC-17-{14.4}	MUDDY CREEK NEAR HEADWATERS		CHEAT B110	6/19/1996	18	86	9	69	68	74	23	78	76	37	5	68	69
1	WVMC-17-{3.2}	MUDDY CREEK ABOVE MARTIN CREEK		CHEAT B66	6/17/1996	11	52	7	54	64	70	29	72	71	46	5	71	61
1	WVMC-17-{6.8}	MUDDY CREEK @ BRANDONVILLE TURNPIKE		CHEAT B84	6/18/1996	6	29	4	31	84	91	3	98	84	25	2	109	62
1	WVMC-17-A.1	UNNAMED TRIB/MUDDY CREEK @ MOUTH		CHEAT B86	6/18/1996	13	62	7	54	72	79	19	82	58	65	5	76	70
1	WVMC-17-B	JUMP ROCK RUN AT MOUTH		CHEAT B99	6/19/1996	9	43	4	31	87	94	2	99	83	27	2	106	66
1	WVMC-17-C	SUGARCAMP RUN/MUDDY CREEK		CHEAT B163	7/24/1996	15	71	7	54	87	95	5	96	69	49	3	97	77
1	WVMC-18-.1A	1ST UNNAMED TRIB /ROARING CREEK @ MOUTH		CHEAT B91	6/19/1996	15	71	7	54	74	81	14	86	67	52	5	77	70
1	WVMC-18-{0.0}	ROARING CREEK @ MOUTH		CHEAT B112	6/19/1996	12	57	7	54	58	63	4	97	46	85	4	84	73
1	WVMC-18-{6.0}	ROARING CREEK @ HEADWATERS		CHEAT B111	6/19/1996	24	114	17	131	84	91	5	96	51	77	4	89	92
1	WVMC-19	DAUGHERTY RUN		CHEAT B75	6/18/1996	17	81	10	77	82	89	7	94	54	72	4	78	82
1	WVMC-19-A	DORITY RUN @ MOUTH		CHEAT B93	6/19/1996	18	86	12	92	68	74	6	95	30	110	3	94	90
1	WVMC-2	MORGAN RUN		CHEAT B145	7/23/1996	19	90	10	77	61	66	15	86	41	93	5	77	82
1	WVMC-2.5	COLES RUN		CHEAT B139	7/23/1996	11	52	3	23	42	46	8	93	68	49	5	68	55
1	WVMC-2.5-A	BIRCH HOLLOW		CHEAT B137	7/23/1996	18	86	7	54	32	35	23	78	36	100	5	68	70
1	WVMC-2.7	KELLY RUN		CHEAT B142	7/23/1996	7	33	2	15	54	59	1	100	96	7	5	64	47
1	WVMC-20-{0.0}	ELSEY RUN		CHEAT B76	6/18/1996	16	76	13	100	88	96	6	94	53	74	4	88	88
1	WVMC-20-{6.0}	ELSEY RUN NEAR HEADWATERS		CHEAT B58	6/17/1996	17	81	9	69	46	50	33	67	59	65	4	78	68
1	WVMC-21	ASHPOLE RUN		CHEAT B72	6/18/1996	14	67	8	62	67	73	10	91	46	84	5	72	75
1	WVMC-22-{1.5}	BUFFALO RUN BELOW 1ST UNNAMED TRIB		CHEAT B56	6/17/1996	12	57	8	62	84	92	9	92	72	44	3	103	74
1	WVMC-22-{2.0}	BUFFALO RUN ABOVE 2ND UNNAMED TRIB		CHEAT B55	6/17/1996	12	57	8	62	88	95	2	99	72	44	2	109	76
1	WVMC-22-B	2ND UNNAMED TRIB /BUFFALO RUN		CHEAT B71	6/18/1996	17	81	8	62	21	23	68	32	75	40	6	60	50
1	WVMC-26-{0.0}	JOES RUN NEAR MOUTH		CHEAT B80	6/18/1996	8	38	6	46	61	66	34	66	78	34	4	83	56
1	WVMC-28	STAMPING GROUND RUN		CHEAT B162	7/24/1996	11	52	7	54	63	69	2	99	56	69	5	72	69
1	WVMC-31.7	FILL HOLLOW		CHEAT B152	7/24/1996	14	67	10	77	61	66	6	95	49	80	5	69	76
1	WVMC-31-{0.0}	BUCKHORN RUN		CHEAT B166	7/25/1996	8	38	1	8	31	34	13	88	56	68	4	78	52

Site metrics and metric scores

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
1	WVMC-32	SALTLICK CREEK		CHEAT B214	8/7/1996	11	52	9	69	85	92	14	87	54	72	4	84	76
1	WVMC-32-B	SPRUCE RUN/SALTLICK RUN		CHEAT B173	7/25/1996	18	86	11	85	83	91	5	96	47	83	4	86	88
1	WVMC-32-C-1	CABBAGE RUN		CHEAT B169	7/25/1996	16	76	10	77	75	81	3	98	33	104	3	102	89
1	WVMC-32-D	WOLF RUN /SALTLICK CREEK		CHEAT B174	7/25/1996	18	86	11	85	87	95	6	95	44	88	4	88	89
1	WVMC-32-E	BUCKLICK RUN/SALTLICK CREEK		CHEAT B167	7/25/1996	15	71	10	77	78	85	10	91	57	67	5	74	78
1	WVMC-32-F	LITTLE BUCKLICK RUN		CHEAT B172	7/25/1996	18	86	12	92	67	73	26	74	42	90	4	82	83
1	WVMC-32-G	IRISH RUN		CHEAT B154	7/24/1996	14	67	9	69	83	90	4	97	48	81	3	103	84
1	WVMC-33-{0.0}	BUFFALO CREEK @ MOUTH		CHEAT B168	7/25/1996	20	95	12	92	66	72	25	76	50	78	5	73	81
1	WVMC-33-A	FLAGG RUN		CHEAT B153	7/24/1996	20	95	13	100	74	80	13	87	43	89	4	81	89
1	WVMC-33-A.5	BELL HOLLOW		CHEAT B150	7/24/1996	15	71	11	85	83	91	10	91	34	103	3	92	88
1	WVMC-33-B.5	DOG RUN		CHEAT B140	7/23/1996	16	76	11	85	72	78	20	81	49	79	3	97	83
1	WVMC-33-C	BIRCHROOT RUN		CHEAT B151	7/24/1996	17	81	12	92	78	85	6	95	36	101	4	85	90
1	WVMC-33-D	LITTLE BUFFALO CREEK		CHEAT B143	7/23/1996	15	71	10	77	77	83	12	89	44	88	4	86	82
1	WVMC-33-E	BUCKLICK RUN/BUFFALO CREEK		CHEAT B138	7/23/1996	13	62	7	54	82	89	12	89	42	91	4	84	78
1	WVMC-33-F	SUGARCAMP RUN/BUFFALO CREEK		CHEAT B148	7/23/1996	17	81	10	77	72	79	15	86	41	92	4	81	83
1	WVMC-34-{0.0}	SCOTT RUN/CHEAT RIVER NEAR MACOMBER		CHEAT B161	7/24/1996	15	71	9	69	67	73	8	93	54	72	4	82	77
1	WVMC-35	MADISON RUN		CHEAT B158	7/24/1996	20	95	15	115	66	72	19	81	36	100	4	87	89
1	WVMC-35.5-{0.0}	KEYSER RUN		CHEAT B155	7/24/1996	16	76	9	69	71	78	14	87	35	101	4	91	83
1	WVMC-36-{0.0}	WOLF CREEK		CHEAT B164	7/24/1996	17	81	10	77	85	93	8	93	51	76	4	90	85
1	WVMC-36-A	LITTLE WOLF CREEK		CHEAT B157	7/24/1996	15	71	10	77	75	82	14	87	53	73	5	73	77
1	WVMC-39	MUDDY RUN		CHEAT B146	7/23/1996	15	71	11	85	90	97	5	96	41	93	3	100	90
1	WVMC-4	WHITES RUN		CHEAT B149	7/23/1996	9	43	3	23	13	15	10	90	69	49	5	65	47
1	WVMC-40	FORD RUN		CHEAT B141	7/23/1996	12	57	9	69	77	83	12	89	50	77	5	74	75
1	WVMC-42	LOUSE CAMP RUN		CHEAT B144	7/23/1996	14	67	11	85	88	95	8	93	48	81	4	87	85
1	WVMC-43-{0.0}	LICKING CREEK		CHEAT B171	7/25/1996	15	71	10	77	89	97	4	97	49	80	4	84	84
1	WVMC-43-A	BEARPEN HOLLOW		CHEAT B165	7/25/1996	14	67	11	85	79	85	9	92	41	92	4	91	85
1	WVMC-43-B	JACOBS RUN		CHEAT B170	7/25/1996	11	52	8	62	88	96	4	97	65	54	4	80	74
1	WVMC-44-{0.0}	BEARWALLOW RUN		CHEAT B175	7/26/1996	13	62	9	69	68	74	9	92	38	97	5	77	79
1	WVMC-46	BULL RUN		CHEAT B190	7/30/1996	18	86	11	85	71	77	17	84	33	104	4	87	86
1	WVMC-46-A	LEFT FORK BULL RUN		CHEAT B176	7/26/1996	15	71	12	92	91	99	4	97	52	75	3	97	89
1	WVMC-46-B	RIGHT FORK BULL RUN		CHEAT B177	7/26/1996	16	76	11	85	90	98	4	97	37	98	3	93	91
1	WVMC-47	JOHNATHAN RUN		CHEAT B198	7/30/1996	15	71	11	85	75	82	5	96	46	84	4	83	83
1	WVMC-49	CLAY LICK RUN		CHEAT B191	7/30/1996	10	48	5	38	51	55	29	72	52	74	5	66	59
1	WVMC-50	UPPER JOHNATHAN RUN		CHEAT B209	7/30/1996	16	76	11	85	71	77	15	86	31	108	4	86	85
1	WVMC-51	CLOVER RUN		CHEAT B192	7/30/1996	18	86	11	85	78	85	5	96	47	83	4	82	86
1	WVMC-51-A	RIGHT FORK CLOVER RUN		CHEAT B206	7/30/1996	18	86	12	92	81	89	11	90	30	110	3	95	92
1	WVMC-51-B	LEFT FORK/CLOVER RUN		CHEAT B202	7/30/1996	14	67	9	69	84	92	9	92	63	57	4	78	76
1	WVMC-51-B-2	MILL RUN /LEFT FORK		CHEAT B205	7/30/1996	15	71	10	77	79	86	7	94	38	98	3	97	87
1	WVMC-51-B-3	BEAR RUN		CHEAT B188	7/30/1996	16	76	12	92	71	78	9	92	35	102	4	89	88
1	WVMC-51-B-4	VALLEY FORK		CHEAT B210	7/30/1996	12	57	9	69	91	99	3	98	45	86	3	105	85
1	WVMC-52	MINEAR RUN		CHEAT B184	7/29/1996	14	67	9	69	95	103	2	99	63	58	4	83	79
1	WVMC-52-.7A	BRIDGE RUN		CHEAT B178	7/29/1996	18	86	13	100	85	92	4	96	30	109	3	99	96
1	WVMC-53	DRY RUN NEAR ST. GEORGE		CHEAT B193	7/30/1996	14	67	10	77	84	91	10	91	57	68	4	81	79
1	WVMC-54	HORSESHOE RUN		CHEAT B195	7/30/1996	14	67	9	69	82	90	3	98	55	71	4	82	79
1	WVMC-54-D	HYLE RUN		CHEAT B196	7/30/1996	23	110	13	100	71	77	12	89	26	116	4	84	92
1	WVMC-54-F	LAUREL RUN/HORSE SHOE RUN		CHEAT B200	7/30/1996	18	86	12	92	81	88	10	91	47	82	4	87	88
1	WVMC-54-H	THUNDERS TRUCK RUN		CHEAT B217	8/7/1996	18	86	12	92	90	97	5	96	44	87	3	101	93
1	WVMC-54-H-1	WALNUT HOLLOW RUN		CHEAT B219	8/7/1996	12	57	10	77	80	87	19	82	48	82	4	86	78
1	WVMC-54-I	LEADMINE RUN		CHEAT B201	7/30/1996	16	76	12	92	84	91	8	92	48	81	4	90	87
1	WVMC-54-I-1	LIME HOLLOW RUN		CHEAT B203	7/30/1996	15	71	12	92	86	94	10	90	31	107	3	92	90
1	WVMC-54-J	WOLF RUN /HORSESHOE RUN		CHEAT B211	7/30/1996	13	62	10	77	84	91	12	89	51	76	4	78	79
1	WVMC-54-K	TWELVEMILE RUN		CHEAT B208	7/30/1996	14	67	9	69	88	96	7	94	38	96	3	101	87
1	WVMC-56	MILL RUN /CHEAT RIVER		CHEAT B221	8/8/1996	18	86	12	92	86	94	4	97	40	94	3	93	93
1	WVMC-57	WOLF RUN /CHEAT RIVER		CHEAT B222	8/8/1996	12	57	8	62	81	88	15	85	85	24	5	68	64
1	WVMC-59-{00.0}	SHAVERS FORK @ PARSONS		CHEAT B45	6/12/1996	17	81	13	100	51	56	43	58	54	71	5	70	73
1	WVMC-59-{20.4}	SHAVERS FORK @ STEWART PARK		CHEAT B30	6/11/1996	19	90	12	92	73	79	16	85	36	100	4	82	88
1	WVMC-60-{11.6}	DRY FORK NEAR CANAAN VALLEY		CHEAT B5	6/10/1996	17	81	12	92	87	94	8	93	41	92	3	97	92
1	WVMC-60-{25.1}	DRY FORK ABOVE JOB		CHEAT B4	6/10/1996	15	71	10	77	50	55	13	88	56	69	4	83	74
1	WVMC-60-A	ROARING FORK		CHEAT B29	6/11/1996	14	67	11	85	87	95	5	96	56	68	4	90	83
1	WVMC-60-D-11	YOOKUM RUN		CHEAT B128	7/16/1996	12	57	8	62	55	59	40	61	60	62	5	67	61
1	WVMC-60-D-12	FREELAND RUN		CHEAT B124	7/16/1996	14	67	8	62	26	29	66	35	81	30	6	55	46
1	WVMC-60-D-14	MILL RUN /BLACKWATER RIVER		CHEAT B126	7/16/1996	24	114	12	92	45	49	35	66	58	65	6	61	72
1	WVMC-60-D-3-B	MIDDLE RUN		CHEAT B125	7/16/1996	11	52	4	31	72	78	5	96	69	48	4	85	65

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1	WVMC-60-D-3-C	SNYDER RUN		CHEAT B127	7/16/1996	8	38	4	31	77	83	14	87	78	35	3	95	62
1	WVMC-60-D-3-E	SAND RUN		CHEAT B134	7/17/1996	9	43	5	38	84	92	7	93	75	39	4	80	64
1	WVMC-60-G	RED RUN/ DRY FORK		CHEAT B28	6/11/1996	10	48	7	54	83	90	5	96	60	63	4	82	72
1	WVMC-60-J	ELKLICK RUN NEAR ELK		CHEAT B18	6/11/1996	18	86	13	100	71	77	1	100	30	109	3	97	93
1	WVMC-60-K-16	WEST FORK OF GLADY CREEK		CHEAT B90	6/18/1996	23	110	14	108	90	98	2	99	52	75	4	90	94
1	WVMC-60-K-17	EAST FORK OF GLADY FORK		CHEAT B38	6/12/1996	14	67	10	77	84	91	8	92	42	91	3	97	86
1	WVMC-60-K-17-A	LOUK RUN		CHEAT B42	6/12/1996	22	105	15	115	88	96	0	101	41	92	3	93	97
1	WVMC-60-K-5	WOODFORD RUN		CHEAT B187	7/29/1996	18	86	13	100	56	61	1	100	59	65	4	88	83
1	WVMC-60-K-8	FLANNIGAN RUN		CHEAT B39	6/12/1996	14	67	11	85	92	101	5	96	54	72	3	96	86
1	WVMC-60-L	BIG RUN/ DRY FORK		CHEAT B1	6/10/1996	14	67	12	92	78	85	5	96	47	83	4	90	85
1	WVMC-60-N {01}	LAUREL FK/DRY FK NEAR MOUTH		CHEAT B51	6/13/1996	17	81	13	100	71	77	23	78	42	91	4	81	85
1	WVMC-60-N {20}	LAUREL FK/DRY FK @ LAUREL FK CAMPGROUND		CHEAT B24	6/11/1996	22	105	14	108	93	101	1	100	36	100	3	100	100
1	WVMC-60-N-4	BEAVERDAM RUN		CHEAT B34	6/12/1996	17	81	10	77	61	66	18	82	46	85	4	79	78
1	WVMC-60-N-8	FIVE LICK RUN/LAUREL FK/ DRY FK		CHEAT B20	6/11/1996	18	86	13	100	86	93	4	97	43	88	3	99	94
1	WVMC-60-O-{01.0}	RED CREEK NEAR MOUTH		CHEAT B133	7/17/1996	14	67	9	69	83	90	10	91	58	66	4	80	77
1	WVMC-60-O-{07.0}	RED CREEK NEAR LANEVILLE		CHEAT B132	7/17/1996	13	62	8	62	44	47	19	82	57	67	5	66	64
1	WVMC-60-O-1	BIG RUN/ RED CREEK		CHEAT B130	7/17/1996	13	62	8	62	67	73	26	75	46	84	5	71	71
1	WVMC-60-P	SPRUCE RUN/DRY FORK		CHEAT B13	6/10/1996	15	71	11	85	88	96	9	92	50	78	4	85	84
1	WVMC-60-Q	HORSE CAMP RUN		CHEAT B7	6/10/1996	10	48	7	54	79	86	15	86	55	71	4	82	71
1	WVMC-60-R	TORY CAMP RUN		CHEAT B218	8/7/1996	14	67	7	54	6	7	1	100	92	12	4	84	54
1	WVMC-60-T-{02.5}	GANDY CREEK @ WHITMER		CHEAT B6	6/10/1996	16	76	10	77	86	94	2	99	47	82	3	94	87
1	WVMC-60-T-{13.0}	GANDY CREEK/BELOW SINKS GANDY		CHEAT B21	6/11/1996	15	71	10	77	81	88	7	94	52	76	4	85	82
1	WVMC-60-T-10	NARROW RIDGE RUN		CHEAT B9	6/10/1996	16	76	11	85	83	90	1	100	61	61	4	90	84
1	WVMC-60-T-11	WARNER RUN		CHEAT B32	6/11/1996	16	76	10	77	89	97	1	100	51	76	4	88	86
1	WVMC-60-T-13	BIG RUN NEAR GANDY SINKS		CHEAT B16	6/11/1996	20	95	14	108	80	87	6	95	36	100	4	88	94
1	WVMC-60-T-9	GRANTS BRANCH		CHEAT B194	7/30/1996	16	76	11	85	82	90	14	87	46	84	3	104	87
1	WVMCS-13	LITTLE BLACK FORK		CHEAT B181	7/29/1996	18	86	13	100	92	100	3	98	35	102	3	95	96
1	WVMCS-15	RATTLESNAKE RUN		CHEAT B44	6/12/1996	16	76	13	100	86	93	11	90	29	112	4	90	91
1	WVMCS-16	JOHNS RUN		CHEAT B199	7/30/1996	14	67	10	77	82	89	14	87	48	82	4	90	82
1	WVMCS-18	WOLF RUN /SHAVERS FORK		CHEAT B33	6/11/1996	18	86	14	108	97	105	0	101	62	59	3	92	90
1	WVMCS-2	HAWK RUN		CHEAT B41	6/12/1996	18	86	13	100	80	87	1	100	45	86	4	87	91
1	WVMCS-22	TAYLOR RUN		CHEAT B31	6/11/1996	18	86	14	108	93	101	4	97	37	99	3	99	97
1	WVMCS-25	COLLETT GAP RUN		CHEAT B37	6/12/1996	19	90	15	115	58	64	0	101	57	67	3	100	87
1	WVMCS-3	HADDIX RUN		CHEAT B40	6/12/1996	16	76	11	85	81	89	8	93	42	91	4	86	87
1	WVMCS-33	FISHING HAWK CREEK		CHEAT B19	6/11/1996	10	48	8	62	89	96	0	101	66	54	2	112	77
1	WVMCS-3-A	SOUTH BRANCH/HADDIX RUN		CHEAT B216	8/7/1996	16	76	11	85	86	93	3	98	40	94	3	101	91
1	WVMCS-46	RED RUN/ SHAVERS FORK		CHEAT B10	6/10/1996	9	43	6	46	92	100	1	100	82	28	2	107	69
1	WVMCS-47	BLISTER RUN		CHEAT B3	6/10/1996	17	81	12	92	89	97	4	97	46	85	3	98	92
1	WVMCS-5	LAUREL RUN/SHAVERS FK @ MOUTH		CHEAT B212	8/7/1996	17	81	11	85	90	98	4	96	44	88	3	98	91
1	WVMCS-6	PLEASANT RUN		CHEAT B43	6/12/1996	13	62	8	62	89	97	4	97	42	91	3	93	83
1	WVMCS-6-B	AARONS RUN/PLEASANT RUN		CHEAT B48	6/13/1996	17	81	12	92	92	100	2	99	64	57	3	97	88
1	WVMCS-6-E	CHOKE TRAP RUN		CHEAT B49	6/13/1996	20	95	12	92	87	94	1	99	41	91	3	92	94
1	WVMCS-7	STONELICK RUN		CHEAT B46	6/12/1996	22	105	16	123	80	87	3	98	23	121	3	96	97
1	WVMCS-7.5	CANOE RUN		CHEAT B35	6/12/1996	18	86	14	108	86	93	10	91	31	108	4	88	93
1	WVMT-11-{6.6}	BERKELY RUN		TYVAR B310	8/27/1997	8	38	3	23	51	56	3	98	54	72	4	78	61
1	WVMT-11-B	LONG RUN		TYVAR B300	8/26/1997	11	52	3	23	21	22	9	92	47	83	7	42	52
1	WVMT-12-{10.2}	THREE FORK CREEK		TYVAR B327	9/2/1997	6	29	1	8	8	9	42	59	67	52	5	68	37
1	WVMT-18-E-3-A-{1.2}	U.T. OF LEFT FORK/LITTLE SANDY CREEK		TYVAR B342	9/3/1997	18	86	10	77	50	55	16	85	39	96	4	80	80
1	WVMT-18-E-4-A	TIBBS RUN		TYVAR B340	9/3/1997	15	71	9	69	46	50	25	76	46	85	5	68	70
1	WVMT-18-G-2	U.T. OF LEFT FORK/LITTLE SANDY CREEK		TYVAR B343	9/3/1997	14	67	6	46	63	69	2	99	51	77	5	71	71
1	WVMT-22	CUNNINGHAM RUN		TYVAR B356	9/9/1997	13	62	7	54	63	68	10	91	33	105	4	88	77
1	WVMT-23	TETER CREEK		TYVAR B366	9/9/1997	16	76	9	69	59	65	1	100	44	87	4	80	80
1	WVMT-23-B-1	STONY RUN/RACOON CREEK/TETER CREEK		TYVAR B347	9/4/1997	12	57	5	38	34	37	1	100	60	62	5	77	62
1	WVMT-23-C-{5.6}	BRUSHY FORK		TYVAR B344	9/4/1997	13	62	9	69	88	96	9	92	54	71	3	95	81
1	WVMT-23-F	MILL RUN /TETER CREEK		TYVAR B359	9/9/1997	12	57	6	46	77	84	15	85	40	93	5	77	74
1	WVMT-24-{0.03}	LAUREL CREEK		TYVAR B374	9/10/1997	14	67	7	54	73	80	8	93	46	85	5	76	76
1	WVMT-24-A	FROST RUN		TYVAR B370	9/10/1997	10	48	2	15	60	65	31	69	89	17	6	63	46
1	WVMT-24-C	SUGAR CREEK		TYVAR B365	9/9/1997	17	81	6	46	57	62	7	94	49	80	6	63	71
1	WVMT-24-C-3.5	HUNTER FORK		TYVAR B373	9/10/1997	11	52	5	38	63	68	7	94	51	76	4	82	69
1	WVMT-26-{0.4}	HACKERS CREEK		TYVAR B313	8/27/1997	14	67	3	23	55	60	27	74	75	38	6	62	54
1	WVMT-26-B	FOXGRAPE RUN		TYVAR B390	9/16/1997	9	43	2	15	25	27	57	43	82	29	6	54	35
1	WVMT-29	ANGLINS RUN		TYVAR B379	9/11/1997	11	52	3	23	40	43	47	54	76	38	6	53	44
1	WVMT-33-{11.8}	MIDDLE FORK RIVER		TYVAR B317	8/27/1997	10	48	6	46	57	62	2	99	60	63	5	74	65

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1	WVMT-36	ISLAND RUN		TYVAR B385	9/15/1997	10	48	2	15	50	54	24	77	71	45	6	63	51
1	WVMT-37-{2.8}	BEAVER CREEK		TYVAR B383	9/15/1997	10	48	4	31	60	65	8	93	50	79	4	89	68
1	WVMT-39	LAUREL RUN		TYVAR B386	9/15/1997	12	57	5	38	57	62	21	80	61	61	5	71	61
1	WVMT-4	GOOSE CREEK		TYVAR B286	8/25/1997	2	10	1	8	67	73	0	101	100	0	5	70	43
1	WVMT-40	BIG LAUREL RUN		TYVAR B384	9/15/1997	12	57	6	46	63	69	20	81	47	82	5	72	68
1	WVMT-40-A	LITTLE LAUREL RUN		TYVAR B387	9/15/1997	13	62	7	54	41	45	24	77	46	84	5	74	66
1	WVMT-43-{13.2}	LEADING CREEK		TYVAR B323	9/2/1997	13	62	5	38	54	59	11	90	59	63	5	73	64
1	WVMT-43-{15.6}	LEADING CREEK		TYVAR B316	8/27/1997	17	81	7	54	54	58	4	97	47	82	5	75	75
1	WVMT-43-F-1	LOGLICK RUN		TYVAR B289	8/25/1997	18	86	12	92	90	97	7	94	53	74	4	81	87
1	WVMT-43-H	DAVIS LICK		TYVAR B380	9/11/1997	8	38	2	15	12	13	51	50	67	52	7	41	35
1	WVMT-43-M	CAMPFIELD RUN		TYVAR B312	8/27/1997	19	90	11	85	77	84	11	90	53	74	5	75	83
1	WVMT-43-O	LAUREL RUN		TYVAR B315	8/27/1997	15	71	6	46	40	43	40	61	73	43	5	64	55
1	WVMT-45	CHENOWETH CREEK		TYVAR B293	8/26/1997	19	90	9	69	65	71	7	94	56	68	5	76	78
1	WVMT-48	KINGS RUN		TYVAR B297	8/26/1997	16	76	5	38	42	46	21	79	55	71	5	69	63
1	WVMT-5	LOST RUN		TYVAR B290	8/25/1997	16	76	8	62	50	54	7	94	42	91	4	78	76
1	WVMT-50-A-1	LIMEKILN RUN		TYVAR B299	8/26/1997	15	71	12	92	82	89	14	86	49	80	4	82	83
1	WVMT-50-B-3	HILL RUN		TYVAR B295	8/26/1997	15	71	10	77	88	96	3	98	55	71	4	84	83
1	WVMT-57-{0.4}	JONES RUN		TYVAR B314	8/27/1997	16	76	8	62	63	68	18	83	38	96	4	79	77
1	WVMT-61-{2.0}	SHAVERS RUN		TYVAR B339	9/3/1997	15	71	8	62	84	91	12	89	57	67	4	81	77
1	WVMT-64-A.5	BUCK RUN		TYVAR B331	9/3/1997	13	62	8	62	61	66	22	78	49	80	5	72	70
1	WVMT-64-E	MEATBOX RUN		TYVAR B376	9/10/1997	13	62	9	69	73	79	20	81	44	87	3	95	79
1	WVMT-64-F	POTATOHOLE FORK		TYVAR B378	9/10/1997	13	62	9	69	88	96	10	91	66	53	2	116	79
1	WVMT-66	RIFFLE CREEK		TYVAR B325	9/2/1997	16	76	7	54	41	44	42	59	77	36	6	58	55
1	WVMT-68	BECKY CREEK		TYVAR B329	9/3/1997	19	90	11	85	73	79	24	77	57	67	5	76	79
1	WVMT-68-D	WAMSLEY RUN		TYVAR B367	9/9/1997	16	76	10	77	72	79	15	86	59	64	4	81	77
1	WVMT-69	POUNDMILL RUN		TYVAR B361	9/9/1997	12	57	7	54	28	31	67	34	78	35	6	55	44
1	WVMT-7	PLUM RUN		TYVAR B303	8/26/1997	14	67	6	46	40	44	12	89	49	80	5	73	66
1	WVMT-74	ELKWATER FORK		TYVAR B357	9/9/1997	20	95	10	77	75	81	7	94	56	68	4	91	84
1	WVMT-74-B-1	FORTLICK RUN		TYVAR B358	9/9/1997	20	95	11	85	64	70	4	97	46	84	4	86	86
1	WVMT-78	RALSTON RUN		TYVAR B362	9/9/1997	15	71	8	62	60	65	18	83	47	83	4	79	74
1	WVMT-8	WICKWIRE RUN		TYVAR B308	8/26/1997	13	62	6	46	24	26	14	87	64	56	5	71	58
1	WVMTB-10-A	SUGAR RUN		TYVAR B326	9/2/1997	8	38	2	15	14	15	74	26	87	20	7	49	27
1	WVMTB-11	FINK RUN		TYVAR B322	9/2/1997	10	48	2	15	35	38	38	63	71	45	7	48	43
1	WVMTB-11-B	MUDLICK RUN		TYVAR B324	9/2/1997	4	19	0	0	0	0	19	82	93	12	9	12	21
1	WVMTB-18-B	BULL RUN		TYVAR B332	9/3/1997	11	52	3	23	70	76	12	89	81	29	5	66	56
1	WVMTB-18-B-3	MUDLICK RUN		TYVAR B336	9/3/1997	17	81	2	15	4	4	59	42	66	53	7	46	40
1	WVMTB-18-D {3.9}	LAUREL FORK/FRENCH CREEK		TYVAR B375	9/10/1997	19	90	9	69	72	78	10	91	59	64	5	76	78
1	WVMTB-19-{0.9}	TRUBIE RUN		TYVAR B348	9/4/1997	21	100	8	62	41	44	9	92	41	92	5	74	77
1	WVMTB-20	SAWMILL RUN		TYVAR B346	9/4/1997	5	24	3	23	82	89	7	94	91	15	5	67	52
1	WVMTB-24	LAUREL RUN		TYVAR B345	9/4/1997	6	29	3	23	86	94	6	95	85	24	5	73	56
1	WVMTB-25	TENMILE CREEK		TYVAR B394	9/17/1997	8	38	2	15	70	76	21	80	88	19	5	67	49
1	WVMTB-25-A	RIGHT FORK OF TENMILE CREEK		TYVAR B393	9/17/1997	16	76	9	69	58	63	26	74	45	86	4	83	75
1	WVMTB-27	PANTHER FORK		TYVAR B391	9/16/1997	13	62	6	46	58	63	36	65	71	45	5	70	59
1	WVMTB-3	BIG RUN		TYVAR B392	9/17/1997	11	52	5	38	57	62	4	97	57	67	4	81	66
1	WVMTB-30	HEROLDS RUN		TYVAR B372	9/10/1997	14	67	5	38	74	80	13	88	63	58	4	79	68
1	WVMTB-31-C	ALEC RUN		TYVAR B354	9/9/1997	14	67	8	62	92	100	3	98	67	52	4	87	78
1	WVMTB-31-D	MILLSITE RUN		TYVAR B360	9/9/1997	14	67	11	85	77	83	21	80	55	70	5	76	77
1	WVMTB-31-F-1	TROUT RUN		TYVAR B352	9/8/1997	15	71	9	69	64	69	24	76	63	58	5	72	69
1	WVMTB-31-F-2-{0.8}	UPPER TROUT RUN		TYVAR B353	9/8/1997	18	86	11	85	79	86	14	87	58	65	4	82	82
1	WVMTB-31-F-5	SALT BLOCK RUN		TYVAR B351	9/8/1997	15	71	11	85	85	93	9	91	63	58	4	80	80
1	WVMTB-32-H	BEECH RU N		TYVAR B355	9/9/1997	14	67	9	69	61	66	24	77	44	88	5	70	73
1	WVMTB-32-I-1	PHILLIPS CAMP RUN		TYVAR B388	9/15/1997	11	52	8	62	77	84	15	86	41	92	2	107	79
1	WVMTB-7-{1.0}	SAND RUN		TYVAR B337	9/3/1997	17	81	9	69	72	78	5	96	44	87	4	80	82
1	WVMTB-7-A-{0.5}	LAUREL FORK/SAND RUN		TYVAR B333	9/3/1997	14	67	9	69	64	70	33	67	68	50	5	65	65
1	WVMTB-7-A-{2.9}	LAUREL FORK/SAND RUN		TYVAR B334	9/3/1997	16	76	6	46	45	49	31	69	44	87	5	69	66
1	WVMTB-7-C {0.32}	UT OF SAND RUN		TYVAR B395	9/22/1997	15	71	8	62	67	73	7	94	42	91	4	83	79
1	WVMTB-8	BIG RUN		TYVAR B330	9/3/1997	10	48	4	31	56	61	17	84	58	66	5	66	59
1	WVMTM-0.5-{0.6}	SWAMP RUN		TYVAR B291	8/25/1997	18	86	7	54	33	36	12	89	34	103	4	86	75
1	WVMTM-11-{0.3}	RIGHT FORK MIDDLE FORK		TYVAR B304	8/26/1997	19	90	10	77	45	49	12	89	59	64	5	72	73
1	WVMTM-13	LONG RUN		TYVAR B349	9/8/1997	18	86	10	77	85	93	5	96	74	41	4	78	78
1	WVMTM-17	THREE FORKS RUN		TYVAR B321	8/27/1997	15	71	6	46	9	10	55	45	70	46	6	60	46
1	WVMTM-2	LAUREL RUN		TYVAR B298	8/26/1997	22	105	13	100	46	50	16	85	37	98	4	80	86
1	WVMTM-21	PLEASANT RUN		TYVAR B319	8/27/1997	16	76	5	38	44	48	24	76	62	59	5	69	61

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1	WVMTM-27	MITCHELL LICK FORK		TYVAR B396	9/29/1997	15	71	9	69	64	69	29	72	52	75	4	79	73
1	WVMTM-3	HOOPPOLE RUN		TYVAR B288	8/25/1997	3	14	2	15	67	73	33	67	78	35	5	70	46
1	WVMTM-5	SERVICE RUN		TYVAR B305	8/26/1997	13	62	7	54	73	79	14	87	51	76	3	94	75
1	WVMTM-7	SHORT RUN		TYVAR B307	8/26/1997	18	86	9	69	79	86	11	90	59	64	4	81	79
1	WVMY-11	SOUTH BRANCH LAUREL RUN		YOUGH B117	7/8/1996	17	81	8	62	36	39	11	90	46	84	4	82	73
1	WVMY-2	SNOWY CREEK		YOUGH B116	7/8/1996	9	43	3	23	63	68	5	95	75	40	6	60	55
1	WVMY-2-A	NORTH BRANCH		YOUGH B115	7/8/1996	13	62	7	54	89	97	2	99	73	42	5	77	72
1	WVMY-2-A-1	WARDWELL RUN		YOUGH B118	7/8/1996	13	62	5	38	39	42	36	64	67	51	6	60	53
1	WVMY-2-B-1	PINE RUN		YOUGH B121	7/9/1996	18	86	13	100	85	92	4	97	51	76	3	98	92
1	WVMY-3-A	LITTLE LAUREL RUN		YOUGH B114	7/8/1996	8	38	3	23	73	79	7	94	83	27	3	95	59
1	WVMY-4	RHINE CREEK		YOUGH B122	7/9/1996	14	67	9	69	64	69	25	76	47	83	5	71	72
1	WVMY-9	BUFFALO RUN		YOUGH B113	7/8/1996	9	43	4	31	72	78	1	100	78	34	4	88	62
1	WVP-20-{52.0}	NORTH BRANCH POTOMAC RIVER		NBRPO B318	8/27/1997	7	33	1	8	16	18	74	26	91	15	7	49	25
1	WVP-20-{81.6}	NORTH BRANCH POTOMAC RIVER		NBRPO B301	8/26/1997	11	52	6	46	85	93	11	90	72	45	4	80	68
1	WVP-20-{82.6}	NORTH BRANCH POTOMAC RIVER		NBRPO B302	8/26/1997	10	48	5	38	84	92	11	90	73	43	4	81	65
1	WVP-20-{88.9}	NORTH BRANCH POTOMAC RIVER		NBRPO B244	8/11/1997	10	48	5	38	68	74	24	77	88	18	5	68	54
1	WVP-20-{97.9}	NORTH BRANCH POTOMAC RIVER		NBRPO B268	8/13/1997	14	67	7	54	81	88	8	93	56	69	5	76	74
1	WVPNB-1 {4.2}	GREEN SPRING RUN		NBRPO B279	8/19/1997	22	105	10	77	52	57	24	77	39	95	5	74	80
1	WVPNB-15	DEEP RUN		NBRPO B263	8/13/1997	11	52	8	62	93	101	4	97	57	67	4	84	77
1	WVPNB-16-.5A-{0.4}	U.T. OF ABRAMS CREEK		NBRPO B275	8/14/1997	9	43	4	31	58	63	0	101	83	27	5	75	57
1	WVPNB-16 {05.4}	ABRAM CREEK		NBRPO B273	8/14/1997	3	14	1	8	71	77	25	76	96	7	5	65	41
1	WVPNB-16 {16.8}	ABRAM CREEK		NBRPO B309	8/27/1997	6	29	3	23	83	91	6	95	78	35	5	71	57
1	WVPNB-16-A-{0.8}	EMORY CREEK		NBRPO B274	8/14/1997	6	29	3	23	79	86	9	92	81	29	5	74	55
1	WVPNB-16-B.5	LAUREL RUN		NBRPO B282	8/19/1997	7	33	3	23	78	85	11	90	86	22	5	69	54
1	WVPNB-17 {15.6}	STONY RIVER		NBRPO B284	8/19/1997	10	48	5	38	47	52	47	53	83	26	6	61	46
1	WVPNB-17-B	MILL RUN		NBRPO B266	8/13/1997	16	76	10	77	75	81	8	93	42	91	4	85	84
1	WVPNB-17-C	FOURMILE RUN		NBRPO B278	8/19/1997	5	24	1	8	17	18	33	67	50	78	6	63	43
1	WVPNB-17-E	HEMLICK RUN		NBRPO B280	8/19/1997	9	43	3	23	15	17	33	68	78	35	6	60	41
1	WVPNB-19 {1.4}	BUFFALO CREEK		NBRPO B239	8/11/1997	20	95	13	100	78	85	9	92	39	96	4	87	92
1	WVPNB-19-A	LITTLE BUFFALO CREEK		NBRPO B241	8/11/1997	4	19	2	15	88	95	0	101	88	20	5	73	54
1	WVPNB-22	DEAKIN RUN		NBRPO B262	8/13/1997	9	43	3	23	49	53	23	78	57	67	5	73	56
1	WVPNB-4 {04.6}	PATTERSON CREEK		NBRPO B269	8/13/1997	26	124	13	100	30	33	38	63	58	66	6	61	70
1	WVPNB-4 {20.2}	PATTERSON CREEK		NBRPO B255	8/12/1997	21	100	10	77	67	73	1	100	32	107	4	84	89
1	WVPNB-4 {29.7}	PATTERSON CREEK		NBRPO B245	8/11/1997	23	110	11	85	77	84	10	91	48	81	5	77	86
1	WVPNB-4 {33.0}	PATTERSON CREEK		NBRPO B270	8/13/1997	23	110	12	92	70	77	7	94	35	101	4	83	91
1	WVPNB-4 {39.4}	PATTERSON CREEK		NBRPO B246	8/11/1997	23	110	13	100	82	89	7	94	57	67	4	87	90
1	WVPNB-4-C.5	HORSESHOE CREEK		NBRPO B281	8/19/1997	22	105	11	85	88	96	5	96	66	54	5	71	84
1	WVPNB-4-CC	ROSSER RUN		NBRPO B248	8/11/1997	20	95	9	69	60	65	19	82	53	73	5	76	77
1	WVPNB-4-DD-{2.0}	THORN CREEK		NBRPO B257	8/12/1997	17	81	9	69	82	89	9	92	56	68	3	97	83
1	WVPNB-4-FF	MIDDLE FORK/PATTERSON CREEK		NBRPO B242	8/11/1997	18	86	8	62	36	39	21	80	46	85	5	71	70
1	WVPNB-4-FF-5-A-{0.6}	UT OF UT OF MIDDLE FORK / PATTERSON		NBRPO B260	8/12/1997	12	57	3	23	18	20	8	93	68	49	4	90	55
1	WVPNB-4-J-{1.6}	CABIN RUN		NBRPO B251	8/12/1997	14	67	6	46	46	50	23	77	55	70	5	71	64
1	WVPNB-4-J-1	PARGUT RUN		NBRPO B254	8/12/1997	13	62	6	46	29	31	55	46	68	51	6	59	49
1	WVPNB-4-S-{04.7}	MILLL CREEK		NBRPO B243	8/11/1997	14	67	4	31	46	50	15	86	73	42	5	72	58
1	WVPNB-4-S-{5.6}	MILL CREEK		NBRPO B277	8/18/1997	19	90	10	77	81	88	15	86	59	64	4	84	82
1	WVPNB-4-V	ELLIBER RUN		NBRPO B240	8/11/1997	15	71	6	46	95	104	2	99	83	26	3	99	74
1	WVPNB-4-W-3	WHIP RUN		NBRPO B272	8/13/1997	15	71	9	69	85	93	13	88	46	84	4	88	82
1	WVPNB-7 {03.8}	NEW CREEK		NBRPO B267	8/13/1997	14	67	8	62	66	72	13	88	35	101	4	87	79
1	WVPNB-7 {08.4}	NEW CREEK		NBRPO B252	8/12/1997	15	71	9	69	85	93	12	89	75	39	3	95	76
1	WVPNB-7 {10.4}	NEW CREEK		NBRPO B253	8/12/1997	16	76	7	54	75	82	13	88	63	57	4	80	73
1	WVPNB-7-F {0.6}	ASH SPRING RUN		NBRPO B250	8/12/1997	17	81	10	77	82	89	9	92	47	83	4	86	85
1	WVPNB-7-H	LINTON CREEK		NBRPO B265	8/13/1997	21	100	12	92	86	94	2	99	59	64	3	99	91
1	WVPSB-0.5	IST UNNAMED TRIB /SOUTH BR POTOMAC		SBRPO B296	8/27/1996	11	52	6	46	58	63	15	86	58	65	4	79	65
1	WVPSB-1	STONEY RUN/SOUTH BR POTOMAC		SBRPO B285	8/26/1996	14	67	7	54	79	86	12	88	47	83	4	84	77
1	WVPSB-1.8	ABERNATHY RUN		SBRPO B280	8/26/1996	13	62	5	38	35	38	4	97	77	36	4	81	59
1	WVPSB-1.9	2ND UNNAMED TRIB /SOUTH BR POTOMAC		SBRPO B288	8/27/1996	14	67	6	46	46	50	33	68	56	69	5	66	61
1	WVPSB-11	MCDOWELL RUN		SBRPO B298	8/27/1996	11	52	6	46	18	19	61	40	79	33	6	54	41
1	WVPSB-13	MILL RUN		SBRPO B301	8/27/1996	15	71	9	69	70	76	22	78	54	71	4	82	75
1	WVPSB-14	BUFFALO RUN		SBRPO B309	8/28/1996	12	57	6	46	71	77	4	97	58	66	5	70	69
1	WVPSB-16	DEVIL HOLE RUN		SBRPO B311	8/28/1996	11	52	8	62	73	79	20	81	44	87	4	83	74
1	WVPSB-16-A	SAWMILL RUN		SBRPO B315	8/28/1996	14	67	7	54	58	63	14	87	27	114	4	80	75
1	WVPSB-17-A	CLIFFORD HOLLOW		SBRPO B310	8/28/1996	9	43	6	46	78	85	20	81	68	50	4	89	66
1	WVPSB-18	ANDERSON RUN		SBRPO B281	8/26/1996	9	43	4	31	43	47	37	64	59	64	6	59	51

Site metrics and metric scores

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
1	WVPSB-18.2	UNNAMED TRIB/S BR POT SOUTH OF MCNEIL		SBRPO B332	9/10/1996	11	52	8	62	92	100	4	97	67	52	3	103	77
1	WVPSB-18-A {1.0}	MUDLICK RUN AT MOUTH		SBRPO B284	8/26/1996	13	62	8	62	45	49	28	72	45	85	5	67	66
1	WVPSB-18-A-0.5	UNNAMED TRIB/MUDLICK RUN		SBRPO B287	8/26/1996	10	48	5	38	49	53	31	69	51	76	5	63	58
1	WVPSB-18-A-1	TURNMILL RUN/MUD LICK RUN		SBRPO B286	8/26/1996	14	67	8	62	59	65	18	83	56	69	4	84	71
1	WVPSB-18-B	WALNUT BOTTOM RUN		SBRPO B317	8/28/1996	14	67	9	69	68	74	17	84	45	86	5	73	75
1	WVPSB-19	WILLIAMS HOLLOW/ GLEBE RUN		SBRPO B318	8/28/1996	14	67	6	46	63	69	23	78	51	76	4	86	70
1	WVPSB-2	JOHN'S RUN		SBRPO B297	8/27/1996	12	57	8	62	44	48	18	83	53	73	5	72	66
1	WVPSB-21-{01.0}	SOUTH FK /SOUTH BR POT NEAR MOUTH		SBRPO B235	8/19/1996	14	67	9	69	61	66	8	93	52	75	5	73	74
1	WVPSB-21-AA	MILLER RUN		SBRPO B271	8/21/1996	8	38	2	15	33	36	11	90	66	54	6	60	49
1	WVPSB-21-F	DUMPLING RUN/MOOREFIELD RUN		SBRPO B228	8/19/1996	16	76	6	46	12	13	1	100	85	23	4	82	57
1	WVPSB-21-F	DUMPLING RUN/MOOREFIELD RUN		SBRPO B335	9/19/1996	1	5	1	8	100	109	0	101	100	0	5	70	47
1	WVPSB-21-GG	LITTLE FORK		SBRPO B269	8/21/1996	13	62	7	54	65	70	4	97	63	58	5	64	68
1	WVPSB-21-HH	STONY RUN/MOOREFIELD RUN		SBRPO B278	8/21/1996	13	62	7	54	85	93	1	100	67	52	5	76	73
1	WVPSB-21-I	KETTLE CREEK		SBRPO B248	8/20/1996	19	90	11	85	60	65	21	79	44	88	5	75	80
1	WVPSB-21-II	BRUSHY FORK		SBRPO B265	8/21/1996	11	52	6	46	80	88	14	87	68	50	4	87	68
1	WVPSB-21-K	ROUGH RUN/MOOREFIELD RUN		SBRPO B233	8/19/1996	14	67	8	62	64	69	22	79	43	89	4	78	74
1	WVPSB-21-K-1	LITTLE ROUGH RUN		SBRPO B229	8/19/1996	13	62	7	54	55	60	30	71	50	79	4	79	67
1	WVPSB-21-N	DICE RUN /SOUTH FK/SOUTH BR POT		SBRPO B244	8/20/1996	12	57	8	62	63	69	12	89	53	73	6	61	68
1	WVPSB-21-O	WAGNER RUN		SBRPO B262	8/20/1996	13	62	8	62	66	72	13	88	50	78	5	69	72
1	WVPSB-21-Q	DEAN GAP		SBRPO B243	8/20/1996	18	86	10	77	57	62	29	71	41	92	5	73	77
1	WVPSB-21-R	STONY RUN		SBRPO B258	8/20/1996	8	38	2	15	43	47	18	82	70	48	6	59	48
1	WVPSB-21-T	HIVELY GAP		SBRPO B267	8/21/1996	16	76	5	38	26	28	44	56	57	67	5	63	55
1	WVPSB-23-A	DURGEON RUN		SBRPO B323	9/10/1996	9	43	4	31	57	62	5	96	65	55	5	66	59
1	WVPSB-23-A-1	MITCHELL RUN/DURGEON RUN		SBRPO B327	9/10/1996	12	57	6	46	59	64	7	94	64	56	5	66	64
1	WVPSB-26	LUNICE CREEK		SBRPO B231	8/19/1996	11	52	5	38	81	88	3	98	57	67	4	88	72
1	WVPSB-26-A	ROBINSON RUN		SBRPO B329	9/10/1996	10	48	6	46	72	78	8	92	38	97	5	77	73
1	WVPSB-26-B	NORMAN RUN		SBRPO B328	9/10/1996	13	62	8	62	85	92	7	94	55	70	4	79	77
1	WVPSB-26-C	BRUSHY RUN/LUNICE CK		SBRPO B227	8/19/1996	14	67	8	62	42	46	7	94	61	61	5	74	67
1	WVPSB-26-D	SOUTH FORK/LUNICE CREEK		SBRPO B236	8/19/1996	10	48	4	31	49	53	5	96	76	37	5	65	55
1	WVPSB-26-D-2	BIG STAR RUN		SBRPO B223	8/19/1996	16	76	11	85	86	93	9	92	30	109	4	90	89
1	WVPSB-26-D-3	LITTLE STAR RUN		SBRPO B230	8/19/1996	15	71	13	100	78	85	11	89	27	114	4	91	89
1	WVPSB-26-E	NORTH FK /LUNICE CREEK		SBRPO B232	8/19/1996	15	71	8	62	75	81	4	97	42	91	5	74	79
1	WVPSB-26-E-2	SALT BLOCK RUN		SBRPO B234	8/19/1996	16	76	6	46	66	72	2	99	53	74	4	82	75
1	WVPSB-28-.5A	POWERS HOLLOW		SBRPO B274	8/21/1996	11	52	6	46	27	29	31	70	63	57	7	42	49
1	WVPSB-28-{00.5}	NORTH FK /SOUTH BR POT NEAR PETERSBURG		SBRPO B273	8/21/1996	14	67	8	62	73	79	17	84	52	75	4	78	74
1	WVPSB-28-{18.8}	NORTH FK /SOUTH BR POT NEAR SENECA ROCKS		SBRPO B254	8/20/1996	13	62	7	54	86	94	10	91	69	48	5	75	71
1	WVPSB-28-A-1	BIG RUN/ JORDAN RUN		SBRPO B239	8/20/1996	18	86	11	85	75	82	13	88	37	99	4	82	87
1	WVPSB-28-A-2	LAUREL RUN/JORDAN RUN		SBRPO B250	8/20/1996	16	76	12	92	83	91	10	91	39	95	4	86	89
1	WVPSB-28-B	SAMUEL RUN		SBRPO B321	9/9/1996	15	71	10	77	56	60	6	95	52	75	5	64	74
1	WVPSB-28-CC	TETER GAP		SBRPO B237	8/19/1996	15	71	7	54	47	51	37	63	56	69	6	61	62
1	WVPSB-28-E	HIGH RIDGE RUN		SBRPO B319	9/9/1996	13	62	12	92	98	107	0	101	73	42	3	96	82
1	WVPSB-28-EE	BIG RUN/ NORTH FORK		SBRPO B264	8/21/1996	10	48	7	54	96	104	3	98	72	44	4	78	70
1	WVPSB-28-EE-1	COLD SPRING RUN		SBRPO B242	8/20/1996	14	67	9	69	72	78	13	88	32	106	4	82	81
1	WVPSB-28-EE-2	SAWMILL BRANCH/BIG RUN		SBRPO B255	8/20/1996	13	62	11	85	97	105	2	99	73	42	4	78	77
1	WVPSB-28-GG	LAUREL FORK/NORTH FK/SOUTH BR POTOMAC		SBRPO B249	8/20/1996	13	62	7	54	79	86	9	92	55	70	5	73	73
1	WVPSB-28-HH	STRAIGHT FORK/NORTH FK/SOUTH BR POT		SBRPO B260	8/20/1996	14	67	8	62	50	55	34	67	51	76	5	67	66
1	WVPSB-28-K	SENECA CREEK		SBRPO B256	8/20/1996	12	57	7	54	60	66	25	76	66	53	5	68	62
1	WVPSB-28-K-1	BRUSHY RUN/SENECA CREEK		SBRPO B240	8/20/1996	12	57	10	77	59	65	35	66	53	73	5	73	68
1	WVPSB-28-K-2	ROARING CREEK		SBRPO B275	8/21/1996	13	62	7	54	91	99	4	97	66	53	4	84	75
1	WVPSB-28-K-3	HORSECAMP RUN		SBRPO B247	8/20/1996	14	67	11	85	71	78	26	75	66	53	5	70	71
1	WVPSB-28-K-4	STRADER RUN		SBRPO B259	8/20/1996	16	76	10	77	86	94	5	96	53	73	4	85	83
1	WVPSB-28-K-5	GULF RUN		SBRPO B245	8/20/1996	17	81	11	85	87	95	4	97	42	91	3	96	91
1	WVPSB-28-K-6	WHITES RUN		SBRPO B263	8/20/1996	15	71	11	85	91	99	4	97	74	41	5	76	78
1	WVPSB-28-P	ROOT RUN		SBRPO B276	8/21/1996	9	43	5	38	56	61	10	90	65	55	5	63	58
1	WVPSB-28-Q	DICE RUN /NORTH FK/SOUTH BR POTOMAC		SBRPO B322	9/10/1996	17	81	13	100	93	101	3	98	51	77	4	89	91
1	WVPSB-28-R	BLIZZARD RUN		SBRPO B224	8/19/1996	13	62	10	77	96	104	1	100	69	48	4	81	78
1	WVPSB-28-S	BRIERY GAP RUN		SBRPO B226	8/19/1996	9	43	6	46	79	86	3	98	61	61	5	75	68
1	WVPSB-28-U	JUDY RUN		SBRPO B268	8/21/1996	11	52	4	31	31	33	9	92	74	41	8	34	47
1	WVPSB-28-V	NELSON RUN		SBRPO B272	8/21/1996	13	62	8	62	89	97	7	94	85	23	5	69	68
1	WVPSB-28-Z	BOUSES RUN		SBRPO B225	8/19/1996	10	48	6	46	94	102	2	99	88	19	5	72	64
1	WVPSB-30	LONG RUN /SOUTH BR POTOMAC		SBRPO B312	8/28/1996	19	90	12	92	63	68	9	92	32	106	4	86	88
1	WVPSB-30.5	UNNAMED TRIB/SOUTH BR POTOMAC		SBRPO B316	8/28/1996	13	62	7	54	58	64	25	76	60	63	6	61	63
1	WVPSB-32	BRIGGS RUN		SBRPO B308	8/28/1996	13	62	9	69	93	101	3	98	79	33	5	76	73

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
1	WVPSB-33	REEDS CREEK		SBRPO B314	8/28/1996	14	67	7	54	62	68	28	73	80	31	5	65	60
1	WVPSB-34	MILL RUN /SOUTH BR POTOMAC		SBRPO B313	8/28/1996	10	48	5	38	32	35	56	44	69	48	6	51	44
1	WVPSB-4	FOX RUN		SBRPO B293	8/27/1996	12	57	6	46	56	61	23	78	40	95	4	78	69
1	WVPSB-40	PETERS RUN		SBRPO B302	8/27/1996	19	90	11	85	75	82	7	94	49	79	4	82	85
1	WVPSB-41	TROUT RUN		SBRPO B305	8/27/1996	16	76	9	69	81	88	10	91	56	69	4	86	80
1	WVPSB-46	SMITH CREEK		SBRPO B303	8/27/1996	12	57	8	62	26	28	71	29	84	25	6	55	43
1	WVPSB-46-A	LITTLE CREEK		SBRPO B326	9/10/1996	19	90	13	100	86	94	7	94	63	59	4	79	86
1	WVPSB-46-B	TWIN RUN /SMITH CREEK		SBRPO B331	9/10/1996	16	76	11	85	89	97	6	95	63	57	4	79	81
1	WVPSB-47	THORN CREEK		SBRPO B304	8/27/1996	16	76	9	69	51	56	18	82	51	76	5	76	73
1	WVPSB-47-B	BLACKTHORN CREEK		SBRPO B289	8/27/1996	13	62	7	54	71	78	14	87	40	94	5	71	74
1	WVPSB-47-C	WHITETHORN CREEK		SBRPO B307	8/27/1996	19	90	11	85	64	70	19	81	37	98	5	73	83
1	WVPSB-5	BUFFALO CREEK		SBRPO B282	8/26/1996	9	43	4	31	16	18	58	43	80	31	6	57	37
1	WVPSB-50	HAMMER RUN/SOUTH BR POTOMAC		SBRPO B325	9/10/1996	15	71	11	85	90	98	3	98	57	67	4	84	84
1	WVPSB-53	EAST DRY RUN		SBRPO B324	9/10/1996	5	24	3	23	98	107	1	100	97	4	5	71	54
1	WVPSB-9-{10.7}	MILL CREEK/SOUTH BR POT @ HEADWATERS		SBRPO B299	8/27/1996	18	86	9	69	76	83	4	97	39	95	4	84	86
1	WVPSB-9-B	DUMPLING RUN/MILL CREEK		SBRPO B291	8/27/1996	10	48	2	15	71	77	13	88	82	28	5	64	53
1	WVPSB-9-B-2	MAYHEW RUN		SBRPO B334	9/11/1996	11	52	5	38	27	29	61	39	67	51	6	59	45
1	WVPSB-9-F	CAMP RUN /MILL CREEK		SBRPO B290	8/27/1996	14	67	8	62	76	83	8	93	44	87	4	84	79
1	WVPSB-9-F.5	UNNAMED TRIB/MILL CREEK		SBRPO B306	8/27/1996	16	76	8	62	80	87	8	93	47	83	4	84	81
1	WVPSB-9-G	ELKLICK RUN		SBRPO B292	8/27/1996	19	90	10	77	73	80	11	90	45	86	4	78	83
1	WVK-11	POND BRANCH	stressed	LOKAN B20	5/13/1997	14	67	8	62	38	42	52	49	68	50	5	65	56
1	WVK-12-{12.0}	THIRTEEN MILE CREEK	stressed	LOKAN B51	5/19/1997	14	67	8	62	71	77	16	85	55	70	3	92	75
1	WVK-12-A	ROCKY FORK	stressed	LOKAN B35	5/14/1997	17	81	9	69	61	67	27	74	53	73	5	74	73
1	WVK-12-F	POPLAR FORK	stressed	LOKAN B33	5/14/1997	14	67	9	69	36	39	56	45	78	34	5	69	54
1	WVK-12-H	BAKER BRANCH	stressed	LOKAN B46	5/19/1997	17	81	10	77	83	91	9	92	45	85	3	93	86
1	WVK-14	SIXTEENMILE CREEK	stressed	LOKAN B36	5/14/1997	14	67	8	62	55	59	35	66	54	72	5	77	67
1	WVK-16-{25.0}	EIGHTEEN MILE CREEK	stressed	LOKAN B60	5/21/1997	14	67	8	62	75	81	18	83	57	67	3	98	76
1	WVK-16-G-1-{0.4}	LEFT FORK TURKEY BRANCH	stressed	LOKAN B99	6/16/1997	15	71	9	69	55	60	37	64	57	67	5	73	67
1	WVK-19-C	LEFT FORK FIVE AND TWENTY MILE CREEK	stressed	LOKAN B56	5/20/1997	12	57	8	62	64	70	34	67	72	43	5	67	61
1	WVK-22-{10.6}	HURRICANE CREEK	stressed	LOKAN B103	6/24/1997	10	48	1	8	48	53	34	66	83	27	6	59	43
1	WVK-22-{14.4}	HURRICANE CREEK	stressed	LOKAN B104	6/24/1997	6	29	1	8	5	6	39	62	93	12	6	51	28
1	WVK-22-B-2	COW CREEK	stressed	LOKAN B73	5/28/1997	11	52	5	38	23	25	65	36	79	33	6	56	40
1	WVK-22-B-3	LONG BRANCH	stressed	LOKAN B75	5/28/1997	12	57	7	54	6	7	88	12	91	15	7	47	32
1	WVK-22-B-5-B	U.T. OF CROOKED CREEK	stressed	LOKAN B78	5/28/1997	8	38	3	23	4	4	45	56	72	44	7	36	33
1	WVK-22-J {1.3}	RIDER CREEK	stressed	LOKAN B101	6/19/1997	10	48	5	38	57	62	20	80	61	61	6	61	59
1	WVK-30	ARMOUR CREEK	stressed	LOKAN B38	5/15/1997	3	14	0	0	0	0	88	12	99	1	7	37	11
1	WVK-33	GALLATIN BRANCH	stressed	LOKAN B28	5/14/1997	4	19	2	15	2	2	89	11	98	3	7	40	15
1	WVK-41-A	WOODWARD BRANCH	stressed	LOKAN B45	5/16/1997	2	10	0	0	0	0	10	90	100	0	10	4	17
1	WVK-6	FIVE MILE CREEK	stressed	LOKAN B17	5/13/1997	9	43	6	46	89	97	9	92	76	37	3	99	69
1	WVKE-14-G-2-A	SCHOOLHOUSE FORK	stressed	ELK B119	6/26/1997	7	33	4	31	87	95	6	95	86	22	2	107	63
1	WVKE-23 {12.6}	BIG SANDY CREEK	stressed	ELK B163	7/14/1997	11	52	5	38	33	36	27	74	59	63	5	65	55
1	WVKE-23-D-6	COLEMAN RUN	stressed	ELK B194	7/21/1997	8	38	4	31	65	71	0	101	63	58	4	85	64
1	WVKE-23-P-3-B	SIMONS FORK	stressed	ELK B210	7/23/1997	13	62	5	38	53	58	14	87	44	88	5	74	68
1	WVKE-26-A-{0.16}	LEFT FORK OF MORRIS CREEK	stressed	ELK B167	7/14/1997	5	24	1	8	54	59	23	78	77	36	4	89	49
1	WVKE-78	UPPER MILL RUN	stressed	ELK B184	7/16/1997	13	62	5	38	39	42	30	71	51	77	5	64	59
1	WVKE-87-C	U.T./GRANNY CREEK	stressed	ELK B215	7/24/1997	6	29	1	8	20	22	10	91	50	78	7	44	45
1	WVKE-9-J	JAKES RUN	stressed	ELK B124	7/1/1997	11	52	4	31	71	77	11	90	71	45	5	68	61
1	WVKP-1	HEIZER CREEK	stressed	LOKAN B30	5/14/1997	11	52	6	46	49	53	16	85	41	92	4	88	69
1	WVKP-13 {1.3}	TUPPERS CREEK	stressed	LOKAN B53	5/19/1997	7	33	3	23	17	18	54	46	67	52	7	46	37
1	WVKP-13 {3.0}	TUPPER CREEK	stressed	LOKAN B106	6/24/1997	5	24	0	0	0	0	29	72	81	30	6	59	31
1	WVKP-13-A-1-A	TURKEYPEN BRANCH	stressed	LOKAN B58	5/20/1997	14	67	9	69	51	56	43	58	57	68	5	68	64
1	WVKP-1-A	MANILA CREEK	stressed	LOKAN B32	5/14/1997	9	43	4	31	74	80	0	101	68	51	1	121	67
1	WVKP-43 {1.6}	LAUREL FORK	stressed	LOKAN B95	6/12/1997	10	48	7	54	66	71	24	77	55	70	4	85	67
1	WVMC-11-D {00}	LEFT FORK BULL RUN @ MOUTH	stressed	CHEAT B81	6/18/1996	9	43	3	23	89	96	2	99	87	20	2	109	63
1	WVMC-12-C {04}	HAZEL RUN AT HEADWATERS	stressed	CHEAT B97	6/19/1996	12	57	8	62	93	101	0	101	62	60	2	110	80
1	WVMC-13-{01}	GIBSON RUN	stressed	CHEAT B60	6/17/1996	18	86	10	77	69	75	5	96	46	84	4	90	85
1	WVMC-14-{02}	HACKELBARNEY RUN NEAR HEADWATERS	stressed	CHEAT B63	6/17/1996	15	71	9	69	71	77	0	101	56	69	4	85	79
1	WVMC-17-{2.6}	MUDDY CREEK BELOW MARTIN CREEK	stressed	CHEAT B67	6/17/1996	6	29	2	15	18	20	18	83	55	71	5	70	48
1	WVMC-17-A-.5 {0}	FICKY RUN AT MOUTH	stressed	CHEAT B59	6/17/1996	7	33	0	0	0	0	40	61	72	44	6	55	32
1	WVMC-17-A-.5 {3}	FICKY RUN NEAR HEADWATERS	stressed	CHEAT B77	6/18/1996	4	19	4	31	100	109	0	101	78	35	3	99	64
1	WVMC-17-A-{0.0}	MARTIN CREEK @ MOUTH	stressed	CHEAT B65	6/17/1996	2	10	0	0	0	0	50	50	100	0	5	77	23
1	WVMC-17-A-1-{0.0}	GLADE RUN AT MOUTH	stressed	CHEAT B61	6/17/1996	5	24	0	0	0	0	84	16	91	15	7	44	17
1	WVMC-18-A	LICK RUN /ROARING CK ABOVE LITTLE LICK RUN	stressed	CHEAT B104	6/19/1996	12	57	5	38	67	73	11	90	74	41	3	92	65

Site metrics and metric scores

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1	WVMC-23-A-{2.9}	CHURCH RUN NEAR HEADWATERS	stressed	CHEAT B74	6/18/1996	6	29	1	8	61	67	27	73	89	18	4	91	48
1	WVMC-26-{1.5}	JOES RUN ABOVE 1ST UNNAMED TRIB	stressed	CHEAT B79	6/18/1996	7	33	1	8	39	43	3	98	90	16	2	110	50
1	WVMC-51-B-5	INDIAN RUN	stressed	CHEAT B197	7/30/1996	18	86	10	77	77	84	5	96	53	73	4	80	83
1	WVMC-60-D-1	BIG RUN/ BLACKWATER RIVER	stressed	CHEAT B129	7/17/1996	10	48	7	54	92	100	5	96	73	43	2	108	73
1	WVMC-60-D-4.5	SHAYS RUN	stressed	CHEAT B135	7/18/1996	10	48	7	54	76	83	7	94	57	67	4	85	72
1	WVMC-60-D-4.7	ENGINE RUN NEAR ELK	stressed	CHEAT B131	7/17/1996	11	52	6	46	93	101	4	97	72	44	3	94	72
1	WVMCS-.5	SMOKY HOLLOW	stressed	CHEAT B12	6/10/1996	8	38	3	23	62	67	19	82	58	66	5	73	58
1	WVMCS-6-C	SLABCAMP RUN	stressed	CHEAT B215	8/7/1996	19	90	12	92	78	85	1	100	36	99	3	100	94
1	WVMT-11-A	SHELBY RUN	stressed	TYVAR B306	8/26/1997	12	57	4	31	50	54	3	98	74	41	5	71	59
1	WVMT-18-{9.6}	SANDY CREEK	stressed	TYVAR B338	9/3/1997	13	62	4	31	6	7	63	38	87	21	7	49	35
1	WVMT-24-C-2	BILLS CREEK	stressed	TYVAR B369	9/10/1997	11	52	5	38	34	37	23	77	47	83	5	71	60
1	WVMT-37-{0.0}	BEAVER CREEK	stressed	TYVAR B382	9/15/1997	6	29	0	0	0	0	61	40	82	28	5	66	27
1	WVMT-42-B-3-{1.0}	U.T. OF FLATBUSH FORK	stressed	TYVAR B292	8/25/1997	6	29	3	23	18	19	59	41	77	36	6	62	35
1	WVMT-43-A	CRAVEN RUN	stressed	TYVAR B285	8/25/1997	10	48	3	23	15	16	36	65	57	67	7	46	44
1	WVMT-66-B	MCGEE RUN	stressed	TYVAR B335	9/3/1997	7	33	4	31	18	20	78	22	88	19	6	49	29
1	WVMTB-11-B.5	WASH RUN	stressed	TYVAR B328	9/2/1997	10	48	2	15	4	4	66	34	85	24	7	37	27
1	WVMY-1-A	WHITE OAK SPRING RUN	stressed	YOUGH B119	7/8/1996	12	57	7	54	57	62	3	98	44	87	3	94	75
1	WVMY-2-B	SOUTH BRANCH	stressed	YOUGH B123	7/9/1996	14	67	9	69	74	81	9	91	45	86	4	89	81
1	WVMY-5	MAPLE RUN	stressed	YOUGH B120	7/9/1996	15	71	7	54	29	31	40	61	56	69	6	63	58
1	WVPNB-10	SLAUGHTERHOUSE RUN	stressed	NBRPO B249	8/11/1997	11	52	6	46	45	49	21	79	46	85	5	65	63
1	WVPNB-16 {18.1}	ABRAM CREEK	stressed	NBRPO B276	8/18/1997	5	24	1	8	20	22	20	81	40	94	7	48	46
1	WVPNB-17-D	LAUREL RUN	stressed	NBRPO B283	8/19/1997	11	52	3	23	24	27	41	60	61	61	6	58	47
1	WVPNB-4 {45.2}	PATTERSON CREEK	stressed	NBRPO B247	8/11/1997	16	76	10	77	74	81	10	91	48	82	4	81	81
1	WVPNB-7-C.4-1 {0.2}	U.T OF U .T. OF NEW CREEK	stressed	NBRPO B271	8/13/1997	12	57	2	15	3	3	2	99	95	8	4	84	45
1	WVPNB-7-H-2-{1.0}	U.T. OF LINTON CREEK	stressed	NBRPO B258	8/12/1997	16	76	11	85	83	90	2	99	55	70	4	90	85
1	WVPSB-18-A {6.7}	MUDLICK RUN AT HEADWATERS	stressed	SBRPO B283	8/26/1996	8	38	4	31	8	8	71	30	85	23	7	49	30

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2	WVBST-27-C	MILL FORK	reference	TUG98 B60	7/7/1998	20	95	10	77	39	42	16	85	46	84	5	75	76
2	WVBST-60-E	GEORGE BRANCH	reference	TUG98 B88	7/7/1998	19	90	11	85	90	98	1	100	69	48	4	87	85
2	WVBST-60-F	CRANE CREEK	reference	TUG98 B89	7/7/1998	19	90	11	85	88	95	2	99	54	73	4	83	87
2	WVBST-60-G-{0.9}	HURRICANE BRANCH	reference	TUG98 B90	6/17/1998	19	90	13	100	90	98	4	97	66	53	3	99	90
2	WVBST-60-I-2	WHITE OAK BRANCH	reference	TUG98 B91	7/8/1998	21	100	14	108	87	94	3	98	64	56	3	103	91
2	WVBST-70-Z-{2.3}	VALL CREEK	reference	TUG98 B110	7/1/1998	18	86	13	100	81	88	8	93	63	58	3	97	87
2	WVBST-76-E	DAYCAMP BRANCH	reference	TUG98 B116	6/24/1998	15	71	9	69	90	98	5	96	63	58	3	96	81
2	WVK-14-B-1-98	U.T. OF FIVEFORK BRANCH	reference	LOK98 B1	5/26/1998	17	81	9	69	71	77	15	86	35	102	4	90	84
2	WVK-39-E-3-{0.6}98	BAYS FORK	reference	LOK98 B2	6/4/1998	24	114	14	108	53	58	21	80	38	98	4	83	86
2	WVK-39-M-1-A {1.0}98	HOFFMAN HOLLOW	reference	LOK98 B3	6/4/1998	25	119	11	85	71	77	8	93	42	91	4	91	89
2	WVKG-19-V-5	LAUREL CREEK/LITTLE CLEAR CREEK	reference	GAU98 B43R	7/29/1998	17	81	13	100	92	100	1	100	34	104	3	96	96
2	WVKG-34-H-14	BEAR RUN	reference	GAU98 B97	8/3/1998	15	71	12	92	86	94	7	94	60	63	3	102	86
2	WVKG-34-H-4	HUNTERS RUN	reference	GAU98 B98	8/4/1998	13	62	8	62	91	99	5	96	51	77	3	92	81
2	WVKG-34-H-9	ARMSTRONG RUN	reference	GAU98 B100	8/3/1998	15	71	11	85	90	98	8	93	51	77	3	102	87
2	WVKG-5-F-3	BEARPEN FORK	reference	GAU98 B119	7/22/1998	23	110	15	115	82	90	9	92	60	63	3	98	90
2	WVKG-5-H	ASH FORK	reference	GAU98 B120	7/21/1998	19	90	13	100	80	87	14	87	30	110	3	96	93
2	WVKG-5-J	NEIL BRANCH	reference	GAU98 B121	7/21/1998	22	105	13	100	63	69	26	75	39	95	4	81	87
2	WVKGC-23-{2.3}	SOUTH FORK CRANBERRY RIVER	reference	GAU98 B152	8/5/1998	23	110	14	108	78	85	10	91	31	107	4	87	94
2	WVKGW-22-{0.4}	LITTLE LAUREL CREEK	reference	GAU98 B180	8/6/1998	21	100	13	100	83	91	7	94	47	83	3	92	93
2	WVKGW-27	MOUNTAIN LICK RUN	reference	GAU98 B181	8/11/1998	20	95	15	115	92	100	4	97	47	83	4	91	94
2	WVO-2-P-23	ARKANSAS BRANCH	reference	TUG98 B138	7/7/1998	19	90	8	62	63	68	16	85	46	84	4	85	79
2	WVO-2-P-26	LONG BRANCH	reference	TUG98 B1	7/7/1998	17	81	9	69	80	87	9	91	60	62	3	95	81
2	WVO-2-Q-17	ALUM FORK	reference	TPO98 B7	5/28/1998	16	76	10	77	83	90	8	93	63	58	4	90	81
2	WVO-2-Q-18-A	LITTLE LAUREL CREEK	reference	TPO98 B8	5/28/1998	23	110	14	108	57	62	8	93	46	84	3	92	88
2	WVOG-29-C	HORSESHOE BRANCH	reference	LGU98 B24	5/13/1998	24	114	13	100	84	91	5	96	50	78	4	88	92
2	WVOG-32-F	PLUM BRANCH	reference	LGU98 B28	5/27/1998	18	86	12	92	74	81	7	93	52	74	4	91	86
2	WVOG-34-E-1-{0.8}	NELSON FORK	reference	LGU98 B33	5/11/1998	15	71	9	69	48	52	6	95	34	104	4	83	79
2	WVOG-37	LITTLE UGLY CREEK	reference	LGU98 B36	5/11/1998	19	90	13	100	89	97	4	97	62	59	4	89	89
2	WVOG-38-{11.6}	BIG UGLY CREEK	reference	LGU98 B45	5/19/1998	19	90	10	77	79	86	6	95	69	48	5	74	78
2	WVOG-38-A	PIGEONROOST CREEK	reference	LGU98 B37	5/19/1998	13	62	8	62	80	87	4	97	62	59	4	81	75
2	WVOG-38-D {3.9}	LAUREL CREEK	reference	LGU98 B38	5/18/1998	24	114	15	115	80	87	1	100	39	96	3	93	96
2	WVOGM-8-B	LEFT FORK/MILL CREEK	reference	LGU98 B135	5/3/1998	12	57	8	62	69	76	4	97	50	78	4	86	76
2	WVP-16-{0.1}	ROCKWELL RUN	reference	POT98 B68	6/3/1998	24	114	15	115	69	75	13	88	35	102	4	89	92
2	WVP-6-A.5-{0.2}	U.T. OF BACK CREEK	reference	POT98 B42	6/3/1998	17	81	8	62	63	69	28	72	69	49	4	85	69
2	WVP-6-G-1-{0.0}	LITTLE BRUSH CREEK	reference	POT98 B64	6/2/1998	18	86	10	77	61	66	17	84	44	88	4	86	81
2	WVP-9-B-{0.0}	MEADOW BRANCH	reference	POT98 B21	6/1/1998	16	76	11	85	57	61	38	63	53	73	5	75	72
2	WVP-9-B-{12.8}	MEADOW BRANCH	reference	POT98 B65	6/3/1998	18	86	7	54	40	43	30	70	62	59	4	80	65
2	WVP-9-G-2-{0.0}	SOUTH FORK/INDIAN CREEK	reference	POT98 B66	6/3/1998	18	86	14	108	66	72	16	84	35	102	4	88	88
2	WVPC-0.9A-{0.2}	CONNOR HOLLOW	reference	CAP98 B70	6/3/1998	25	119	15	115	64	70	20	81	31	107	4	86	90
2	WVPC-1-{0.2}	CONSTANT RUN	reference	CAP98 B69	6/4/1998	17	81	12	92	81	88	16	85	48	81	3	93	87
2	WVBS-{47.4}	TUG FORK RIVER		TUG98 B6	7/8/1998	15	71	7	54	64	69	13	88	49	79	5	72	72
2	WVBS-{51.6}	TUG FORK RIVER		TUG98 B7	7/8/1998	17	81	6	46	73	79	4	97	54	72	5	77	76
2	WVBS-{76.4}	TUG FORK RIVER		TUG98 B9	7/7/1998	9	43	3	23	29	32	29	72	52	76	5	64	51
2	WVBST-100	LITTLE INDIAN CREEK		TUG98 B11	6/17/1998	15	71	4	31	38	41	46	54	76	38	6	55	48
2	WVBST-103	ROCK NARROWS BRANCH		TUG98 B13	6/23/1998	10	48	5	38	41	45	53	48	77	36	6	60	46
2	WVBST-104	HARRIS BRANCH		TUG98 B14	6/18/1998	15	71	7	54	70	76	2	99	63	58	5	75	72
2	WVBST-105	MITCHELL BRANCH		TUG98 B15	7/1/1998	13	62	8	62	62	67	30	71	80	31	5	66	60
2	WVBST-109-{0.0}	SANDLICK CREEK		TUG98 B20	6/17/1998	4	19	2	15	50	54	0	101	67	52	5	77	53
2	WVBST-109-{1.7}	SANDLICK CREEK		TUG98 B21	7/1/1998	5	24	2	15	71	77	10	91	73	42	5	68	53
2	WVBST-109-A	RIGHT FORK / SANDLICK CREEK		TUG98 B18	7/1/1998	11	52	4	31	27	29	57	44	77	36	6	56	41
2	WVBST-109-B	LEFT FORK / SANDLICK CREEK		TUG98 B19	7/1/1998	4	19	2	15	69	75	8	93	69	48	5	68	53
2	WVBST-110	ADKIN BRANCH		TUG98 B22	6/17/1998	11	52	3	23	30	33	13	88	56	69	5	75	57
2	WVBST-111	BELCHER BRANCH		TUG98 B23	6/16/1998	10	48	4	31	68	74	10	91	65	54	6	63	60
2	WVBST-112	TURNHOLE BRANCH		TUG98 B24	6/30/1998	13	62	4	31	63	68	11	90	55	71	5	71	66
2	WVBST-113	HARMON BRANCH		TUG98 B25R	6/30/1998	7	33	2	15	38	41	12	89	58	66	5	71	52
2	WVBST-115	SOUTH FORK		TUG98 B27	7/6/1998	15	71	6	46	44	48	18	83	48	81	5	72	67
2	WVBST-115-A	TEA BRANCH		TUG98 B28	7/1/1998	17	81	9	69	74	80	12	89	50	79	4	79	80
2	WVBST-115-B	MCCLURE BRANCH		TUG98 B29	6/25/1998	19	90	10	77	85	92	2	99	53	74	3	96	88
2	WVBST-115-D	JUMP BRANCH		TUG98 B30	6/25/1998	21	100	11	85	52	57	31	70	51	76	5	74	77
2	WVBST-115-E	SPICE CREEK		TUG98 B31	6/24/1998	15	71	8	62	75	82	11	89	47	82	4	86	79
2	WVBST-115-F	LAUREL BRANCH		TUG98 B32	7/6/1998	15	71	8	62	81	88	4	97	47	82	4	84	81
2	WVBST-115-G	ROAD FORK		TUG98 B33	6/25/1998	15	71	6	46	71	77	6	95	65	55	3	94	73
2	WVBST-117	LOOP BRANCH		TUG98 B35	6/24/1998	12	57	5	38	30	33	13	88	64	57	5	71	57

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2	WVBST-118	MILL BRANCH		TUG98 B36	6/24/1998	18	86	9	69	61	66	4	97	54	72	4	82	79
2	WVBST-119	DRY BRANCH		TUG98 B37	6/24/1998	23	110	12	92	84	91	5	96	52	76	3	93	91
2	WVBST-120-{0.0}	LITTLE CREEK		TUG98 B40	6/23/1998	12	57	3	23	20	21	62	39	75	39	6	54	39
2	WVBST-120-{2.0}	LITTLE CREEK		TUG98 B41	6/23/1998	23	110	12	92	63	68	6	95	53	73	4	89	86
2	WVBST-120-A	INDIAN GRAVE BRANCH		TUG98 B38	6/23/1998	17	81	9	69	27	29	33	67	61	61	5	67	62
2	WVBST-121	MILLSEAT BRANCH		TUG98 B42	6/24/1998	20	95	10	77	76	82	7	94	34	103	4	86	89
2	WVBST-14-B	RIGHT FORK/BULL CREEK		TUG98 B44	6/24/1998	15	71	6	46	80	87	3	98	65	54	4	79	73
2	WVBST-17-{2.7}	JENNIE CREEK		TUG98 B46	6/30/1998	13	62	5	38	30	33	43	57	59	64	6	63	53
2	WVBST-24	PIGEON CREEK		TUG98 B49	7/6/1998	12	57	5	38	25	27	27	74	56	69	6	49	53
2	WVBST-24-{29.3}	PIGEON CREEK		TUG98 B57	6/23/1998	7	33	2	15	38	41	55	45	91	14	6	55	34
2	WVBST-24-{31.8}	PIGEON CREEK		TUG98 B58	6/3/1998	16	76	11	85	86	94	3	97	42	91	4	90	89
2	WVBST-24-N	ELK CREEK		TUG98 B139	6/16/1998	9	43	4	31	19	21	3	97	86	23	5	71	48
2	WVBST-24-O	MILLSTONE BRANCH		TUG98 B54	6/16/1998	15	71	6	46	48	52	13	87	38	96	5	76	71
2	WVBST-24-P	PIGEONROOST CREEK		TUG98 B55	6/16/1998	18	86	10	77	62	67	7	94	38	97	5	75	83
2	WVBST-24-Q-7	SPRING BRANCH		TUG98 B56	6/16/1998	11	52	4	31	63	69	17	83	63	57	6	63	59
2	WVBST-27-{2.5}	MILLER CREEK		TUG98 B61	6/17/1998	12	57	7	54	46	51	9	92	54	73	5	74	67
2	WVBST-31-B	SOUTH FORK / BUFFALO CREEK		TUG98 B63	6/15/1998	18	86	8	62	44	48	19	81	47	83	5	69	71
2	WVBST-32	SUGARTREE CREEK		TUG98 B65	6/15/1998	7	33	3	23	55	59	9	92	55	71	4	81	60
2	WVBST-34	SYCAMORE CREEK		TUG98 B67	6/22/1998	16	76	6	46	47	51	2	99	64	56	5	71	67
2	WVBST-35	LICK CREEK		TUG98 B68	6/15/1998	9	43	3	23	63	69	17	84	77	36	6	61	53
2	WVBST-40	MATE CREEK		TUG98 B71	6/15/1998	9	43	3	23	7	7	50	51	74	40	7	45	35
2	WVBST-40-C	MITCHELL BRANCH		TUG98 B73	6/16/1998	8	38	1	8	10	11	8	93	81	30	9	17	33
2	WVBST-40-H	DOUBLE CAMP FORK		TUG98 B75	6/15/1998	16	76	6	46	65	70	26	75	65	55	5	64	64
2	WVBST-41	SULPHUR CREEK		TUG98 B76	6/16/1998	4	19	0	0	0	0	40	61	60	63	6	59	34
2	WVBST-42	THACKER CREEK		TUG98 B77	6/16/1998	7	33	1	8	13	15	40	61	63	57	6	59	39
2	WVBST-42-A	SCISSORSVILLE BRANCH		TUG98 B78	6/16/1998	6	29	2	15	63	68	13	88	66	54	3	96	58
2	WVBST-42-B	MAUCHINVILLE BRANCH		TUG98 B79	6/16/1998	4	19	1	8	54	59	4	97	92	13	4	85	47
2	WVBST-43	GRAPEVINE CREEK		TUG98 B80	6/16/1998	7	33	2	15	75	82	2	99	92	13	5	70	52
2	WVBST-60	PANTHER CREEK		TUG98 B84R	7/7/1998	10	48	4	31	51	55	40	61	77	36	6	62	49
2	WVBST-60-A-{2.0}	GREENBRIER FORK		TUG98 B86	7/7/1998	14	67	3	23	2	2	79	21	86	23	7	44	30
2	WVBST-60-D	CUB BRANCH		TUG98 B87	6/17/1998	21	100	12	92	77	84	13	88	46	85	5	77	88
2	WVBST-63-{1.2}	HORSE CREEK		TUG98 B92	7/7/1998	19	90	8	62	59	64	17	83	41	92	5	71	77
2	WVBST-70-{1.3}	DRY FORK		TUG98 B111	7/7/1998	13	62	6	46	59	64	5	96	69	49	5	72	65
2	WVBST-70-{18.4}	DRY FORK		TUG98 B112	7/6/1998	16	76	7	54	30	32	50	50	63	57	6	59	55
2	WVBST-70-{7.4}	DRY FORK		TUG98 B113	7/7/1998	14	67	8	62	44	47	31	69	51	77	5	64	64
2	WVBST-70-C	MILE BRANCH		TUG98 B93	7/2/1998	16	76	10	77	73	80	17	84	44	88	5	71	79
2	WVBST-70-F	GRAPEVINE BRANCH		TUG98 B94	7/2/1998	14	67	6	46	53	58	41	60	88	19	6	61	52
2	WVBST-70-I	BEARTOWN BRANCH		TUG98 B95	7/2/1998	12	57	7	54	88	96	3	98	76	38	5	76	70
2	WVBST-70-M-{1.8}	BRADSHAW CREEK		TUG98 B98	7/9/1998	17	81	6	46	35	38	50	50	68	49	6	62	54
2	WVBST-70-M-1	GROUNDHOG BRANCH		TUG98 B96	7/9/1998	11	52	3	23	8	9	61	40	84	25	7	38	31
2	WVBST-70-M-3	WOLFPEN BRANCH		TUG98 B97	7/8/1998	18	86	7	54	41	45	41	60	65	55	6	58	59
2	WVBST-70-N {2.7}	LITTLE SLATE CREEK		TUG98 B101	7/8/1998	19	90	11	85	84	91	2	99	49	79	4	83	88
2	WVBST-70-N {4.5}	LITTLE SLATE CREEK		TUG98 B99	7/6/1998	19	90	13	100	74	80	14	87	44	87	4	88	89
2	WVBST-70-Q	BARTLEY CREEK		TUG98 B103	7/9/1998	17	81	7	54	48	52	33	68	60	63	5	74	65
2	WVBST-70-T-2	CLEAR FORK		TUG98 B104	7/1/1998	8	38	2	15	4	5	66	35	87	20	6	54	28
2	WVBST-70-U-1	BIG BRANCH / WAR CREEK		TUG98 B105	7/6/1998	19	90	12	92	84	91	5	96	70	48	3	103	86
2	WVBST-70-W-{0.8}	JACOB FORK		TUG98 B107	6/30/1998	14	67	5	38	66	72	22	79	49	80	5	71	68
2	WVBST-70-W-{7.8}	JACOB FORK		TUG98 B108	7/1/1998	15	71	6	46	39	43	32	69	65	54	5	68	59
2	WVBST-70-W-1-A-{0.8}	MOUNTAIN FORK		TUG98 B106	7/2/1998	10	48	5	38	63	68	25	76	72	44	6	62	56
2	WVBST-70-Z-{0.0}	VALL CREEK		TUG98 B109	7/1/1998	17	81	9	69	67	73	21	79	47	83	4	78	77
2	WVBST-71	LICK BRANCH		TUG98 B114	6/25/1998	10	48	3	23	5	6	63	38	84	25	7	40	30
2	WVBST-72	HARMAN BRANCH		TUG98 B115	6/25/1998	16	76	9	69	89	97	4	97	58	65	4	79	81
2	WVBST-76-{0.0}	CLEAR FORK		TUG98 B117R	7/7/1998	13	62	7	54	81	88	2	99	54	72	4	80	76
2	WVBST-76-{10.2}	CLEAR FORK		TUG98 B119	6/30/1998	14	67	5	38	10	10	62	38	82	28	6	63	41
2	WVBST-76-{5.6}	CLEAR FORK		TUG98 B120	6/24/1998	13	62	4	31	46	50	17	83	48	82	5	71	63
2	WVBST-78-D	HONEYCAMP BRANCH		TUG98 B122	7/9/1998	18	86	5	38	70	76	12	89	61	61	3	92	74
2	WVBST-78-E	COONTREE BRANCH		TUG98 B123	7/9/1998	14	67	5	38	25	27	42	59	63	58	6	55	51
2	WVBST-78-F	STONECOAL BRANCH		TUG98 B124	6/30/1998	19	90	8	62	76	82	13	88	64	57	5	72	75
2	WVBST-78-H	NEWSON BRANCH		TUG98 B126	6/24/1998	11	52	2	15	1	1	89	11	93	11	7	43	22
2	WVBST-78-I	MOORECAMP BRANCH		TUG98 B127	6/24/1998	14	67	5	38	60	65	9	92	56	69	5	67	66
2	WVBST-85-A	LEFT FORK / DAVY BRANCH		TUG98 B128	6/23/1998	10	48	5	38	48	52	23	78	44	87	5	70	62
2	WVBST-85-A-{0.8}	LEFT FORK / DAVY BRANCH		TUG98 B129	6/23/1998	21	100	11	85	75	82	0	101	61	61	4	89	86
2	WVBST-94	SHANNON BRANCH		TUG98 B130	6/12/1998	15	71	9	69	80	87	5	96	59	64	4	88	79

Site metrics and metric scores

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
2	WVBST-95	UPPER SHANNON BRANCH		TUG98 B131	6/17/1998	8	38	2	15	16	18	74	27	89	17	7	49	27
2	WVBST-98-A	PUNCHEON CAMP BRANCH		TUG98 B132	6/17/1998	11	52	4	31	94	102	3	98	93	11	5	70	60
2	WVBST-99-{0.0}	ELKHORN CREEK		TUG98 B136	6/22/1998	11	52	2	15	34	37	36	64	62	60	6	59	48
2	WVBST-99-{16.4}	ELKHORN CREEK		TUG98 B137	6/22/1998	8	38	4	31	46	50	5	96	51	76	6	57	58
2	WVBST-99-L-{0.0}	NORTH FORK / ELKHORN CREEK		TUG98 B134	6/22/1998	6	29	3	23	68	74	25	75	83	26	5	65	49
2	WVBST-99-L-{6.2}	NORTH FORK / ELKHORN CREEK		TUG98 B135	6/16/1998	10	48	2	15	24	26	64	36	80	31	7	49	34
2	WVBST-99-L-1	BUZZARD BRANCH		TUG98 B133	6/22/1998	10	48	6	46	75	82	4	97	82	29	5	72	62
2	WVK-34-{23.8}	BIG COAL RIVER		COAL97 B15	10/8/1997	18	86	10	77	82	89	2	99	68	50	4	79	80
2	WVK-34-{58.4}	COAL RIVER		COAL97 B16R	10/7/1997	16	76	9	69	78	85	5	96	51	77	4	82	81
2	WVK-82-{18.6}	GAULEY RIVER		GAU98 B2	7/15/1998	10	48	4	31	20	21	61	40	72	43	6	56	40
2	WVK-82-{55.2}	GAULEY RIVER		GAU98 B4	7/29/1998	15	71	10	77	69	75	15	86	47	83	5	73	78
2	WVK-82-{61.6}	GAULEY RIVER		GAU98 B5	7/30/1998	14	67	9	69	75	81	11	90	55	70	5	75	75
2	WVK-82-{80.2}	GAULEY RIVER		GAU98 B6	8/5/1998	16	76	10	77	87	94	5	96	44	87	4	82	86
2	WVKC-10-I-6-C	RATTLESNAKE HOLLOW		COAL97 B65	9/22/1997	13	62	5	38	28	31	20	81	42	90	5	70	62
2	WVKC-10-L	CAMP CREEK		COAL97 B11	9/23/1997	16	76	8	62	71	77	8	93	56	69	4	83	77
2	WVKC-10-N {3.0}	ROCK CREEK		COAL97 B68	9/25/1997	16	76	6	46	25	28	32	68	65	55	5	64	56
2	WVKC-10-P-.5	LONG BRANCH		COAL97 B46	9/24/1997	16	76	5	38	27	29	17	84	46	85	5	76	65
2	WVKC-10-T-{17.4}	SPRUCE FORK		COAL97 B75	9/25/1997	12	57	5	38	52	57	10	91	45	86	5	74	67
2	WVKC-10-T-{18.5}	SPRUCE FORK		COAL97 B76	9/25/1997	10	48	5	38	27	29	10	90	74	40	5	71	53
2	WVKC-10-T-11-{15.3}	SPRUCE LAUREL FORK		COAL97 B79	9/15/1997	12	57	7	54	88	96	4	97	79	33	5	72	68
2	WVKC-10-T-11-H.5-{0.3}	TICKLE BRITCHES FORK		COAL97 B86	9/15/1997	6	29	5	38	36	39	0	101	76	38	4	86	55
2	WVKC-10-T-2	LAUREL BRANCH		COAL97 B38	9/24/1997	17	81	7	54	60	66	13	88	64	57	4	81	71
2	WVKC-10-T-9	HEWITT CREEK		COAL97 B30R	9/24/1997	11	52	4	31	72	79	11	90	62	60	4	79	65
2	WVKC-10-T-9-B	MISSOURI FORK/HEWITT		COAL97 B58	9/23/1997	13	62	3	23	8	9	8	93	56	69	5	74	55
2	WVKC-10-T-9-B.5	ISOM BRANCH		COAL97 B34	9/24/1997	15	71	4	31	48	52	13	88	48	82	5	76	67
2	WVKC-10-T-9-C-2	SYCAMORE BRANCH		COAL97 B85	9/24/1997	16	76	4	31	26	28	3	98	52	74	5	76	64
2	WVKC-10-U-13	GRAPEVINE BRANCH		COAL97 B28	9/23/1997	16	76	8	62	62	67	24	77	62	59	5	68	68
2	WVKC-10-U-17	JASPER WORKMAN BRANCH		COAL97 B35	9/22/1997	18	86	9	69	65	70	18	83	64	56	5	67	72
2	WVKC-10-U-21	LACEY BRANCH		COAL97 B37	9/22/1997	14	67	7	54	43	47	34	66	62	59	5	64	59
2	WVKC-10-U-3-B	BENNETT FORK		COAL97 B4	9/23/1997	14	67	7	54	60	65	15	86	44	88	5	74	72
2	WVKC-10-U-7-A	ROACH BRANCH		COAL97 B67	9/22/1997	14	67	7	54	46	50	16	85	66	54	4	82	65
2	WVKC-11-{5.6}	ALUM CREEK		COAL97 B2	9/18/1997	16	76	6	46	31	34	31	69	50	78	6	63	61
2	WVKC-14	FORK CREEK		COAL97 B27	10/6/1997	19	90	9	69	73	80	12	89	56	69	5	77	79
2	WVKC-16-A	LEFT FORK/BULL CREEK		COAL97 B40	9/26/1997	11	52	4	31	84	92	4	97	64	57	4	81	68
2	WVKC-21	BRUSH CREEK		COAL97 B9	9/26/1997	14	67	4	31	9	10	54	46	73	42	6	54	41
2	WVKC-21-C	RIDGEVIEW HOLLOW		COAL97 B66	10/8/1997	14	67	3	23	3	3	58	43	67	52	7	45	39
2	WVKC-29	JOES CREEK		COAL97 B36	9/17/1997	12	57	5	38	38	41	30	71	57	68	6	57	55
2	WVKC-29-A	LEFT FORK JOES CREEK		COAL97 B42	10/7/1997	16	76	7	54	56	61	12	89	59	64	5	71	69
2	WVKC-29-A-3	SPICELICK FORK		COAL97 B73	9/17/1997	22	105	8	62	50	54	10	91	42	91	4	78	79
2	WVKC-31-{0.4}	LAUREL CREEK		COAL97 B39	10/7/1997	12	57	7	54	61	67	7	94	71	46	5	72	65
2	WVKC-31-B-{0.2}	HOPKINS FORK		COAL97 B32	10/7/1997	14	67	6	46	72	78	4	97	41	93	5	77	76
2	WVKC-31-B-{10.9}	HOPKINS FORK		COAL97 B33	10/6/1997	19	90	12	92	73	79	6	95	54	71	4	85	85
2	WVKC-31-C	COLD FORK		COAL97 B18	10/7/1997	14	67	9	69	85	93	9	92	79	33	5	75	71
2	WVKC-35-{3.0}	WHITE OAK CREEK		COAL97 B92	10/8/1997	8	38	4	31	43	47	29	72	68	50	5	64	50
2	WVKC-35-F	LEFT FORK OF WHITE OAK CREEK		COAL97 B41	10/8/1997	16	76	8	62	67	73	19	82	63	58	5	70	70
2	WVKC-43-{0.0}	ELK RUN		COAL97 B24	10/7/1997	20	95	7	54	38	41	35	66	55	70	6	62	65
2	WVKC-43-{2.8}	ELK RUN		COAL97 B25	10/7/1997	19	90	9	69	41	44	34	67	65	54	6	63	65
2	WVKC-46-{0.0}	MARSH FORK		COAL97 B50	10/6/1997	13	62	5	38	80	87	4	97	62	59	4	88	72
2	WVKC-46-{15.3}	MARSH FORK		COAL97 B51	10/6/1997	14	67	6	46	70	76	6	95	55	71	5	77	72
2	WVKC-46-{20.2}	MARSH FORK		COAL97 B52	9/29/1997	15	71	7	54	72	78	4	97	52	74	4	80	76
2	WVKC-46-{5.8}	MARSH FORK		COAL97 B54	10/6/1997	15	71	6	46	80	87	5	96	47	83	4	82	78
2	WVKC-46-C	HAZY CREEK		COAL97 B29	10/6/1997	14	67	7	54	85	92	9	92	73	42	5	72	70
2	WVKC-46-E	STINK RUN		COAL97 B81	10/6/1997	17	81	6	46	52	57	10	91	50	79	5	69	70
2	WVKC-46-G	PEACHTREE CREEK		COAL97 B60	9/25/1997	17	81	8	62	79	86	5	96	66	53	4	78	76
2	WVKC-46-G-1	DREWS CREEK		COAL97 B22	9/25/1997	16	76	9	69	90	98	7	94	81	29	5	74	73
2	WVKC-46-G-1-.5A	CANTERBURY BRANCH		COAL97 B12	9/25/1997	2	10	1	8	50	54	0	101	100	0	3	99	45
2	WVKC-46-G-2	MARTIN FORK		COAL97 B55	9/25/1997	19	90	8	62	84	92	4	97	69	49	4	82	79
2	WVKC-46-H	DRY CREEK		COAL97 B23	10/6/1997	13	62	7	54	66	72	7	94	62	60	5	76	70
2	WVKC-46-I	ROCK CREEK		COAL97 B69	10/7/1997	18	86	9	69	60	66	9	92	43	88	4	80	80
2	WVKC-46-J-2	BEE BRANCH		COAL97 B3	9/29/1997	8	38	3	23	24	26	21	80	64	57	5	77	50
2	WVKC-46-K	COVE CREEK		COAL97 B19	9/29/1997	20	95	10	77	59	65	21	80	37	99	4	82	83
2	WVKC-46-L.5	SHILOH FORK		COAL97 B71	9/29/1997	10	48	4	31	81	88	7	93	74	40	3	95	66
2	WVKC-46-P	SURVEYOR CREEK		COAL97 B84	10/7/1997	14	67	7	54	29	31	48	52	66	53	6	58	53

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
2	WVKC-46-Q	MILLERS CAMP BRANCH		COAL97 B57	10/7/1997	11	52	4	31	5	5	34	66	90	16	5	77	41
2	WVKC-47	CLEAR FORK		COAL97 B13R	9/23/1997	8	38	5	38	87	95	6	95	60	62	4	80	68
2	WVKC-47-A-{1.3}	ROCKHOUSE CREEK		COAL97 B70	9/23/1997	20	95	11	85	66	72	2	99	51	76	4	79	84
2	WVKC-47-C	PANTHER BRANCH		COAL97 B59	9/24/1997	18	86	8	62	48	53	27	74	49	79	5	69	70
2	WVKC-47-F	STONECOAL BRANCH		COAL97 B83	9/24/1997	6	29	2	15	49	53	20	81	67	52	5	75	51
2	WVKC-47-G	LONG FORK		COAL97 B47	9/24/1997	12	57	8	62	78	85	7	94	72	43	5	76	70
2	WVKC-47-G-1	DOW FORK		COAL97 B21	9/24/1997	13	62	5	38	66	72	13	88	73	43	5	74	63
2	WVKC-47-H	MARE BRANCH		COAL97 B49	9/24/1997	15	71	10	77	73	79	12	89	62	59	5	77	75
2	WVKC-47-N {1.4}	MCDOWELL BRANCH		COAL97 B56	9/22/1997	11	52	7	54	89	97	4	97	58	65	4	91	76
2	WVKC-47-O-{0.0}	WORKMAN CREEK		COAL97 B93	9/22/1997	14	67	6	46	52	56	27	73	53	73	5	66	64
2	WVKC-47-O-{2.4}	WORKMAN CREEK		COAL97 B94	9/22/1997	15	71	8	62	84	91	10	91	63	58	5	76	75
2	WVKC-5	FALLS CREEK		COAL97 B26	9/17/1997	19	90	8	62	38	41	29	71	48	82	5	71	70
2	WVKC-9	CROOKED CREEK		COAL97 B20	9/17/1997	11	52	5	38	29	32	43	58	62	59	6	62	50
2	WVKG-13-{0.0}	PETERS CREEK		GAU98 B18	7/14/1998	15	71	6	46	46	50	8	93	45	86	5	68	69
2	WVKG-13-{7.9}	PETERS CREEK		GAU98 B20R	8/4/1998	14	67	5	38	63	69	5	96	41	92	4	82	74
2	WVKG-13-B	OTTER CREEK		GAU98 B12	7/14/1998	16	76	8	62	65	71	11	90	40	94	5	75	78
2	WVKG-13-F	JERRY FORK		GAU98 B14	8/4/1998	16	76	7	54	76	83	15	86	69	49	5	68	69
2	WVKG-13-K	BUCK GARDEN CREEK		GAU98 B15	8/4/1998	13	62	9	69	84	91	3	98	54	72	4	81	79
2	WVKG-19-{14.4}	MEADOW RIVER		GAU98 B48	7/29/1998	11	52	8	62	95	103	2	99	82	28	5	74	69
2	WVKG-19-{18.0}	MEADOW RIVER		GAU98 B49	7/22/1998	26	124	12	92	43	46	13	88	32	106	5	67	82
2	WVKG-19-{40.4}	MEADOW RIVER		GAU98 B51	7/27/1998	15	71	6	46	55	60	0	101	55	70	5	69	69
2	WVKG-19-E {2.0}	GLADE CREEK		GAU98 B22	7/30/1998	11	52	4	31	59	64	10	91	55	71	5	75	64
2	WVKG-19-G-{2.8}	ANGLINS CREEK		GAU98 B25	7/30/1998	22	105	13	100	64	70	17	84	45	86	5	77	86
2	WVKG-19-G-{9.6}	ANGLINS CREEK		GAU98 B26	8/13/1998	22	105	13	100	71	78	4	97	45	86	4	81	90
2	WVKG-19-G-3-{1.0}	SUGARGROVE CREEK		GAU98 B23	7/30/1998	12	57	8	62	80	87	3	98	50	79	4	89	79
2	WVKG-19-G-9-{7.5}	U.T. OF ANGLINS CREEK		GAU98 B24	8/3/1998	18	86	12	92	79	86	8	93	38	96	4	85	90
2	WVKG-19-H-{0.8}	YOUNGS CREEK		GAU98 B28	7/27/1998	15	71	11	85	85	93	11	89	52	75	4	86	83
2	WVKG-19-H-1-A-{1.2}	NORTH PRONG CREEK		GAU98 B27	7/27/1998	9	43	5	38	56	61	2	99	47	84	4	79	67
2	WVKG-19-J-1	HAYNES BRANCH		GAU98 B29	7/29/1998	14	67	9	69	84	91	6	95	61	61	4	82	77
2	WVKG-19-J-2	ROAD FORK		GAU98 B30	7/29/1998	19	90	11	85	78	85	14	87	38	97	4	88	89
2	WVKG-19-P	MEADOW CREEK		GAU98 B31	7/29/1998	15	71	10	77	76	83	13	88	42	91	4	84	82
2	WVKG-19-P {5.4}	MEADOW CREEK		GAU98 B32	7/21/1998	21	100	9	69	55	60	22	79	43	89	5	74	79
2	WVKG-19-Q	SEWELL CREEK		GAU98 B33	7/28/1998	13	62	5	38	36	39	11	90	39	95	5	64	65
2	WVKG-19-Q-1-A-{1.4}	BOGGS CREEK		GAU98 B34	7/28/1998	25	119	13	100	63	69	16	84	42	91	5	77	87
2	WVKG-19-Q-5	GOULD HOLLOW		GAU98 B35	7/27/1998	17	81	7	54	38	41	42	59	73	43	6	56	55
2	WVKG-19-U-{3.8}	BIG CLEAR CREEK		GAU98 B39	8/10/1998	18	86	10	77	69	75	7	94	47	83	4	80	82
2	WVKG-19-U-{7.8}	BIG CLEAR CREEK		GAU98 B40	7/21/1998	18	86	12	92	86	94	9	92	51	77	4	81	87
2	WVKG-19-U-2-C	OLD FIELD BRANCH		GAU98 B36	7/21/1998	19	90	13	100	90	98	3	98	65	54	4	81	87
2	WVKG-19-U-2-D	JOB KNOB BRANCH		GAU98 B37	7/21/1998	17	81	11	85	95	104	2	99	67	51	4	82	83
2	WVKG-19-U-4	ELIJAH BRANCH		GAU98 B38	7/21/1998	20	95	12	92	83	90	6	95	50	78	4	84	89
2	WVKG-19-V {4.4}	LITTLE CLEAR CREEK		GAU98 B46	7/30/1998	12	57	5	38	79	86	7	94	77	36	4	81	65
2	WVKG-24-{4.0}	HOMINY CREEK		GAU98 B59	7/15/1998	20	95	11	85	53	57	10	91	32	106	5	77	84
2	WVKG-24-{6.2}	HOMINY CREEK		GAU98 B60	7/16/1998	19	90	11	85	72	78	5	96	31	108	4	86	89
2	WVKG-24-E {1.0}	GRASSY CREEK		GAU98 B54	7/20/1998	20	95	11	85	68	74	7	94	62	60	5	75	81
2	WVKG-24-E-2	BRUSHY MEADOW CREEK		GAU98 B52	7/16/1998	19	90	7	54	74	80	9	92	57	67	5	73	76
2	WVKG-24-G	ROARING CREEK		GAU98 B55	7/20/1998	17	81	9	69	72	79	14	87	57	67	4	80	77
2	WVKG-26-{1.6}	MUDDLETY CREEK		GAU98 B71	7/20/1998	14	67	8	62	49	54	22	79	43	89	4	83	72
2	WVKG-26-{8.8}	MUDDLETY CREEK		GAU98 B72	7/14/1998	16	76	6	46	27	29	7	94	66	53	5	72	62
2	WVKG-26-O	CLEAR FORK		GAU98 B68	7/20/1998	15	71	7	54	77	83	9	92	67	52	5	73	71
2	WVKG-26-O-2	FALLS RUN		GAU98 B69	7/22/1998	24	114	12	92	55	60	20	81	45	86	4	85	84
2	WVKG-26-P	LAUREL FORK		GAU98 B70	7/22/1998	13	62	8	62	89	97	8	92	57	67	4	78	76
2	WVKG-27	PERSINGER CREEK		GAU98 B73	7/29/1998	22	105	11	85	73	79	7	94	53	74	4	82	86
2	WVKG-3	BIG CREEK		GAU98 B74	7/15/1998	18	86	7	54	56	61	3	98	48	81	5	64	74
2	WVKG-30-{0.4}	BIG BEAVER CREEK		GAU98 B83	7/29/1998	14	67	8	62	75	81	12	88	40	93	4	80	79
2	WVKG-30-{3.8}	BIG BEAVER CREEK		GAU98 B84	7/28/1998	21	100	12	92	69	76	2	99	45	85	4	85	90
2	WVKG-30-{4.3}	BIG BEAVER CREEK		GAU98 B85	7/28/1998	19	90	10	77	67	73	9	91	39	95	4	83	85
2	WVKG-30-D-{0.8}	WYATT RU N		GAU98 B76	7/30/1998	18	86	10	77	92	100	3	98	70	46	5	76	80
2	WVKG-30-E	LITTLE BEAVER CREEK		GAU98 B77	7/28/1998	13	62	2	15	61	66	7	94	79	33	5	66	56
2	WVKG-30-H	LEFT FORK/BEAVER CREEK		GAU98 B78	7/28/1998	17	81	5	38	23	25	36	64	49	80	6	52	57
2	WVKG-30-L	BEARPEN FORK/BEAVER CREEK		GAU98 B80	7/27/1998	8	38	2	15	52	56	6	95	64	57	6	61	54
2	WVKG-30-N	LOWER LAUREL RUN		GAU98 B81	7/27/1998	10	48	2	15	36	40	9	92	85	24	6	60	46
2	WVKG-30-P	UPPER LAUREL RUN		GAU98 B82	7/27/1998	22	105	5	38	9	10	25	75	41	92	6	52	61
2	WVKG-32	PANTHER CREEK		GAU98 B87	8/5/1998	14	67	7	54	85	93	2	99	77	37	5	74	70

Site metrics and metric scores

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
2	WVKG-34-{0.0}	CHERRY RIVER		GAU98 B103	7/30/1998	15	71	11	85	85	92	2	99	56	68	4	79	82
2	WVKG-34-{8.8}	CHERRY RIVER		GAU98 B104	8/4/1998	17	81	8	62	52	57	36	65	57	66	5	67	66
2	WVKG-34-B	COAL SIDING RUN		GAU98 B89	8/5/1998	17	81	12	92	88	96	5	96	45	86	3	92	91
2	WVKG-34-E	LAUREL CREEK		GAU98 B90	8/5/1998	20	95	14	108	81	88	7	94	32	106	4	89	94
2	WVKG-34-E-3	SPRING RUN		GAU98 B91	8/5/1998	19	90	11	85	66	72	11	89	38	97	4	89	87
2	WVKG-34-F-{1.8}	LITTLE LAUREL CREEK		GAU98 B92	8/4/1998	18	86	11	85	79	86	11	90	30	109	4	85	89
2	WVKG-34-G-{1.0}	SOUTH FORK/ CHERRY RIVER		GAU98 B95	8/4/1998	20	95	12	92	86	93	10	91	62	60	4	80	85
2	WVKG-34-G-{9.6}	SOUTH FORK/CHERRY RIVER		GAU98 B96	8/4/1998	18	86	13	100	91	99	4	97	57	68	4	83	89
2	WVKG-34-G-8	BECKY RUN		GAU98 B94	8/4/1998	15	71	12	92	95	104	3	98	65	55	4	84	83
2	WVKG-34-H-{0.3}	NORTH FORK/CHERRY RIVER		GAU98 B101	8/4/1998	18	86	11	85	73	80	10	91	46	84	5	77	84
2	WVKG-34-H-{9.5}	NORTH FORK/CHERRY RIVER		GAU98 B102	8/4/1998	14	67	12	92	94	102	6	95	56	68	4	81	84
2	WVKG-34-H-11.5	CARPENTER RUN		GAU98 B93	8/5/1998	10	48	7	54	88	96	11	90	48	82	4	88	76
2	WVKG-34-H-8	WINDY RUN		GAU98 B99	8/3/1998	10	48	8	62	92	100	0	101	59	64	3	92	78
2	WVKG-35-{0.0}	CRANBERRY RIVER		GAU98 B105	7/15/1998	17	81	11	85	81	88	8	93	44	87	4	84	86
2	WVKG-35-{17.5}	CRANBERRY RIVER		GAU98 B106	7/16/1998	17	81	12	92	92	101	2	99	55	70	4	86	88
2	WVKG-35-{19.7}	CRANBERRY RIVER		GAU98 B107	7/16/1998	19	90	13	100	91	99	4	97	54	71	4	90	91
2	WVKG-35-{23.7}	CRANBERRY RIVER		GAU98 B108	7/16/1998	21	100	14	108	78	85	15	86	52	75	4	78	87
2	WVKG-5-{0.0}	TWENTYMILE CREEK		GAU98 B126	7/16/1998	14	67	8	62	49	53	19	82	59	64	5	63	65
2	WVKG-5-{15.6}	TWENTYMILE CREEK		GAU98 B127	7/20/1998	14	67	7	54	79	86	3	98	81	30	5	74	68
2	WVKG-51-{0.2}	WILLIAMS RIVER		GAU98 B128	8/5/1998	18	86	11	85	69	75	8	93	42	90	4	78	84
2	WVKG-51-{1.2}	WILLIAMS RIVER		GAU98 B129	8/4/1998	13	62	7	54	63	69	7	94	42	91	5	76	74
2	WVKG-51-{10.0}	WILLIAMS RIVER		GAU98 B130	8/4/1998	20	95	11	85	71	77	13	88	46	84	4	80	85
2	WVKG-51-{20.0}	WILLIAMS RIVER		GAU98 B131	8/4/1998	21	100	15	115	74	81	20	81	49	80	5	72	86
2	WVKG-5-A	BUCKLES BRANCH		GAU98 B110	7/16/1998	22	105	11	85	65	71	20	81	67	52	4	89	80
2	WVKG-5-B {1.3}	BELLS CREEK		GAU98 B115	7/22/1998	13	62	7	54	77	84	8	93	67	52	5	73	70
2	WVKG-5-B-1	OPEN FORK		GAU98 B111	7/22/1998	13	62	6	46	32	35	39	61	60	63	6	58	54
2	WVKG-5-B-2	SMITH BRANCH		GAU98 B113	7/16/1998	13	62	7	54	84	91	11	90	68	51	5	75	70
2	WVKG-5-B-7	CAMPBELL FORK		GAU98 B114	7/16/1998	9	43	2	15	11	12	81	19	91	14	7	47	25
2	WVKG-5-F	ROCKCAMP FORK		GAU98 B117	7/22/1998	7	33	2	15	70	76	15	86	70	47	4	89	58
2	WVKG-5-L	PEACH ORCHARD BRANCH		GAU98 B122	8/4/1998	13	62	7	54	77	84	4	97	63	57	5	74	71
2	WVKG-6-{0.6}	RICH CREEK		GAU98 B135	8/5/1998	17	81	7	54	39	42	32	68	50	78	5	66	65
2	WVKG-6-{4.8}	RICH CREEK		GAU98 B136	8/5/1998	15	71	8	62	82	90	5	96	68	50	5	75	74
2	WVKG-60	TURKEY CREEK		GAU98 B137	8/5/1998	17	81	10	77	62	67	24	77	50	78	4	84	77
2	WVKG-60-A	RIGHT FORK/TURKEY CREEK		GAU98 B138	8/5/1998	20	95	11	85	94	102	2	99	53	74	4	89	90
2	WVKG-65	WILLIAMS CAMP RUN		GAU98 B139	8/5/1998	22	105	15	115	83	90	4	97	48	81	4	89	93
2	WVKG-6-B {1.6}	BRIDGE FORK		GAU98 B133	7/15/1998	20	95	12	92	80	87	10	91	58	66	3	93	87
2	WVKG-6-D-{1.8}	KELLY FORK		GAU98 B134	7/15/1998	17	81	9	69	81	88	2	99	61	61	4	89	81
2	WVKGC-14	LICK BRANCH		GAU98 B145	8/4/1998	16	76	11	85	76	82	10	91	24	119	3	95	88
2	WVKGC-15	HANGING ROCK BRANCH		GAU98 B7	8/4/1998	18	86	12	92	90	98	3	98	32	106	3	101	96
2	WVKGC-17.3	LITTLE ROUGH RUN		GAU98 B147	8/4/1998	15	71	10	77	24	26	2	99	68	50	4	90	69
2	WVKGC-17.6	PHEASANT HOLLOW		GAU98 B148	8/6/1998	22	105	14	108	65	71	9	92	37	99	3	92	92
2	WVKGC-18	COLD RUN		GAU98 B149	8/6/1998	18	86	10	77	43	47	26	75	52	74	4	84	74
2	WVKGC-21	BIRCHLOG RUN		GAU98 B9	7/16/1998	15	71	10	77	85	92	10	90	40	93	3	99	87
2	WVKGC-23-{3.6}	NORTH FORK / CRANBERRY RIVER		GAU98 B153	7/14/1998	13	62	8	62	62	67	4	97	51	77	4	83	75
2	WVKGC-23-C	LEFT FORK/NORTH FORK/CRANBERRY RIVER		GAU98 B10	7/14/1998	13	62	10	77	81	88	3	98	60	62	3	103	81
2	WVKGC-4-{0.4}	BARRENSHE RUN		GAU98 B161	7/15/1998	19	90	12	92	87	95	4	97	44	87	4	86	91
2	WVKGC-4-A	LITTLE BARRENSHE RUN		GAU98 B160	7/15/1998	21	100	13	100	82	89	6	95	38	97	4	88	95
2	WVKGW-10	MIDDLE FORK WILLIAMS RIVER		GAU98 B166	8/12/1998	13	62	9	69	77	83	7	94	40	94	3	103	84
2	WVKGW-10-C	BEECHY RUN		GAU98 B169	8/12/1998	16	76	12	92	91	99	4	97	49	79	2	111	91
2	WVKGW-10-E	HELL-FOR-CERTAIN BRANCH		GAU98 B171	8/12/1998	19	90	12	92	92	100	2	99	51	76	3	100	93
2	WVKGW-16.5	BRIDGE CREEK		GAU98 B176	8/4/1998	15	71	10	77	95	103	3	98	77	37	4	90	79
2	WVKGW-19	UPPER BANNOCK SHOALS RUN		GAU98 B177	8/13/1998	21	100	12	92	90	98	4	97	52	75	3	94	93
2	WVKGW-20	TEA CREEK		GAU98 B178R	8/13/1998	17	81	12	92	74	80	20	80	53	74	4	80	81
2	WVKGW-8	WHITE OAK RUN		GAU98 B182	8/4/1998	15	71	9	69	95	104	2	99	52	74	3	96	85
2	WVO-2-H-2-B.5	U.T. OF MILLERS FORK		TPO98 B4	5/7/1998	14	67	7	54	75	82	5	96	59	65	5	72	72
2	WVO-2-H-3	RUBENS BRANCH		TPO98 B5	5/27/1998	12	57	4	31	31	33	1	100	87	20	7	49	48
2	WVOG-10	MERRITT CREEK		LGU98 B10	5/21/1998	8	38	4	31	11	12	75	26	86	21	7	49	29
2	WVOG-10-A	RIGHT FORK OF MERRITT CREEK		LGU98 B11	5/21/1998	13	62	7	54	11	12	87	13	93	11	7	47	33
2	WVOG-11	SMITH CREEK		LGU98 B12	5/12/1998	11	52	4	31	14	15	57	43	70	47	6	55	41
2	WVOG-14-D {0.4}	U.T. OF TRACE CREEK		LGU98 B13	5/12/1998	15	71	1	8	26	29	41	60	67	52	7	41	43
2	WVOG-2-{3.6}	MUD RIVER		LGU98 B16	5/29/1998	10	48	5	38	19	21	46	54	71	45	6	51	43
2	WVOG-2-{47.0}	MUD RIVER		LGU98 B17	5/28/1998	11	52	6	46	55	60	20	80	56	68	5	67	62
2	WVOG-2-{48.7}	MUD RIVER		LGU98 B18	5/28/1998	17	81	9	69	49	53	26	74	47	82	5	67	71

Site metrics and metric scores

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
2	WVOG-23.5	STALEY BRANCH		LGU98 B20	5/22/1998	8	38	3	23	5	6	63	37	83	27	7	43	29
2	WVOG-27-A	LOWGAP BRANCH		LGU98 B22	5/22/1998	20	95	9	69	55	60	27	74	48	82	5	70	75
2	WVOG-27-H {1.8}	FALLS BRANCH		LGU98 B23	5/27/1998	13	62	8	62	93	101	3	98	58	66	4	91	80
2	WVOG-3-0.5A	EDENS BRANCH		LGU98 B26	5/18/1998	10	48	5	38	35	38	7	94	87	21	6	51	48
2	WVOG-30-{1.2}	STOUT CREEK		LGU98 B27	5/13/1998	16	76	8	62	87	95	3	98	64	56	4	84	78
2	WVOG-34	FOURTEEN MILE CREEK		LGU98 B29	5/6/1998	13	62	7	54	78	85	12	89	53	73	5	75	73
2	WVOG-34-A	LICK BRANCH		LGU98 B30	5/6/1998	7	33	3	23	83	90	15	86	84	25	5	72	55
2	WVOG-34-B	EAST FORK/FOURTEENMILE CREEK		LGU98 B31	5/6/1998	19	90	9	69	31	34	34	67	59	63	6	63	64
2	WVOG-34-E-1	NELSON FORK		LGU98 B32	5/6/1998	20	95	12	92	77	83	6	95	51	77	3	93	89
2	WVOG-35	AARONS CREEK		LGU98 B34	5/11/1998	10	48	5	38	44	48	35	66	65	54	5	64	53
2	WVOG-36	HAMILTON CREEK		LGU98 B35	5/11/1998	8	38	4	31	94	102	4	97	87	20	5	75	60
2	WVOG-38-D {4.5}	LAUREL CREEK		LGU98 B39	5/18/1998	21	100	13	100	71	77	7	94	34	103	4	87	93
2	WVOG-38-G	SULPHUR CREEK		LGU98 B40	5/19/1998	16	76	11	85	92	100	3	98	69	48	4	86	82
2	WVOG-38-K	LEFTHAND CREEK		LGU98 B41	5/19/1998	16	76	10	77	88	96	4	97	71	45	4	79	78
2	WVOG-38-K.7	LITTLE DEADENING CREEK		LGU98 B43	5/19/1998	11	52	7	54	82	89	17	84	80	31	5	72	64
2	WVOG-38-K-5	PIGEONROOST FORK		LGU98 B42	5/19/1998	19	90	8	62	67	73	1	100	35	102	4	90	86
2	WVOG-40	SAND CREEK		LGU98 B46	5/11/1998	10	48	7	54	77	84	15	86	76	37	5	71	63
2	WVOG-41	DRY BRANCH		LGU98 B47	5/11/1998	8	38	3	23	7	7	90	10	93	11	7	46	23
2	WVOG-42-A	SHORT BEND		LGU98 B48	5/11/1998	8	38	4	31	63	68	34	66	68	49	5	71	54
2	WVOG-42-C {0.2}	LAUREL FORK		LGU98 B49	5/11/1998	13	62	7	54	43	47	50	51	70	47	6	57	53
2	WVOG-42-D	MUDLICK BRANCH		LGU98 B50	5/11/1998	19	90	10	77	59	65	13	88	48	82	4	78	80
2	WVOG-42-E	GARTIN FORK		LGU98 B51	5/11/1998	16	76	11	85	60	65	16	84	40	94	5	73	79
2	WVOG-44-A.5	WORKMAN FORK		LGU98 B53	5/20/1998	16	76	10	77	74	81	13	88	52	75	4	80	79
2	WVOG-44-A-2-{2.8}	MARSH FORK		LGU98 B52	5/20/1998	13	62	8	62	78	85	14	87	74	41	5	72	68
2	WVOG-44-C.3	CANEY BRANCH		LGU98 B54	5/14/1998	20	95	9	69	68	74	16	84	55	70	5	77	78
2	WVOG-44-C.7	THOMPSON BRANCH		LGU98 B55	5/14/1998	18	86	11	85	85	92	3	97	48	81	4	88	88
2	WVOG-44-E	SMOKEHOUSE FORK		LGU98 B56	5/14/1998	15	71	9	69	47	51	28	72	51	76	6	62	67
2	WVOG-44-E-.5	WOLFPEN BRANCH		LGU98 B57	5/4/1998	18	86	13	100	87	95	1	100	50	79	3	92	92
2	WVOG-44-F-1	ADAMS BR ANCH		LGU98 B58	5/4/1998	19	90	10	77	91	99	4	97	66	54	3	98	86
2	WVOG-44-G-{1.9}	BUCK FORK		LGU98 B59	5/14/1998	16	76	10	77	54	59	16	85	41	92	4	79	78
2	WVOG-44-H	HOOVER FORK		LGU98 B60	5/4/1998	24	114	15	115	74	80	9	92	35	101	4	89	94
2	WVOG-44-I	HENDERSON BRANCH		LGU98 B61	5/4/1998	20	95	12	92	73	79	9	92	32	106	4	91	92
2	WVOG-44-K	BULWORK BRANCH		LGU98 B62	5/4/1998	18	86	10	77	82	90	7	94	58	66	4	90	84
2	WVOG-48	LIMESTONE BRANCH		LGU98 B63	5/6/1998	13	62	5	38	42	45	15	86	31	107	4	86	70
2	WVOG-49-{3.3}	BIG CREEK		LGU98 B73	5/20/1998	15	71	8	62	30	33	19	82	62	59	5	67	62
2	WVOG-49-A	ED STONE BRANCH		LGU98 B66	5/5/1998	6	29	2	15	21	23	29	72	57	67	5	69	46
2	WVOG-49-A-1	NORTH BRANCH/ED STONE BRANCH		LGU98 B67	5/5/1998	9	43	4	31	67	73	5	96	64	56	5	73	62
2	WVOG-49-B-1	CHAPMAN BRANCH		LGU98 B68	5/5/1998	12	57	7	54	85	92	8	93	44	88	4	88	79
2	WVOG-49-C	VICKERS BRANCH		LGU98 B69	5/5/1998	6	29	2	15	47	51	13	88	77	36	4	78	50
2	WVOG-49-D-2	DOG FORK		LGU98 B71	5/5/1998	17	81	9	69	83	90	11	89	48	82	4	88	83
2	WVOG-49-E-1	PERRYS BRANCH		LGU98 B72	5/6/1998	6	29	1	8	1	1	97	3	98	3	7	43	14
2	WVOG-50	LILY BRANCH		LGU98 B74	5/6/1998	13	62	8	62	85	92	3	98	63	58	4	83	76
2	WVOG-51.5	FOWLER BRANCH		LGU98 B77	5/13/1998	8	38	1	8	39	42	43	57	82	28	5	74	41
2	WVOG-51-B	CANOE FORK		LGU98 B75	5/6/1998	13	62	8	62	66	72	30	70	56	69	4	79	69
2	WVOG-53	GODBY BRANCH		LGU98 B78	5/13/1998	12	57	4	31	11	12	82	18	87	20	6	52	32
2	WVOG-59	MILL CREEK		LGU98 B82	5/13/1998	18	86	7	54	28	31	49	51	64	56	6	55	56
2	WVOG-60	BIG BRANCH		LGU98 B84	5/13/1998	17	81	11	85	88	96	6	95	38	97	4	90	91
2	WVOG-61	BUFFALO CREEK		LGU98 B85	5/13/1998	13	62	7	54	91	99	1	100	58	66	3	99	80
2	WVOG-9-A-{0.3}	UPPER HEATH CREEK		LGU98 B86	5/21/1998	14	67	8	62	45	48	38	63	61	61	6	61	60
2	WVOGM-13	BRUSH CREEK		LGU98 B89	5/15/1998	18	86	9	69	27	29	6	95	71	45	6	51	62
2	WVOGM-16-A	FALLEN FORK		LGU98 B91	5/4/1998	23	110	15	115	80	87	11	90	51	77	4	82	89
2	WVOGM-19	TRACE CREEK		LGU98 B92	5/4/1998	16	76	10	77	67	72	10	91	54	72	4	79	78
2	WVOGM-20-A	COON CREEK		LGU98 B93	5/4/1998	7	33	4	31	39	43	30	70	55	71	5	69	53
2	WVOGM-20-K-1	LEFTHAND FORK		LGU98 B99	5/7/1998	17	81	10	77	88	96	3	97	57	66	4	84	84
2	WVOGM-20-M {1.8}	BRIDGE CREEK		LGU98 B102	5/27/1998	17	81	8	62	50	55	5	96	56	69	4	79	73
2	WVOGM-20-M-1	FLINT HOLLOW		LGU98 B101	5/6/1998	18	86	12	92	97	106	0	101	52	74	3	94	91
2	WVOGM-20-R-2	DONLEY FORK/HAYZLETT FORK		LGU98 B103	5/27/1998	21	100	9	69	56	61	21	80	41	93	4	80	81
2	WVOGM-20-V	ROCKHOUSE BRANCH		LGU98 B105	5/7/1998	14	67	9	69	96	104	0	101	78	35	4	78	75
2	WVOGM-22-A-{0.7}	STRAIGHT FORK		LGU98 B108	5/4/1998	18	86	9	69	31	34	54	46	63	59	6	59	59
2	WVOGM-25-A	MEADOW BRANCH		LGU98 B109	5/6/1998	13	62	5	38	9	10	64	36	79	33	6	58	40
2	WVOGM-25-B-{2.3}	TRACE CREEK		LGU98 B111	5/28/1998	16	76	7	54	36	39	24	77	45	86	4	78	68
2	WVOGM-25-B-1	TINCTURE FORK		LGU98 B110	5/6/1998	15	71	9	69	79	86	14	87	53	73	4	86	79
2	WVOGM-25-I	SUGARTREE FORK		LGU98 B113	5/26/1998	9	43	5	38	63	68	5	96	79	33	5	73	59

Site metrics and metric scores

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Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
2	WVOGM-25-I-4	SAND FORK		LGU98 B114	5/26/1998	16	76	10	77	70	76	4	97	48	82	4	83	82
2	WVOGM-31	SANDLICK BRANCH		LGU98 B117	5/21/1998	17	81	10	77	52	56	9	92	51	76	4	86	78
2	WVOGM-33-B	DRY FORK		LGU98 B118	5/21/1998	20	95	11	85	88	95	3	98	40	93	3	96	94
2	WVOGM-33-C	BIG BRANCH		LGU98 B119	5/28/1998	21	100	11	85	62	68	17	84	39	95	4	81	85
2	WVOGM-35-E	LAUREL FORK		LGU98 B120	5/28/1998	19	90	12	92	41	45	13	88	52	75	4	81	79
2	WVOGM-39	LEFT FORK/MUD RIVER		LGU98 B123	5/27/1998	20	95	10	77	60	65	12	89	39	96	4	80	84
2	WVOGM-39-{10.2}	LEFT FORK/MUD RIVER		LGU98 B125	5/27/1998	11	52	6	46	40	43	15	86	61	61	5	70	60
2	WVOGM-39-G	FLAT CREEK		LGU98 B124	5/27/1998	15	71	9	69	49	53	32	69	55	70	5	69	67
2	WVOGM-4-{2.0}	BIG CABELL CREEK		LGU98 B127	5/26/1998	18	86	8	62	70	76	17	84	58	66	5	70	74
2	WVOGM-40.3-{0.0}	UPTON BRANCH		LGU98 B128	5/19/1998	21	100	10	77	72	78	6	95	53	73	4	80	84
2	WVOGM-43	STONECOAL BRANCH		LGU98 B130	5/18/1998	14	67	8	62	91	99	3	98	64	57	4	87	78
2	WVOGM-44-{0.2}	BERRY BRANCH		LGU98 B131	5/19/1998	17	81	9	69	79	86	4	97	55	71	4	85	81
2	WVOGM-50	LUKEY FORK		LGU98 B132	5/18/1998	23	110	14	108	84	92	3	98	46	85	3	98	95
2	WVOGM-7-B-1	TONY BRANCH		LGU98 B133	5/3/1998	20	95	11	85	70	76	14	87	51	77	4	83	84
2	WVOGM-8-{4.0}	MILL CREEK		LGU98 B137	5/3/1998	16	76	10	77	43	46	15	86	44	88	4	84	76
2	WVOGM-8-C	RIGHT FORK/MILL CREEK		LGU98 B136	5/26/1998	13	62	6	46	43	46	33	67	67	52	5	66	57
2	WVP-12-{5.2}	SIR JOHNS RUN		POT98 B63	6/1/1998	15	71	8	62	66	72	13	88	45	86	4	83	77
2	WVP-15-{0.4}	WILLET RUN		POT98 B67	6/4/1998	19	90	12	92	89	96	6	95	50	78	3	94	91
2	WVP-2.2 {0.3}	UT POTOMAC RV (TEAGUE'S RUN)		POT98 B29	6/2/1998	11	52	4	31	15	16	20	80	63	58	5	67	51
2	WVP-4.5	JORDAN RUN		POT98 B14	6/25/1998	14	67	5	38	38	42	17	84	55	70	4	81	64
2	WVP-4-{1.3}	OPEQUON CREEK		POT98 B27	6/2/1998	12	57	2	15	5	6	10	91	75	40	5	74	47
2	WVP-4-{17.8}	OPEQUON CREEK		POT98 B28	6/9/1998	11	52	5	38	14	15	81	19	88	18	6	50	32
2	WVP-4-{29.2}	OPEQUON CREEK		POT98 B31	6/9/1998	14	67	7	54	33	36	29	72	56	68	5	67	61
2	WVP-4-B	EAGLE RUN		POT98 B1	6/10/1998	5	24	1	8	1	1	94	6	97	4	7	42	14
2	WVP-4-C-{0.2}	TUSCARORA CREEK		POT98 B2	6/10/1998	4	19	1	8	4	4	68	33	93	12	6	53	21
2	WVP-4-C-{1.5}	TUSCARORA CREEK		POT98 B32	6/2/1998	7	33	1	8	4	4	77	23	89	17	7	39	21
2	WVP-4-C-{6.0}	TUSCARORA CREEK		POT98 B62	6/1/1998	13	62	5	38	31	33	48	52	69	48	6	57	49
2	WVP-4-D	EVANS RUN		POT98 B4	6/10/1998	13	62	6	46	24	26	61	40	73	43	6	56	45
2	WVP-4-I	HOPEWELL RUN		POT98 B5R	6/9/1998	11	52	6	46	25	27	66	34	80	32	6	54	41
2	WVP-4-J	MIDDLE CREEK		POT98 B7	6/9/1998	14	67	6	46	32	35	44	56	61	60	5	65	55
2	WVP-4-K-{1.2}	GOOSE CREEK		POT98 B33	6/8/1998	17	81	6	46	20	22	56	44	69	48	6	57	50
2	WVP-4-M-{7.8}	MILL CREEK		POT98 B34R	6/10/1998	9	43	3	23	9	10	60	40	88	19	6	50	31
2	WVP-4-M-1	SYLVAN RUN		POT98 B11	6/8/1998	16	76	8	62	27	29	67	33	86	21	6	54	46
2	WVP-4-M-2	TORYTOWN RUN		POT98 B9R	6/3/1998	7	33	2	15	1	1	61	40	79	33	7	47	28
2	WVP-4-P	SILVER SPRING RUN		POT98 B12R	6/4/1998	13	62	3	23	14	16	59	41	79	32	6	54	38
2	WVP-5	HARLAN RUN		POT98 B15	6/23/1998	12	57	5	38	34	37	19	82	60	62	6	63	57
2	WVP-5-A-{1.4}	TULLIS BRANCH (TULISUS)		POT98 B35	6/24/1998	15	71	6	46	40	43	11	90	52	75	5	70	66
2	WVP-6-{1.2}	BACK CREEK		POT98 B36	6/2/1998	16	76	9	69	51	56	9	92	40	93	4	78	77
2	WVP-6-{17.3}	BACK CREEK		POT98 B44	6/3/1998	18	86	9	69	76	83	5	95	57	67	3	94	82
2	WVP-6-{18.4}	BACK CREEK		POT98 B45	6/3/1998	15	71	9	69	85	93	5	96	65	54	3	94	80
2	WVP-6-{33.8}	BACK CREEK		POT98 B46	6/8/1998	20	95	11	85	63	69	16	85	43	89	4	80	84
2	WVP-6-A.1	UT OF BACK CREEK #2		POT98 B16	6/2/1998	15	71	9	69	72	79	23	78	76	38	4	91	71
2	WVP-6-A.2	KATES RUN		POT98 B17	6/2/1998	15	71	8	62	32	34	10	91	48	81	4	82	70
2	WVP-6-A-{0.5}	TILHANCE CREEK		POT98 B38	6/9/1998	17	81	9	69	53	58	31	70	50	78	5	72	71
2	WVP-6-A-{1.3}	TILHANCE CREEK		POT98 B39	6/9/1998	20	95	10	77	55	60	29	72	56	69	5	70	74
2	WVP-6-A-{9.4}	TILHANCE CREEK		POT98 B40	6/9/1998	17	81	10	77	77	83	5	96	38	98	3	94	88
2	WVP-6-A-1-{1.6}	HIGGINS RUN		POT98 B41	6/2/1998	15	71	9	69	80	87	15	86	81	30	3	98	74
2	WVP-6-C.8-{0.6}	U.T. OF BACK CREEK @ GANOTOWN		POT98 B43	6/3/1998	18	86	12	92	89	96	5	96	65	55	3	96	87
2	WVP-6-D	SAWMILL RUN		POT98 B18R	6/3/1998	15	71	9	69	53	58	40	60	74	41	5	77	63
2	WVP-8	BIG RUN		POT98 B20	6/2/1998	18	86	10	77	51	55	32	68	48	82	5	74	74
2	WVP-9-{1.0}	SLEEPY CREEK		POT98 B47	6/1/1998	20	95	10	77	63	68	28	73	52	75	4	81	78
2	WVP-9-{10.0}	SLEEPY CREEK		POT98 B48	6/1/1998	15	71	8	62	63	69	8	93	52	76	3	96	78
2	WVP-9-{12.2}	SLEEPY CREEK		POT98 B49	6/2/1998	20	95	10	77	51	56	25	75	45	87	4	83	79
2	WVP-9-{15.2}	SLEEPY CREEK		POT98 B50	6/2/1998	18	86	10	77	76	83	7	93	50	78	3	100	86
2	WVP-9-{18.2}	SLEEPY CREEK		POT98 B51	6/3/1998	18	86	9	69	47	51	33	68	49	80	6	62	69
2	WVP-9-{21.6}	SLEEPY CREEK		POT98 B52	6/3/1998	19	90	10	77	67	73	20	81	48	81	4	82	81
2	WVP-9-{23.6}	SLEEPY CREEK		POT98 B53	6/3/1998	16	76	10	77	88	96	6	95	45	86	3	97	88
2	WVP-9-{33.2}	SLEEPY CREEK		POT98 B57	6/10/1998	19	90	11	85	54	59	38	62	50	77	5	75	75
2	WVP-9-{35.6}	SLEEPY CREEK		POT98 B59	6/10/1998	20	95	12	92	53	58	33	68	47	84	5	77	79
2	WVP-9-{36.8}	SLEEPY CREEK		POT98 B60	6/10/1998	19	90	12	92	64	69	17	84	56	69	5	76	80
2	WVP-9-B-1-A {0.1}	ROARING RUN		POT98 B71	6/3/1998	16	76	7	54	79	86	10	91	67	52	3	98	76
2	WVP-9-D.8-{0.5}	LICK RUN		POT98 B54	6/3/1998	15	71	9	69	62	68	9	92	43	89	4	85	79
2	WVP-9-E-{1.5}	MIDDLE FORK/SLEEPY CREEK		POT98 B55	6/3/1998	15	71	10	77	43	47	6	95	68	49	4	88	71

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2	WVP-9-E-1	SOUTH FORK/SLEEPY CREEK		POT98 B22	6/4/1998	18	86	10	77	68	74	9	92	29	110	4	88	86
2	WVP-9-F	ROCK GAP RUN		POT98 B24	6/2/1998	19	90	11	85	70	76	7	94	54	72	4	81	83
2	WVP-9-G-{0.25}	INDIAN RUN		POT98 B58	6/10/1998	17	81	10	77	87	94	8	93	62	59	3	92	83
2	WVP-9-G-1	NORTH FORK RUN		POT98 B73R	6/1/1998	18	86	11	85	83	90	13	88	81	30	3	100	80
2	WVP-9-G-3	MIDDLE FORK / INDIAN RUN		POT98 B75	6/2/1998	18	86	10	77	67	73	21	80	72	44	4	91	75
2	WVP-9-I	HANDS RUN		POT98 B74	6/10/1998	22	105	13	100	75	82	15	86	50	78	3	101	91
2	WVBS-{104.2}	TUG FORK RIVER	stressed	TUG98 B3	7/6/1998	12	57	4	31	17	19	60	41	74	41	6	57	41
2	WVBST-10	DRAG CREEK	stressed	TUG98 B10	6/30/1998	18	86	9	69	71	78	12	89	70	47	3	98	78
2	WVBST-107	GRAPEVINE BRANCH	stressed	TUG98 B17	6/17/1998	4	19	0	0	0	0	0	101	50	78	4	85	47
2	WVBST-116	BELCHER BRANCH	stressed	TUG98 B34	6/25/1998	6	29	1	8	4	5	67	34	83	26	7	43	24
2	WVBST-120-B	PUNCHEON CAMP BRANCH	stressed	TUG98 B39	6/16/1998	16	76	9	69	57	62	8	93	63	57	5	74	72
2	WVBST-14	BULL CREEK	stressed	TUG98 B43	7/7/1998	9	43	4	31	74	81	9	92	45	86	4	81	69
2	WVBST-16	SILVER CREEK	stressed	TUG98 B45	6/30/1998	12	57	4	31	51	56	16	85	68	50	5	76	59
2	WVBST-19-{0.0}	MARROWBONE CREEK	stressed	TUG98 B47	7/7/1998	10	48	4	31	54	59	21	80	51	76	5	67	60
2	WVBST-19-{8.0}	MARROWBONE CREEK	stressed	TUG98 B48	7/6/1998	20	95	9	69	62	67	2	99	60	62	5	72	77
2	WVBST-24-{9.0}	PIGEON CREEK	stressed	TUG98 B59	6/22/1998	13	62	4	31	16	18	4	97	83	26	5	72	51
2	WVBST-24-E-2-{0.1}	SPRUCE FORK	stressed	TUG98 B51	6/24/1998	8	38	2	15	34	37	3	98	78	34	5	71	49
2	WVBST-24-K-8	SIMMONS FORK	stressed	TUG98 B52	6/22/1998	11	52	2	15	12	13	62	38	76	38	7	46	34
2	WVBST-3	POWDERMILL BRANCH	stressed	TUG98 B62	6/25/1998	14	67	3	23	7	8	69	32	74	40	6	54	37
2	WVBST-31-{1.0}	BUFFALO CREEK	stressed	TUG98 B64	6/23/1998	15	71	6	46	30	33	11	90	59	64	5	65	61
2	WVBST-33	WILLIAMSON CREEK	stressed	TUG98 B66	6/17/1998	7	33	2	15	18	19	18	83	53	74	7	40	44
2	WVBST-36	DICK WILLIAMSON BRANCH	stressed	TUG98 B69	6/22/1998	6	29	2	15	9	10	19	82	78	34	8	25	33
2	WVBST-38	SPROUSE CREEK	stressed	TUG98 B70	7/1/1998	12	57	3	23	46	50	25	75	70	47	6	57	52
2	WVBST-40-B	RUTHERFORD BRANCH	stressed	TUG98 B72	7/1/1998	6	29	1	8	68	73	8	93	85	23	5	70	49
2	WVBST-40-D	CHAFIN BRANCH	stressed	TUG98 B74	6/15/1998	9	43	2	15	49	53	26	74	74	40	6	55	47
2	WVBST-43-A	LICK FORK/GRAPEVINE	stressed	TUG98 B81	6/16/1998	7	33	1	8	56	61	17	84	80	31	5	77	49
2	WVBST-57-{0.6}	BULL CREEK	stressed	TUG98 B83	7/7/1998	13	62	5	38	72	78	17	84	68	50	5	68	63
2	WVBST-57-B	LEFT FORK BULL CREEK	stressed	TUG98 B82	7/7/1998	12	57	3	23	14	15	61	39	78	34	6	52	37
2	WVBST-70-N {0.0}	LITTLE SLATE CREEK	stressed	TUG98 B100	7/8/1998	10	48	5	38	16	18	79	21	88	18	6	52	33
2	WVBST-70-O	ATWELL BRANCH	stressed	TUG98 B102	7/8/1998	21	100	8	62	50	54	26	75	58	66	6	57	69
2	WVBST-78-B	SHABBYROOM BRANCH	stressed	TUG98 B121	7/8/1998	14	67	4	31	64	69	29	72	81	30	6	61	55
2	WVBST-78-G	BADWAY BRANCH	stressed	TUG98 B125	7/1/1998	12	57	4	31	38	41	41	60	64	57	6	59	51
2	WVKC-10-{03.6}	LITTLE COAL RIVER	stressed	COAL97 B43	9/23/1997	16	76	6	46	82	89	6	95	63	57	4	81	74
2	WVKC-10-{17.0}	LITTLE COAL RIVER	stressed	COAL97 B44	9/22/1997	12	57	5	38	80	87	2	99	78	34	5	76	65
2	WVKC-10-I-{0.0}	BIG HORSE CREEK	stressed	COAL97 B5	9/22/1997	14	67	3	23	24	26	28	73	65	54	6	62	51
2	WVKC-10-I-{12.5}	BIG HORSE CREEK	stressed	COAL97 B6	9/23/1997	13	62	3	23	35	39	20	81	67	51	5	66	54
2	WVKC-10-I-{5.6}	BIG HORSE CREEK	stressed	COAL97 B7	9/22/1997	9	43	4	31	20	21	30	71	76	37	6	63	44
2	WVKC-10-J	LITTLE HORSE CREEK	stressed	COAL97 B45	9/22/1997	13	62	2	15	22	24	31	70	50	77	6	60	51
2	WVKC-10-T-{0.3}	SPRUCE FORK	stressed	COAL97 B74	9/24/1997	14	67	6	46	73	80	11	90	52	75	5	74	72
2	WVKC-10-T-{4.6}	SPRUCE FORK	stressed	COAL97 B77	9/24/1997	16	76	7	54	51	55	8	93	49	80	5	73	72
2	WVKC-10-T-10	STOLLINGS BRANCH	stressed	COAL97 B82	9/24/1997	15	71	6	46	60	65	12	89	47	83	4	79	72
2	WVKC-10-T-11-{0.2}	SPRUCE LAUREL FORK	stressed	COAL97 B78	9/25/1997	12	57	4	31	39	43	26	74	55	70	5	68	57
2	WVKC-10-T-11-{4.1}	SPRUCE LAUREL FORK	stressed	COAL97 B80	9/25/1997	9	43	3	23	67	73	14	87	62	60	5	69	59
2	WVKC-10-T-21	ADKINS FORK	stressed	COAL97 B1	9/25/1997	11	52	5	38	62	68	23	78	71	46	5	66	58
2	WVKC-10-T-24-{0.6}	BRUSHY FORK	stressed	COAL97 B10	10/8/1997	13	62	6	46	57	62	7	94	64	56	4	82	67
2	WVKC-10-T-3	LOW GAP CREEK	stressed	COAL97 B48	9/24/1997	7	33	1	8	4	4	9	92	81	30	6	58	38
2	WVKC-10-U {0.4}	POND FORK	stressed	COAL97 B61	9/23/1997	18	86	6	46	59	64	9	92	52	75	5	74	73
2	WVKC-10-U {24.4}	POND FORK	stressed	COAL97 B62	9/22/1997	10	48	4	31	62	68	11	90	71	46	5	68	58
2	WVKC-10-U {4.9}	POND FORK	stressed	COAL97 B63	9/23/1997	13	62	5	38	72	79	7	94	74	41	5	71	64
2	WVKC-10-U {9.0}	POND FORK	stressed	COAL97 B64	9/23/1997	19	90	6	46	47	51	18	83	49	80	6	50	67
2	WVKC-10-U-12-A	TRACE FORK/COW CREEK	stressed	COAL97 B88	9/22/1997	16	76	6	46	44	48	33	67	69	48	6	62	58
2	WVKC-10-U-7-{0.0}	WEST FORK	stressed	COAL97 B89	9/22/1997	10	48	4	31	73	79	16	85	77	35	5	67	58
2	WVKC-10-U-7-{4.3}	WEST FORK OF POND FORK	stressed	COAL97 B90	9/18/1997	10	48	1	8	46	50	19	81	66	54	5	66	51
2	WVKC-10-U-7-{7.9}	WEST FORK OF POND FORK	stressed	COAL97 B91	9/18/1997	10	48	3	23	61	67	19	82	77	37	5	64	53
2	WVKC-2-{2.0}	BROWNS CREEK	stressed	COAL97 B8	9/17/1997	17	81	7	54	41	44	38	62	64	57	6	63	60
2	WVKC-4-{2.5}	SMITH CREEK	stressed	COAL97 B72	9/17/1997	11	52	4	31	30	33	45	55	63	58	6	60	48
2	WVKC-46-{32.8}	MARSH FORK	stressed	COAL97 B53	10/6/1997	13	62	5	38	17	19	63	38	76	38	6	61	43
2	WVKC-47-L-{0.8}	TONEY FORK	stressed	COAL97 B87	9/22/1997	13	62	6	46	48	52	38	63	83	27	6	60	52
2	WVKG-1	SCRABBLE CREEK	stressed	GAU98 B11	7/15/1998	9	43	2	15	4	4	73	27	87	20	7	47	26
2	WVKG-13-{15.6}	PETERS CREEK	stressed	GAU98 B19	7/29/1998	12	57	4	31	58	63	9	92	56	68	5	70	63
2	WVKG-13-L	ROCKCAMP BRANCH	stressed	GAU98 B16	8/4/1998	19	90	6	46	64	70	10	91	57	67	5	69	72
2	WVKG-13-M	MCCLUNG BRANCH	stressed	GAU98 B17	8/5/1998	12	57	7	54	81	88	9	92	54	73	4	85	75
2	WVKG-19-V {1.0}	LITTLE CLEAR CREEK	stressed	GAU98 B45	7/28/1998	8	38	2	15	12	13	39	61	58	66	6	50	41

Site metrics and metric scores

Stations are grouped by data set (1= 1996-1997 calibration data; 2= 1997-1998 validation data). Within each data set, stations are listed by site type (reference, unlabeled, stressed), then within type by ascending Station ID.

Data Set	Station ID	Stream Name	Site Type	Benthic Sample ID	Collect Date	Total taxa	Tot. taxa score	EPT taxa	EPT taxa score	% EPT	% EPT score	% Chiro.	%Chiro score	% Top 2 dominant	% Top 2 score	HBI	HBI score	INDEX (SCI)
2	WVKG-19-V {6.0}	LITTLE CLEAR CREEK	stressed	GAU98 B47	7/30/1998	10	48	4	31	62	67	14	87	58	66	4	91	65
2	WVKG-24-{12.4}	HOMINY CREEK	stressed	GAU98 B58	7/22/1998	8	38	3	23	29	31	21	79	50	78	7	48	50
2	WVKG-24-I	COLT BRANCH	stressed	GAU98 B57	7/22/1998	23	110	11	85	45	49	44	56	61	61	6	60	68
2	WVKG-26-B-2	JONES RUN	stressed	GAU98 B61	7/15/1998	13	62	3	23	30	33	49	51	78	34	6	55	43
2	WVKG-26-F	TROUT RUN	stressed	GAU98 B63	7/14/1998	25	119	9	69	38	41	45	55	75	39	6	60	61
2	WVKG-26-K-1	LOWER SPRUCE RUN	stressed	GAU98 B66	7/22/1998	20	95	7	54	35	38	16	85	44	88	4	84	74
2	WVKG-26-K-1-A	SPRUCE RUN	stressed	GAU98 B67	7/22/1998	19	90	4	31	51	55	17	84	40	93	4	84	73
2	WVKG-30-K	PADDY RUN	stressed	GAU98 B79	7/27/1998	28	133	12	92	47	52	25	76	56	68	5	76	77
2	WVKG-31	LITTLE LAUREL CREEK	stressed	GAU98 B86	8/5/1998	8	38	4	31	86	94	2	99	83	27	5	75	61
2	WVKG-5-B-1-C	SANGAMORE FORK	stressed	GAU98 B112	7/16/1998	7	33	3	23	38	41	0	101	38	98	3	97	65
2	WVKG-5-F-1	SPRING BRANCH	stressed	GAU98 B118	7/22/1998	6	29	0	0	0	0	64	37	85	24	6	61	25
2	WVKG-5-P	ROBINSON FORK	stressed	GAU98 B125	7/20/1998	11	52	5	38	80	87	10	91	86	22	5	69	60
2	WVKG-6-A	LICK BRANCH	stressed	GAU98 B132	8/5/1998	7	33	0	0	0	0	85	15	94	9	7	42	17
2	WVKGW-10-G	MCCLINTOCK RUN	stressed	GAU98 B172	8/5/1998	13	62	10	77	92	100	6	95	72	44	3	94	79
2	WVOG-2-{77.2}	MUD RIVER	stressed	LGU98 B19	5/18/1998	16	76	8	62	42	45	32	68	64	57	5	64	62
2	WVOG-3	DAVIS CREEK	stressed	LGU98 B25	5/18/1998	5	24	2	15	8	9	87	13	93	11	7	45	19
2	WVOG-38-{0.8}	BIG UGLY CREEK	stressed	LGU98 B44	5/19/1998	11	52	6	46	48	52	9	92	52	74	4	79	66
2	WVOG-49-C.1	U.T. OF BIG CREEK	stressed	LGU98 B70	5/6/1998	4	19	2	15	2	2	98	2	99	2	7	43	14
2	WVOG-51-G.5	SOUTH FORK/CRAWLEY CREEK	stressed	LGU98 B76	5/13/1998	7	33	2	15	5	5	43	58	94	10	6	59	30
2	WVOG-6-{0.1}	MILL CREEK	stressed	LGU98 B83	5/18/1998	6	29	2	15	10	11	73	27	86	22	6	50	26
2	WVOGM-1.5	TANYARD BRANCH	stressed	LGU98 B87	5/18/1998	5	24	0	0	0	0	75	25	98	3	8	33	14
2	WVOGM-12	INDIAN FORK	stressed	LGU98 B88	5/15/1998	7	33	3	23	5	5	57	43	88	19	7	47	28
2	WVOGM-14-{7.2}	CHARLEY CREEK	stressed	LGU98 B90	5/29/1998	10	48	5	38	37	40	22	79	52	75	5	75	59
2	WVOGM-20-{21.2}	TRACE FORK	stressed	LGU98 B106	5/29/1998	13	62	6	46	39	42	38	63	57	68	5	66	58
2	WVOGM-20-{6.4}	TRACE FORK	stressed	LGU98 B107	6/9/1998	17	81	7	54	60	65	18	83	56	69	5	74	71
2	WVOGM-20-D-{4.6}	BIG CREEK	stressed	LGU98 B94	5/28/1998	15	71	7	54	44	48	12	89	60	63	4	83	68
2	WVOGM-20-H	CLYMER CREEK	stressed	LGU98 B96	5/27/1998	20	95	8	62	50	54	16	85	48	81	6	61	73
2	WVOGM-20-I-1-{1.5}	KELLYS CREEK	stressed	LGU98 B97	5/28/1998	17	81	8	62	44	48	9	92	47	82	5	66	72
2	WVOGM-20-K	MARTIN RUN	stressed	LGU98 B98	5/6/1998	15	71	9	69	89	96	6	95	63	58	4	85	79
2	WVOGM-20-K-{0.1}	NELSON HOLLOW	stressed	LGU98 B100	5/4/1998	12	57	9	69	82	89	11	90	40	94	3	96	83
2	WVOGM-20-T-{3.5}	JOES CREEK	stressed	LGU98 B104	5/28/1998	13	62	7	54	50	54	20	81	43	90	5	73	69
2	WVOGM-25-H-1	VALLEY FORK	stressed	LGU98 B112	5/26/1998	15	71	10	77	16	17	16	84	79	33	5	68	59
2	WVOGM-25-I {3.0}	SUGARTREE FORK	stressed	LGU98 B115	5/26/1998	17	81	9	69	51	56	9	92	58	66	4	78	74
2	WVOGM-3-{0.9}	LIDTTLE CABELL CREEK	stressed	LGU98 B116	5/26/1998	10	48	5	38	26	28	60	40	72	44	6	56	42
2	WVOGM-35-{1.8}	BIG CREEK	stressed	LGU98 B121	5/21/1998	14	67	8	62	69	75	7	94	58	66	4	80	74
2	WVOGM-35-{4.1}	BIG CREEK	stressed	LGU98 B122	5/19/1998	16	76	8	62	80	87	1	100	50	78	4	89	82
2	WVOGM-4-{0.2}	BIG CABELL CREEK	stressed	LGU98 B126	5/29/1998	10	48	3	23	41	44	47	54	85	23	6	55	41
2	WVOGM-40.3-{2.2}	UPTON BRANCH	stressed	LGU98 B129	5/19/1998	24	114	11	85	67	73	8	93	40	93	3	94	90
2	WVOGM-7-{0.4}	LOWER CREEK	stressed	LGU98 B134	5/26/1998	17	81	8	62	42	46	40	60	64	56	6	61	61
2	WVP-1-A-{0.8}	ELK BRANCH	stressed	POT98 B25	6/2/1998	10	48	4	31	9	10	31	69	66	53	5	64	46
2	WVP-4-{18.8}	OPEQUON CREEK	stressed	POT98 B30	6/3/1998	19	90	10	77	40	44	40	60	54	71	5	69	69
2	WVP-4-C-1	DRY RUN	stressed	POT98 B3	6/3/1998	14	67	4	31	8	9	44	56	65	55	6	55	46
2	WVP-4-M	MILL CREEK	stressed	POT98 B8	6/9/1998	15	71	8	62	42	46	43	58	72	44	5	65	58
2	WVP-6-{9.1}	BACK CREEK	stressed	POT98 B37	6/2/1998	17	81	9	69	83	90	8	93	63	57	3	92	80
2	WVP-9-E-{7.0}	MIDDLE FORK/SLEEPY CREEK	stressed	POT98 B56	6/10/1998	12	57	5	38	48	53	23	78	44	88	4	79	65

APPENDIX D

SUPPORTING GRAPHS

Figures D1-D2. Distributions of metric values in reference sites separated into potential site classes by ecoregions and by index periods.

Figures D3-D6. Discriminatory ability of each candidate metric for West Virginia streams using calibration data (1996-1997) reference and impaired sites.

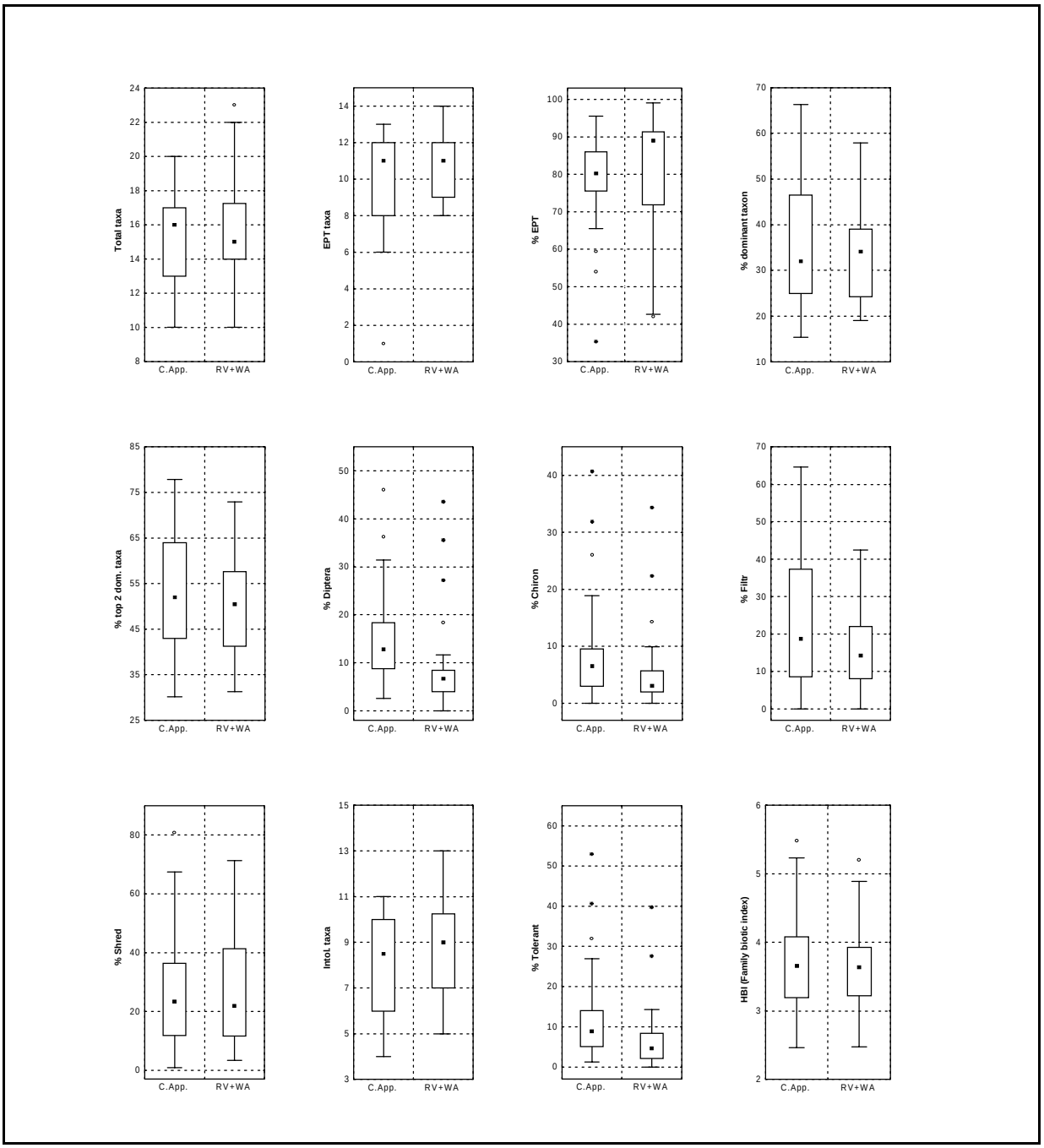

Figure D-1. Benthic attributes (candidate metrics) in 67 reference sites divided into 2 Ecoregion groups. Three Western Allegheny Plateau reference sites combined with 32 Ridge and Valley reference sites were compared with 32 Central Appalachian reference sites. The %Diptera metric shows the most noteworthy difference in ranges of values between the two ecoregion groups, with somewhat lesser separation also shown by % Chironomid and % Tolerants; these three metrics are highly correlated (Table 4-2). In most of these candidate metrics, there is no clear difference in ranges of values between the two ecoregion groups.

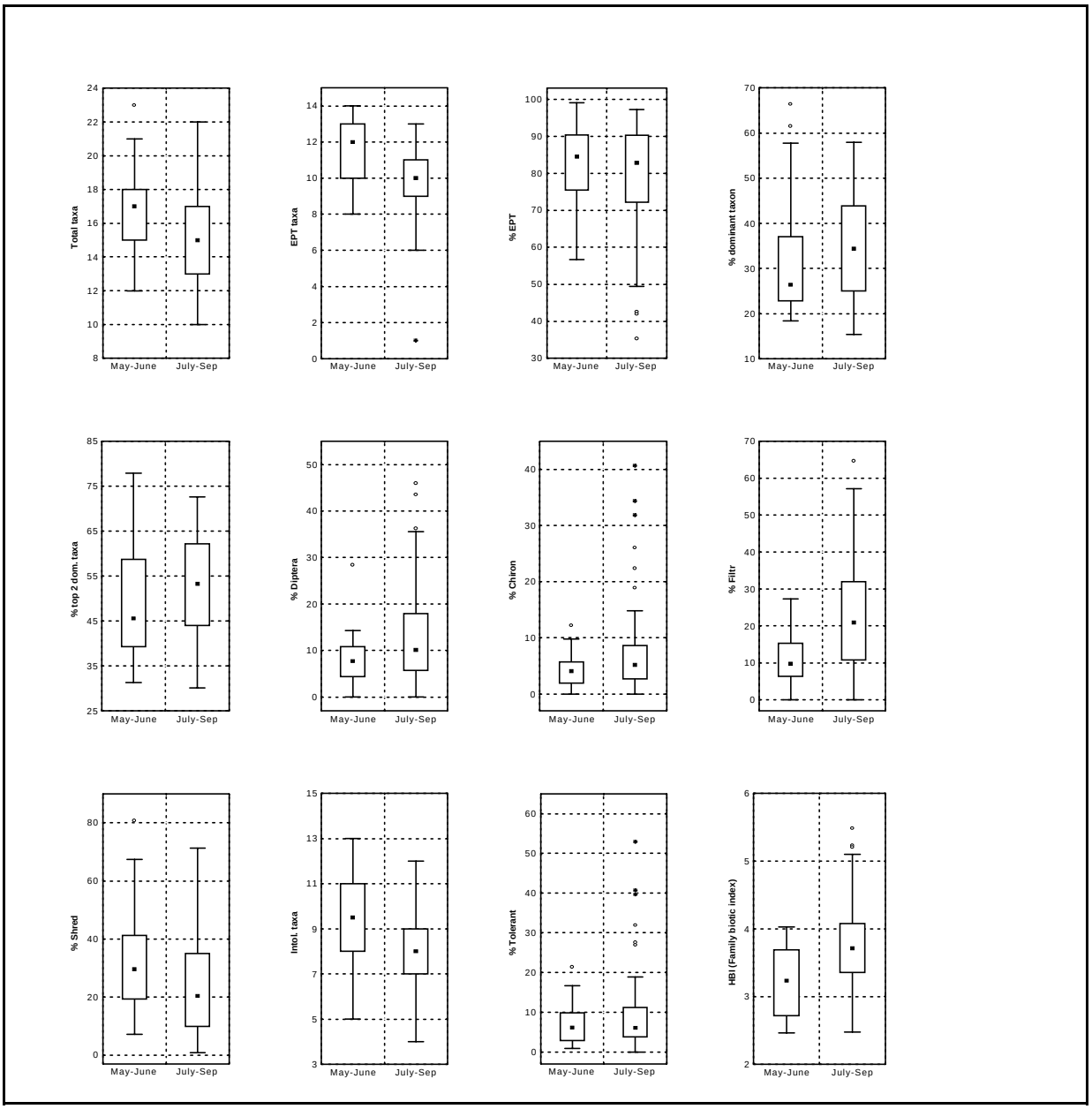

Figure D-2. Benthic attributes (metrics) in 67 reference sites divided into 2 sampling periods. Twenty reference sites sampled in May and June were compared with 47 reference sites sampled in July through September. Possible classification is exhibited by % Filterers, EPT taxa, and Intolerant taxa. However, % Filterers was eliminated as a metric for use in the index because of its poor discrimination of impairment (Chapter 4; Figure D-5). EPT taxa and Intolerant taxa measured essentially the same thing in the WV family-level data (Table 4-2, 92% correlated). The distinction shown here by these metrics most likely reflects the presence of more Ephemeroptera in the earlier sampling period and may support possible improvement in the assessment program by concentrating sampling earlier in the summer. However, combined with other analyses (Chapter 3), we did not conclude that classification by index period was required.

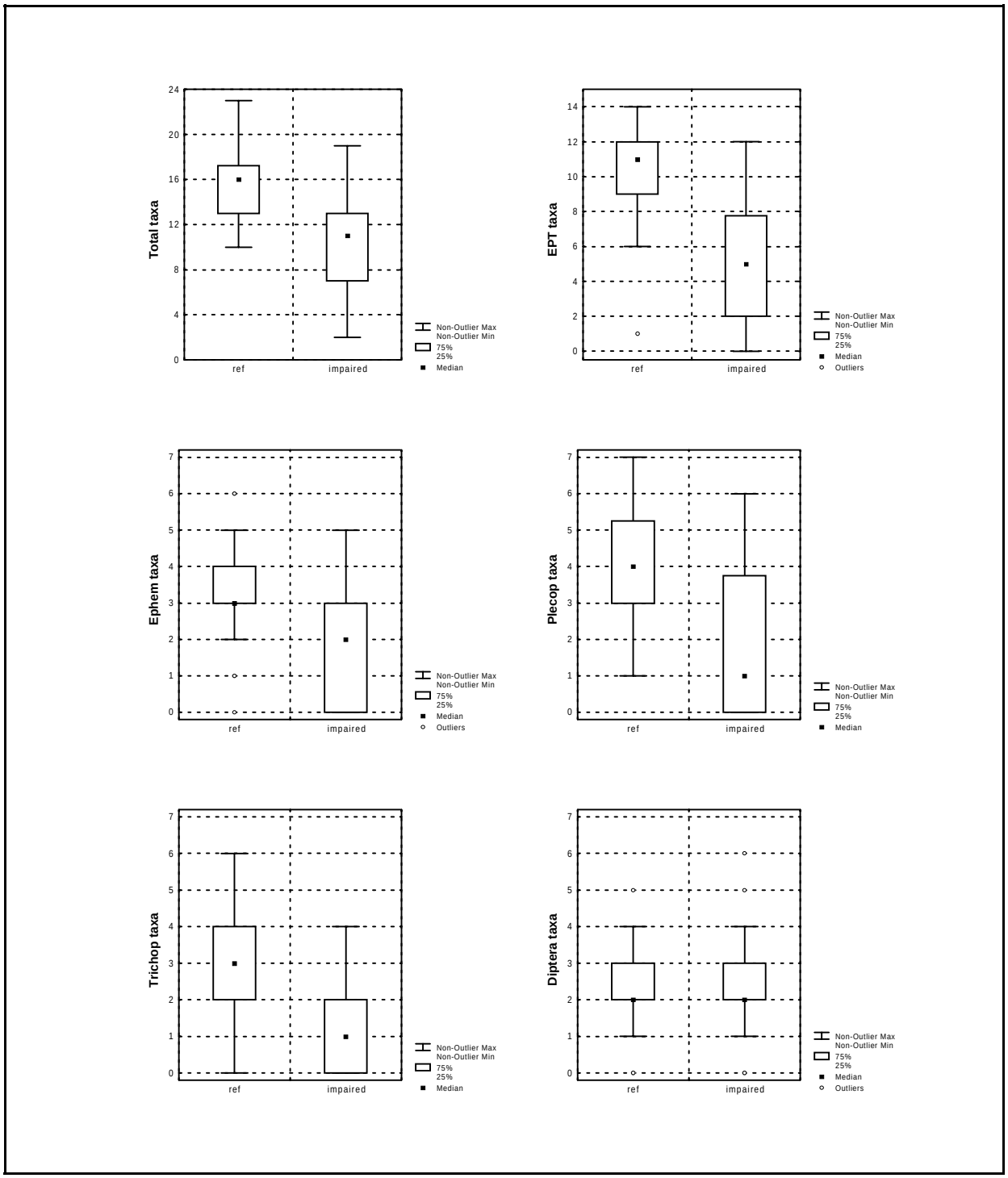

Figure D-3. Discriminatory ability of candidate metrics for West Virginia streams using 1996-1997 calibration data reference and impaired sites: Total taxa, EPT taxa, Ephemeroptera taxa, Plecoptera taxa, Trichoptera taxa, and Diptera taxa.

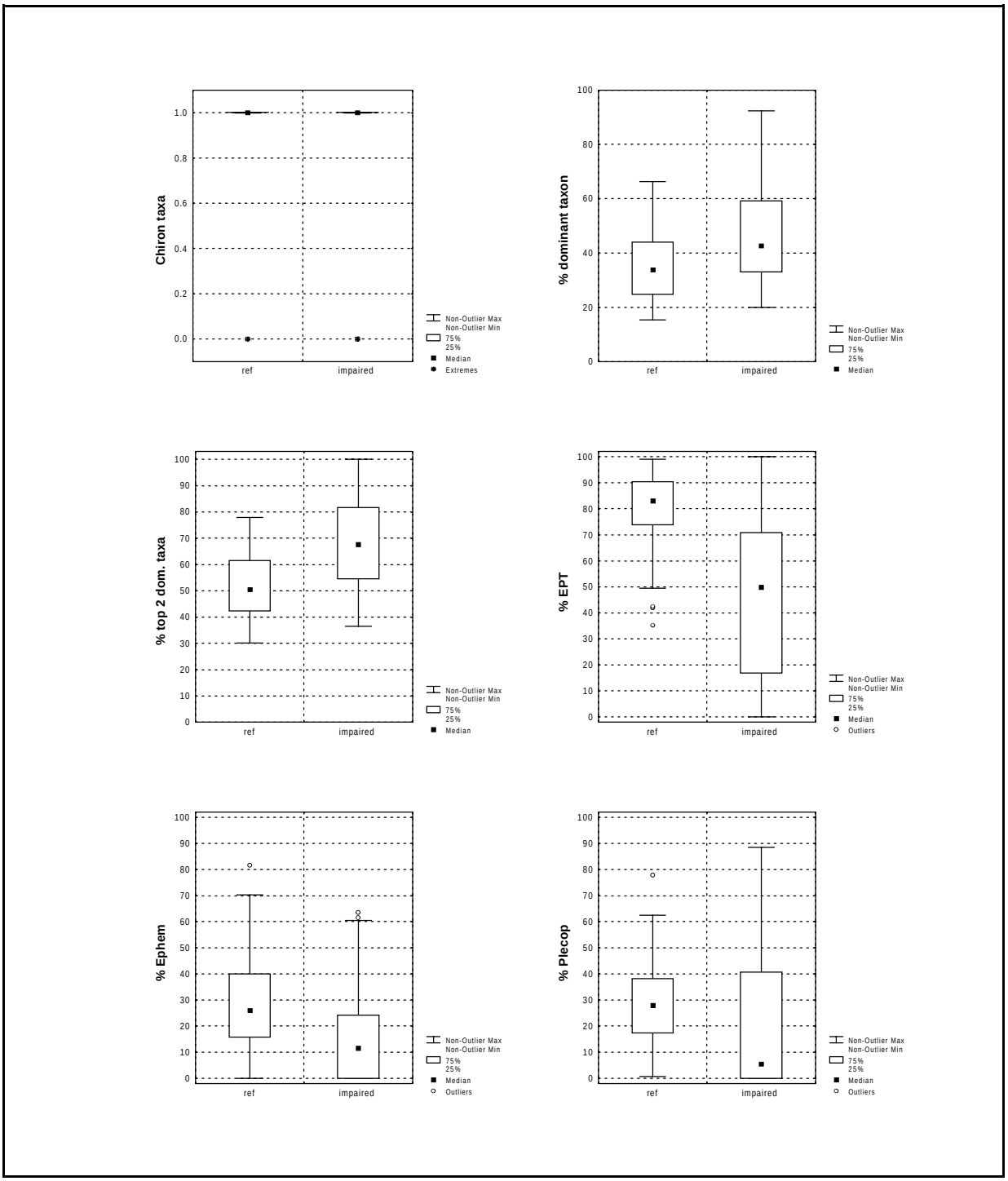

Figure D-4. Discriminatory ability of candidate metrics for West Virginia streams using 1996-1997 calibration data reference and impaired sites: Chironomidae taxa, % dominant, %2 dominant, %EPT, %Ephemeroptera, and %Plecoptera.

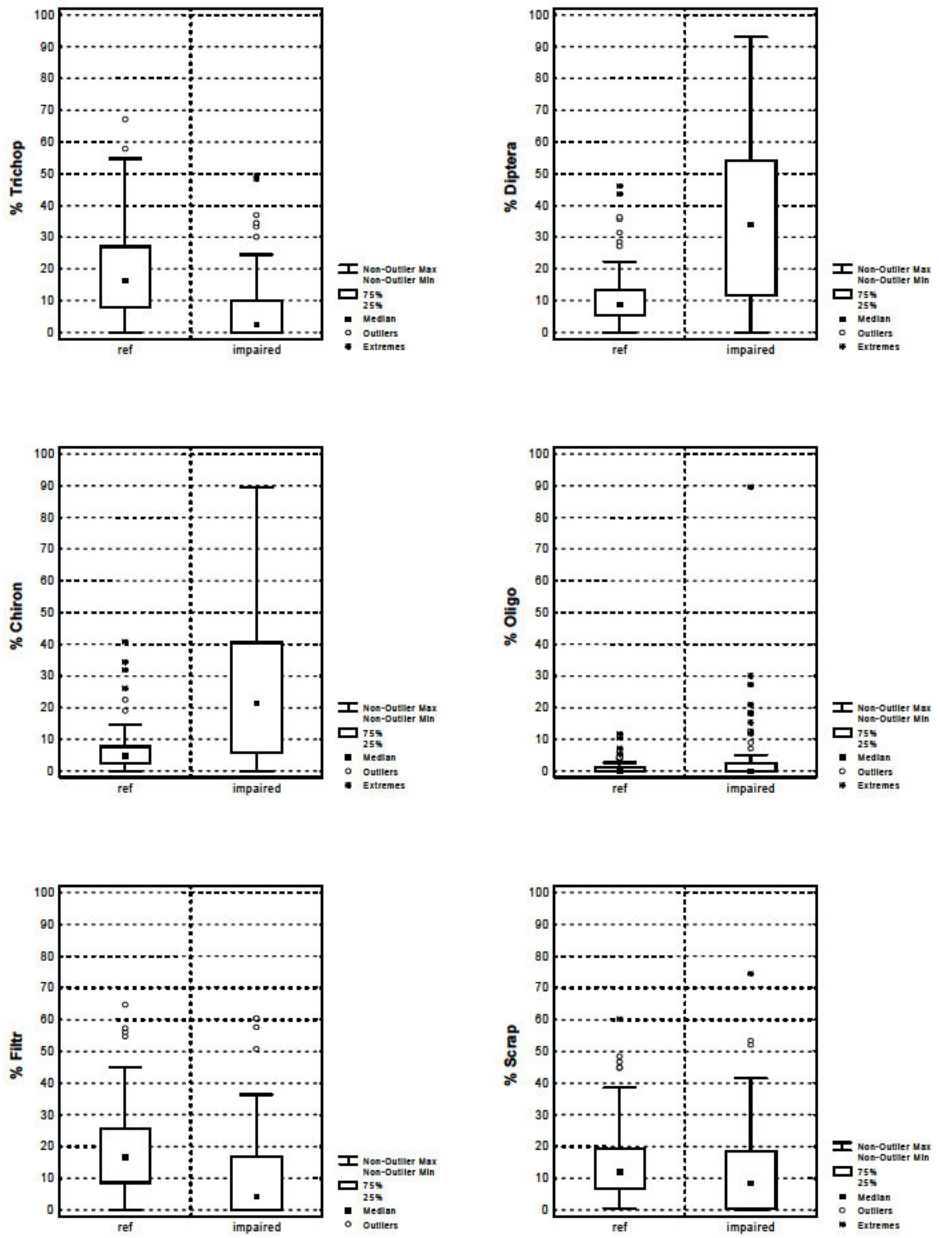

Figure D-5. Discriminatory ability of candidate metrics for West Virginia streams using 1996-1997 calibration data reference and impaired sites: %Trichoptera, %Diptera, %Chironomidae, %Oligochaeta, %Filterers, and %Scrapers.

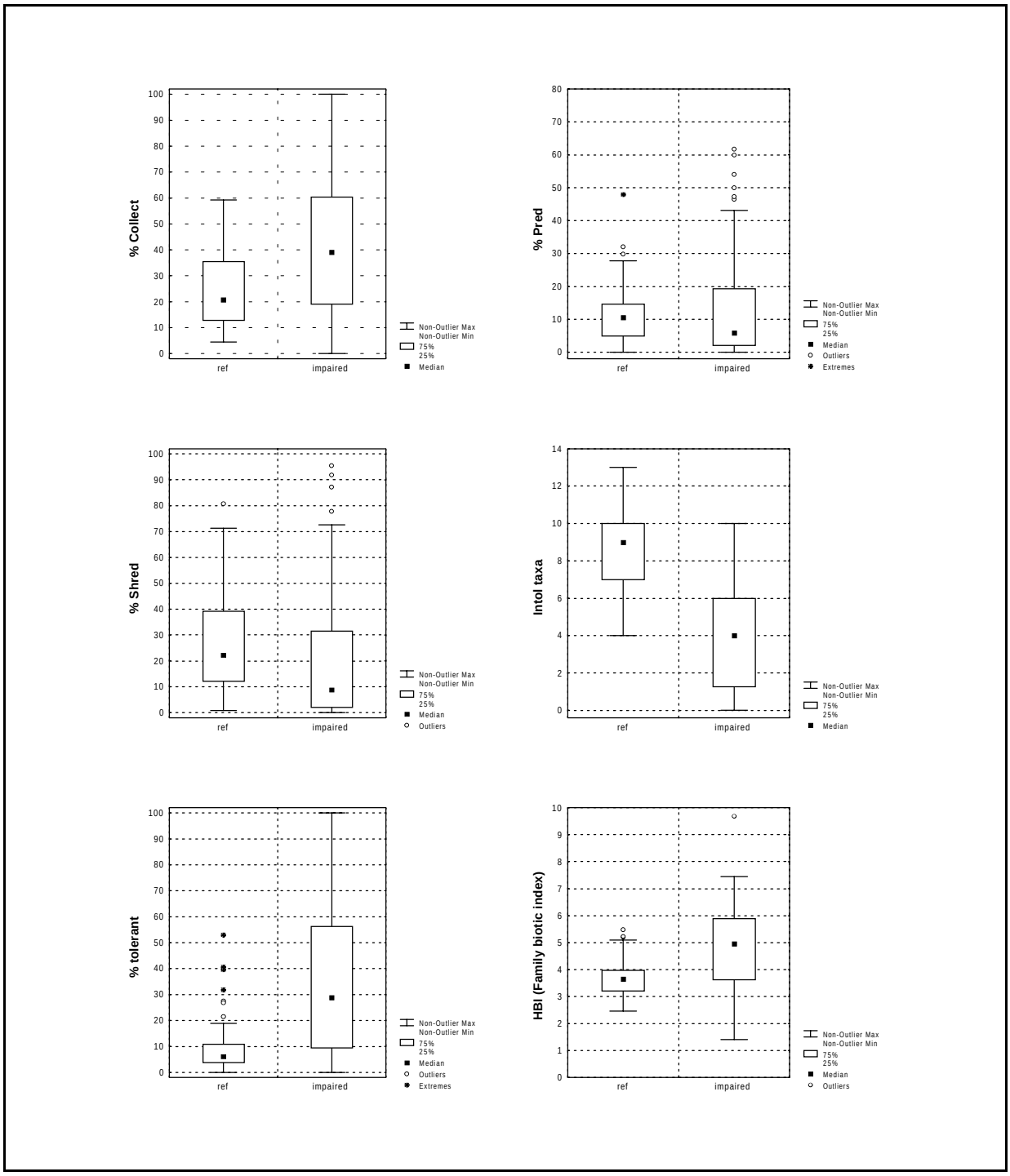

Figure D-6. Discriminatory ability of candidate metrics for West Virginia streams using 1996-1997 calibration data reference and impaired sites: %Collectors, %Predators, %Shredders, Intolerant taxa, %Tolerants, and HBI (Family biotic index).

Jalil Isa/DC/USEPA/US
01/13/2011 09:47 AM

To Betsaida Alcantara
cc Gregory Peck, Roxanne Smith
bcc
Subject Re: nytimes question

Should we work that into the release?: "The company is free to come to EPA and reapply using a less environmentally damaging plan."
This seems like it's a question that will come up repeatedly. Might as well take care of it from the start.

Thanks,
Jalil Isa - Press Officer
U.S. Environmental Protection Agency
Washington, DC
202-564-3226
isa.jalil@epa.gov

Betsaida Alcantara | right | 01/13/2011 09:39:23 AM

From: Betsaida Alcantara/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA
Cc: Bob Sussman/DC/USEPA/US@EPA, Jalil Isa/DC/USEPA/US@EPA
Date: 01/13/2011 09:39 AM
Subject: Re: nytimes question

right

Gregory Peck | The answer is technically yes. But any proposal... | 01/13/2011 09:39:01 AM

From: Gregory Peck/DC/USEPA/US
To: Betsaida Alcantara/DC/USEPA/US@EPA
Cc: Bob Sussman/DC/USEPA/US@EPA, Jalil Isa/DC/USEPA/US@EPA
Date: 01/13/2011 09:39 AM
Subject: Re: nytimes question

The answer is technically yes. But any proposal would have to be reviewed and approved by EPA.

Betsaida Alcantara | Greg and Bob, see below | 01/13/2011 09:35:19 AM

From: Betsaida Alcantara/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA, Bob Sussman/DC/USEPA/US@EPA
Cc: Jalil Isa/DC/USEPA/US@EPA
Date: 01/13/2011 09:35 AM
Subject: nytimes question

Greg and Bob,
see below
----- Forwarded by Betsaida Alcantara/DC/USEPA/US on 01/13/2011 09:34 AM -----

From: "Broder, John" <broder@nytimes.com>
To: Betsaida Alcantara/DC/USEPA/US@EPA
Date: 01/13/2011 09:33 AM
Subject: RE: embargoed spruce release - embargoed til 10:30am

Can the coal company reapply with a less damaging proposal for mining in this area?

jb

-----Original Message-----
From: Alcantara.Betsaida@epamail.epa.gov [
mailto:Alcantara.Betsaida@epamail.epa.gov]
Sent: Thursday, January 13, 2011 9:29 AM
To: Broder, John; Zeller, Tom
Cc: Gilfillan.Brendan@epamail.epa.gov
Subject: embargoed spruce release - embargoed til 10:30am

John and Tom,
Wanted to give you both an embargoed heads up that we are going with Spruce decision this morning. We're putting the release out at 10:30am. So please embargoe til then and let me know if you need to talk to anyone on background. Tom, I recall you went out to W VA last year and did that nytimes.com video and interactive story, so I figured you would be interested.

FOR IMMEDIATE RELEASE
January 13, 2011

EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

Agency cites irreversible damage to clean water, environment in the region

WASHINGTON – After extensive scientific study, a major public hearing in West Virginia and review of more than 50,000 public comments, the U.S. Environmental Protection Agency (EPA) today announced that it will use its authority under the Clean Water Act to halt the proposed disposal of mining waste in streams at the Mingo-Logan Coal Company's Spruce No. 1 coal mine. EPA is acting under the law and using the best science to protect water quality, wildlife and Appalachian communities, who rely on clean waters for drinking, fishing and swimming. EPA has used this Clean Water Act authority in just 12 circumstances since 1972 and reserves this authority for only unacceptable cases.

"The proposed Spruce No. 1 Mine would use destructive and unsustainable mining practices that jeopardize the health of Appalachian communities and clean water on which they depend," said EPA Assistant Administrator for Water Peter S. Silva. "Coal and coal mining are part of our nation's energy future and EPA has worked with companies to design mining operations that adequately protect our nation's waters. We have a responsibility under the law to protect water quality and safeguard the people who rely on clean water."

EPA's final determination on the Spruce Mine comes after discussions with the company spanning more than a year failed to produce an agreement that would lead to a significant decrease in impacts to the environment and Appalachian communities. The action prevents the mine from disposing of the waste into streams unless the company identifies an alternative mining design that would avoid irreversible damage to water quality and meets the requirements of the law. Despite EPA's willingness to consider alternatives, Mingo Logan did not offer any new

proposed mining configurations in response to EPA's Recommended Determination.

EPA believes that companies can design their operations to make them more sustainable and compliant with the law. Last year, EPA worked closely with a mining company in West Virginia to eliminate nearly 50 percent of their water impacts and reduce contamination while at the same time increasing their coal production. These are the kinds of success stories that can be achieved through collaboration and willingness to reduce the impact on mining pollution on our waters. Those changes helped permanently protect local waters, maximize coal recovery and reduce costs for the operators.

EPA's decision to stop mining waste discharges to high quality streams at the Spruce No. 1 mine was based on several major environmental and water quality concerns. The proposed mine project would have:

- Disposed of 110 million cubic yards of coal mine waste into streams.
- Buried more than six miles of high-quality streams in Logan County, West Virginia with millions of tons of mining waste from the dynamiting of more than 2,200 acres of mountains and forestlands.
- Buried more than 35,000 feet of high-quality streams under mining waste, which will eliminate all fish, small invertebrates, salamanders, and other wildlife that live in them.
- Polluted downstream waters as a result of burying these streams, which will lead to unhealthy levels of salinity and toxic levels of selenium that turn fresh water into salty water. The resulting waste that then fills valleys and streams can significantly compromise water quality, often causing permanent damage to ecosystems and streams.
- Caused downstream watershed degradation that will kill wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms.
- Inadequately mitigated for the mine's environmental impacts by not replacing streams being buried, and attempting to use stormwater ditches as compensation for natural stream losses.

Additionally, during the permitting process there was a failure to consider cumulative watershed degradation resulting from past, present, and future mining in the area.

Finally, EPA's decision prohibits five proposed valley fills in two streams, Pigeonroost Branch, and Oldhouse Branch, and their tributaries. Mining activities at the Spruce site are underway in Seng Camp Creek as a result of a prior agreement reached in the active litigation with the Mingo Logan Coal Company. EPA's Final Determination does not affect current mining in Seng Camp Creek.

Background on Clean Water Act Section 404(c)

Clean Water Act Section 404(c) authorizes EPA to restrict or prohibit

placing dredged or fill material in streams, lakes, rivers, wetlands and other waters if the agency determines that the activities would result in “unacceptable adverse effects” to the environment, water quality, or water supplies. This authority applies to proposed projects as well as projects previously permitted under the Clean Water Act although EPA is not considering such action for other previously permitted projects.

With today’s action, EPA has exercised its Section 404(c) authority only 13 times in its history of the CWA. EPA recognizes the importance of ensuring that its Section 404(c) actions are taken only where environmental impacts are truly unacceptable and will use this authority only where warranted by science and the law.

For a copy of the Final Determination:
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/ 404c_index.cfm

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Spruce No. 1 Mine Final Determination 011311.pdf

Final Determination of the U.S. Environmental Protection Agency
Pursuant to § 404(c) of the Clean Water Act
Concerning the Spruce No. 1 Mine, Logan County, West Virginia

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I. Executive Summary

This document explains the basis for the US Environmental Protection Agency (EPA) Clean Water Act § 404(c) Final Determination to withdraw the specification of Pigeonroost Branch, Oldhouse Branch and their tributaries, all of which are waters of the United States within Logan County, West Virginia, as a disposal site for dredged or fill material in connection with construction of the Spruce No. 1 Surface Mine, as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) (DA Permit).[1] This Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine. The DA Permit was issued by the US Army Corps of Engineers, Huntington District (Corps) in January 2007, authorizing the Mingo Logan Coal Company to construct six valley fills, associated sediment structures, and other discharges of fill material to the Right Fork of Seng Camp Creek, Pigeonroost Branch, Oldhouse Branch, and their tributaries. If fully constructed, the project will disturb approximately 2,278 acres (about 3.5 square miles) and bury approximately 7.48 miles of streams beneath 110 million cubic yards of excess spoil. This is among the largest individual surface mines ever authorized in West Virginia.

Under § 404(c) of the Clean Water Act, EPA is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site whenever EPA determines that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. EPA is taking this action under § 404(c) of the Clean Water Act because the discharges associated with the DA Permit in Pigeonroost Branch, Oldhouse Branch and their tributaries will have unacceptable adverse effects on wildlife. In addition, the impacts downstream due to the destruction of those streams will result in unacceptable adverse impacts to wildlife and also warrant EPA's action under § 404(c).

The project, as permitted, will bury 6.6 miles of Pigeonroost Branch, Oldhouse Branch, and their tributaries under excess spoil generated by surface coal mining operations.[2] These streams represent some of the last remaining least-disturbed, high quality stream and riparian resources within the Headwaters Spruce Fork sub-watershed and the Coal

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[1] While the permit also authorizes construction of valley fills and other discharges to the Right Fork of Seng Camp Creek and its tributaries, EPA is not withdrawing specification of those waters, in part because some of those discharges have already occurred and because the stream resources in Right Fork of Seng Camp Creek were subject to a higher level of historic and ongoing human disturbance than those found in Pigeonroost Branch or Oldhouse Branch. Due to litigation and an agreement with environmental groups, represented by Ohio Valley Environmental Coalition, operations following the issuance of this DA Permit have been limited to the Seng Camp Creek watershed, and as part of that agreement one valley fill is partially constructed.

[2] As noted above, the permit authorizes the filling of approximately 7.48 total miles of stream. For the reasons in footnote 1, EPA's Final Determination only addresses the approximately 6.6 miles of Pigeonroost Branch, Oldhouse Branch and their tributaries subject to the DA Permit.

River sub-basin and contain important wildlife resources and habitat. The quality of these streams is comparable to a West Virginia-designated reference site, and the macroinvertebrate communities found in these streams, which are used as an indicator of quality, rank extremely high in comparison to other streams throughout the Central Appalachia ecoregion and the state of West Virginia. These streams perform critical hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role within the context of the overall Headwaters Spruce Fork sub-watershed and Coal River sub-basin.

Unacceptable adverse impacts to Pigeonroost Branch, Oldhouse Branch, and their tributaries include the direct burial of 6.6 miles of high quality stream habitat, including all wildlife in this watershed that utilize these streams for all or part of their life cycles (e.g., macroinvertebrate, amphibian, fish, and water-dependent bird populations). Streams within the Central Appalachian ecoregion have some of the greatest aquatic animal diversity of any area in North America, including one of the richest concentrations of salamander fauna in the world, as well as many endemic and rare species of mayflies, stoneflies and caddisflies. In fact, Pigeonroost Branch and Oldhouse Branch contain extremely high mayfly and stonefly diversity, both within the Central Appalachian ecoregion and within the state of West Virginia. With their adjacent riparian areas, these streams provide important habitat for 84 taxa of macroinvertebrates, up to 46 species of amphibians and reptiles, 4 species of crayfish, and 5 species of fish, as well as birds, bats, and other mammals. As some of the last remaining high quality, least-disturbed headwater stream habitat within the sub-basin, these streams not only support resident wildlife, but also provide ecosystem functions for downstream waters, serve as refugia for aquatic life and potential sources for recolonizing nearby waters, and ultimately serve to maintain the aquatic ecosystem integrity in the sub-basin and the rich animal diversity in the ecoregion.

Burial of Pigeonroost Branch and Oldhouse Branch and their tributaries will also result in unacceptable adverse effects on wildlife downstream through the transformation of the buried areas into sources of pollution that will contribute contaminants to downstream waters and the removal of functions performed by the buried streams. Based on recent peer-reviewed literature, as well as available data from adjacent mine sites and from the active portion of the Spruce No. 1 Surface Mine, EPA has concluded that the full construction of the Spruce No. 1 Surface Mine will transform these headwater streams from high quality habitat into sources of pollutants (particularly total dissolved solids and selenium) that will travel downstream and adversely impact the wildlife communities that utilize these downstream waters. Increased pollutant levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. Through the loss of stream macroinvertebrate communities, there will be, in turn, substantial effects on fish, amphibian, and bird populations that rely on these communities as a food source.

Furthermore, the increased loading of pollutants to downstream receiving waters increases the potential for harmful golden algal blooms, while increased selenium

exposure will result in impaired salamander populations and adverse effects to the reproduction of fish and bird species, thus harming the ability of these local populations to rebound. It is well recognized that the loss of a certain number of individuals of a species in a local ecological community can be tolerated, provided that the species continues to reproduce to replace lost individuals. However, when species are impacted by both acute stressors (e.g., food web changes, algal blooms) and exposure to reproductive toxicants, there is an increased risk of the loss of an entire species within an area. The loss of macroinvertebrate prey populations, increased risk of harmful golden algal blooms, and additional exposure to selenium will have an unacceptable adverse effect on the 26 fish species found in Spruce Fork as well as amphibians, crayfish, and bird species that depend on downstream waters for food or habitat.

The watersheds the project is located in, the Headwaters Spruce Fork sub-watershed and the larger Coal River sub-basin, have been heavily impacted by mining and the streams within this watershed have experienced substantial impairment. Currently, there have been more than 257 past and present surface mining permits issued in the Coal River sub-basin, and the corresponding mines collectively occupy more than 13% of the land area. In the Headwaters Spruce Fork sub-watershed, more than 34 past and present surface mine permits have been issued, and the corresponding mines collectively occupy more than 33% of the land area. If constructed as permitted, the project will occupy an additional 2.8% of the Headwaters Spruce Fork sub-watershed land area, and burial of Pigeonroost Branch, Oldhouse Branch and their tributaries will destroy 5.6% of the streams within the sub-watershed.

As least-disturbed streams in a watershed largely affected by mining, Pigeonroost Branch, Oldhouse Branch and their tributaries represent a high-value resource for the wildlife within the watershed. The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by these streams, including maintenance of biologically diverse wildlife habitat, and will critically degrade the chemical and biological integrity of downstream waters. Because the project will have unacceptable adverse effects on these high quality wildlife resources, EPA believes it is appropriate to withdraw specification to ensure the protection of these resources from discharges of dredged or fill material authorized under this DA permit.

Throughout the history of the Spruce No. 1 Surface Mine DA permit, EPA has raised concerns regarding adverse impacts to the environment. Additional data and information, including peer-reviewed scientific studies of the ecoregion, have become available since permit issuance. The peer-reviewed literature now reflect a growing consensus of the importance of headwater streams; a growing concern about the adverse ecological effects of mountaintop removal mining, specifically with regard to the effects of elevated levels of total dissolved solids discharged by mining operations on downstream aquatic ecosystems; and concerns that impacted streams cannot be easily recreated or replaced. These advances in understanding support EPA's long-standing concerns about this project regarding the potential for unacceptable adverse effects on wildlife, adverse water quality impacts, significant cumulative effects, as well as the shortcomings in avoidance,

minimization, and compensatory mitigation measures designed to reduce environmental impacts from the project.

On April 2, 2010, EPA Region III published in the Federal Register a Proposed Determination to prohibit, restrict or deny the specification or the use for specification (including withdrawal of specification) of certain waters at the project site as disposal sites for the discharge of dredged or fill material for the construction of the Spruce No. 1 Surface Mine. EPA Region III took this step because it believed that discharges authorized by the DA Permit would result in a significant loss of wildlife habitat and also cause significant degradation of downstream aquatic ecosystems and therefore could have unacceptable adverse effects on wildlife. A public hearing regarding the Proposed Determination was conducted on May 18, 2010. EPA Region III received more than 100 oral comments and more than 50,000 written comments both supporting and opposing its Proposed Determination.

On September 24, 2010, U.S. Environmental Protection Agency (EPA) Region III submitted to EPA Headquarters its Recommended Determination that the specification embodied in DA Permit No. 199800436-3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged or fill material for construction of the Spruce No. 1 Surface Mine be withdrawn. EPA Region III based this recommendation upon a conclusion that the discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch for the purpose of constructing the Spruce No. 1 Surface Mine as authorized would likely have unacceptable adverse effects on wildlife.

The U.S. Fish and Wildlife Service (USFWS), in its comments on both the Proposed and Recommended Determinations, concurred with EPA Region III's conclusion that the project, as authorized, would result in unacceptable adverse effects on wildlife and that this conclusion is supported by the available scientific information. USFWS also notes that it has consistently expressed concerns regarding the loss of headwater streams and adjacent riparian and terrestrial habitats associated with the Spruce No. 1 Surface Mine, as well as its likely impacts on downstream water quality, aquatic organisms, and terrestrial and aquatic wildlife that depend on those resources.

Following review of the public comments received, the past and new scientific data, and EPA Region III's Recommended Determination, EPA Headquarters has concluded that the discharge of dredged or fill material to Pigeonroost Branch, Oldhouse Branch, and their tributaries, in connection with the construction of valley fills and sediment ponds, as authorized by DA Permit No. 199800436-3 (Section 10: Coal River), will result in unacceptable adverse effects on wildlife. The administrative record developed in this case fully supports the conclusion that the Spruce No. 1 Surface Mine will have unacceptable adverse effects to wildlife, due to the filling of Pigeonroost and Oldhouse Branch, and their tributaries. In addition, the administrative record demonstrates that the Spruce No. 1 Surface Mine will have unacceptable adverse effects on wildlife downstream of the project site.

Furthermore, these adverse impacts do not comply with the requirements of the Clean Water Act (CWA) and EPA's implementing regulations under § 404(b)(1). EPA has determined that the Spruce No. 1 Surface Mine fails to adequately evaluate less environmentally damaging alternatives, will cause or contribute to significant degradation of waters of the United States (especially when considered in the context of the significant cumulative losses and impairment of streams across the Central Appalachian ecoregion), and lacks compensatory mitigation to adequately offset the impacts to Pigeonroost Branch and Oldhouse Branch. These failures to comply with the Guidelines serve to strengthen EPA's judgment about the unacceptability of the significant adverse impacts that will occur.

Based on these findings and pursuant to § 404(c) of the CWA, this Final Determination withdraws the specification of Pigeonroost Branch, Oldhouse Branch, and their tributaries, as described in DA Permit No. 199800436-3 (Section 10: Coal River), as a disposal site for the discharge of dredged or fill material for the purpose of construction of the Spruce No. 1 Surface Mine. This Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine.

II. Introduction

The purpose of the Clean Water Act is to “restore and maintain the physical, chemical, and biological integrity of the Nation’s waters” (33 U.S.C. 1251(a)). The Act also defines "pollution" as "the man made or man induced alteration of the chemical, physical, biological, and radiological integrity of water" (33 U.S.C. § 1362(19)). The Supreme Court has recognized "[t]his broad conception of pollution--one which expressly evinces Congress' concern with the physical and biological integrity of water" (*PUD No. 1 of Jefferson County v. Washington Dep't of Ecology*, 511 U.S. 700, 719 (1994)). Over the years, various definitions have been given to the term "biological integrity." The working definition that has been in place since 1981 is: "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region." (http://www.epa.gov/bioindicators/html/biointeg.html). This definition includes protection of macroinvertebrate communities, as well as fish populations. This goes beyond protecting the function performed by various members of the aquatic community and extends to protection of the quality of the aquatic community itself.

The CWA, 33 U.S.C. §§ 1251 et seq., prohibits the discharge of pollutants, including dredged or fill material, into waters of the United States (including wetlands) except in compliance with, among other provisions, § 404 of the CWA, 33 U.S.C. § 1344. Section 404 authorizes the Secretary of the Army (Secretary), acting through the Chief of Engineers, to authorize the discharge of dredged or fill material at specified disposal sites. This authorization is conducted, in part, through the application of environmental guidelines developed by EPA, in conjunction with the Secretary, under § 404(b) of the CWA, 33 U.S.C. § 1344(b) (§ 404(b)(1) Guidelines). Section 404(c) of the CWA, 33 U.S.C. § 1344(c), authorizes the EPA to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site. EPA is authorized to restrict or deny the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever it determines, after notice and opportunity for public hearing, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas.

The procedures for implementation of § 404(c) are set forth in 40 CFR Part 231. Under those procedures, if the Regional Administrator has reason to believe that use of a site for the discharge of dredged or fill material may have an unacceptable adverse effect on one or more of the aforementioned resources, he may initiate the § 404(c) process by notifying the U.S. Army Corps of Engineers and the applicant (and/or project proponent) that he intends to issue a Proposed Determination. Each of those parties then has fifteen days to demonstrate to the satisfaction of the Regional Administrator that no unacceptable adverse effects will occur, or that corrective action to prevent an unacceptable adverse effect will be taken. If no such information is provided to the Regional Administrator, or if the Regional Administrator is not satisfied that no unacceptable adverse effect will occur, the Regional Administrator will publish a notice

in the Federal Register of his Proposed Determination, soliciting public comment and offering an opportunity for a public hearing.

The procedures provide that the Regional Administrator will decide whether to withdraw the Proposed Determination or prepare a Recommended Determination following the public hearing and the close of the comment period. A decision to withdraw may be reviewed at the discretion of the Assistant Administrator for Water at EPA Headquarters. If the Regional Administrator prepares a Recommended Determination, the recommendation and the administrative record compiled in the Regional Office is forwarded to the Assistant Administrator for Water at EPA Headquarters. The Assistant Administrator for Water makes the Final Determination affirming, modifying, or rescinding the Recommended Determination.[3]

This document explains the basis for the EPA Final Determination to withdraw the specification of Pigeonroost Branch, Oldhouse Branch and their tributaries, all of which are waters of the United States within Logan County, West Virginia, as a disposal site for dredged or fill material in connection with construction of the Spruce No. 1 Surface Mine (hereafter "Spruce No. 1 Mine" or "the project") as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) (hereafter "DA permit").[4] While the permit also authorizes construction of valley fills and other discharges to the Right Fork of Seng Camp Creek and its tributaries, EPA is not withdrawing specification of those waters, in part because some of those discharges have already occurred and because the stream resources in Right Fork of Seng Camp Creek were subject to a higher level of historic and ongoing human disturbance than those found in Pigeonroost Branch or Oldhouse Branch.

EPA is taking this action under § 404(c) of the Clean Water Act because the discharges to Pigeonroost Branch and Oldhouse Branch and their tributaries for the purpose of constructing Spruce No. 1 Mine as authorized by the permit will have unacceptable adverse effects on wildlife. Pigeonroost Branch and Oldhouse Branch and their tributaries are some of the last remaining streams within the Headwaters Spruce Fork sub-watershed and the larger Coal River sub-basin that represent "least-disturbed" conditions.[5] As such, they perform important hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role within the context of the overall Headwaters Spruce Fork sub-watershed and Coal River sub-basin. Within the streams and riparian areas of the project area, over 84 taxa of macroinvertebrates are

[3] In 1984, the EPA Administrator delegated the authority to make final decisions under § 404(c) to EPA's national Clean Water Act § 404 program manager, who is the Assistant Administrator for Water. That delegation remains in effect.

[4] As stated in the Section VII, this Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 Mine.

[5] Least-disturbed conditions reflect a type of reference condition, where these sites have less human disturbance than others and represent the best existing condition within a watershed (Stoddard et al. 2006).

documented to exist, as well as up to 46 species of reptiles and amphibians, 4 species of crayfish, 5 species of fish and at least one water-dependent bird species.

The construction of Spruce No. 1 Mine as authorized will bury virtually all of Oldhouse Branch and its tributaries and much of Pigeonroost Branch and its tributaries under excess spoil generated by surface coal mining operations. These discharges will result in the burial of approximately 6.6 miles of high quality Appalachian headwater streams in a watershed that has already experienced substantial impairment. The loss of the 6.6 miles of high quality Appalachian headwater streams in this watershed will result in a significant loss (over 5.6% of the total stream miles in Headwaters Spruce Fork sub-watershed) of valuable wildlife habitat for many species in this watershed. These direct impacts will result in unacceptable adverse impacts to wildlife in this watershed, within the project boundaries.

Beyond the direct burial of wildlife species and loss of high quality habitat in this watershed, EPA has also determined that the project will result in unacceptable adverse impacts on downstream wildlife. If constructed as permitted, the Spruce No. 1 Mine will result in increased pollutant loadings in Spruce Fork and the Little Coal River. Increased salinity levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. In addition to these unacceptable adverse impacts, loss of macroinvertebrate prey populations, combined with increased potential for harmful golden algal blooms and additional exposure to selenium will have an unacceptable adverse effect on the 26 fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on aquatic organisms and downstream waters for food or habitat.

In addition, EPA has given consideration to the project's compliance with the § 404(b)(1) Guidelines. As stated in the Preamble to the § 404(c) regulations, "one of the basic functions of 404(c) is to police the application of the 404(b)(1) Guidelines" (44 FR 58076, 58078 (Oct. 9, 1979)). Accordingly, EPA has determined that the Spruce No. 1 Mine, as permitted,

- fails to adequately evaluate less environmentally damaging alternatives (for a non-water dependent project such as this one, a failure to adequately evaluate alternatives means that the applicant has failed to rebut the presumption that there are less environmentally damaging practicable alternatives available);
- will cause or contribute to significant degradation of waters of the United States (especially when considered in the context of the significant cumulative losses and impairment of streams across the Central Appalachian ecoregion); and
- lacks compensatory mitigation to offset the impacts to Pigeonroost Branch and Oldhouse Branch to below the level of significance.

These inconsistencies with the Guidelines provide additional support for EPA's conclusion that the adverse impacts are unacceptable.

This document is divided into seven sections. The next section, Section III., describes the Spruce No. 1 Mine as authorized and summarizes the history of the project. Section IV.

describes the environmental characteristics of the project area, specifically Pigeonroost Branch and Oldhouse Branch, and the overall Coal River sub-basin. Section V. examines the anticipated impacts from the Spruce No. 1 Mine, as authorized. Consistent with § 404(c), this discussion focuses on unacceptable adverse impacts to wildlife. Section VI. discusses other considerations, including impacts from activities associated with the Spruce No. 1 Mine that do not include direct discharges of dredged or fill material to jurisdictional waters but which may depend upon authorization of such discharges, and that are likely to cause direct, indirect, and cumulative effects to the environment and to local communities. Section VII. contains EPA's Final Determination.

III. Background

III.A. Project Description

According to the Environmental Impact Statement (EIS) prepared by the Corps in 2006 (Spruce No. 1 EIS) for the project, the Spruce No. 1 Mine is a mountaintop mining project targeting bituminous coal seams overlying and including the Middle Coalburg coal seam in the western portion of the project area. In the eastern portion of the project area, mountaintop mining would be limited to those seams including and overlying the Upper Stockton seam, with contour mining in conjunction with auger and/or highwall/thin-seam mining utilized to recover the Middle Coalburg seam.

The project is located in the East District of Logan County, West Virginia at Latitude 38°52'39" and Longitude 81°47'52" depicted on the United States Geological Survey 7.5-minute Clothier and Amherstdale Quadrangles (Figure 1). The mine site is located approximately two miles northeast of the town of Blair in Logan County, West Virginia.

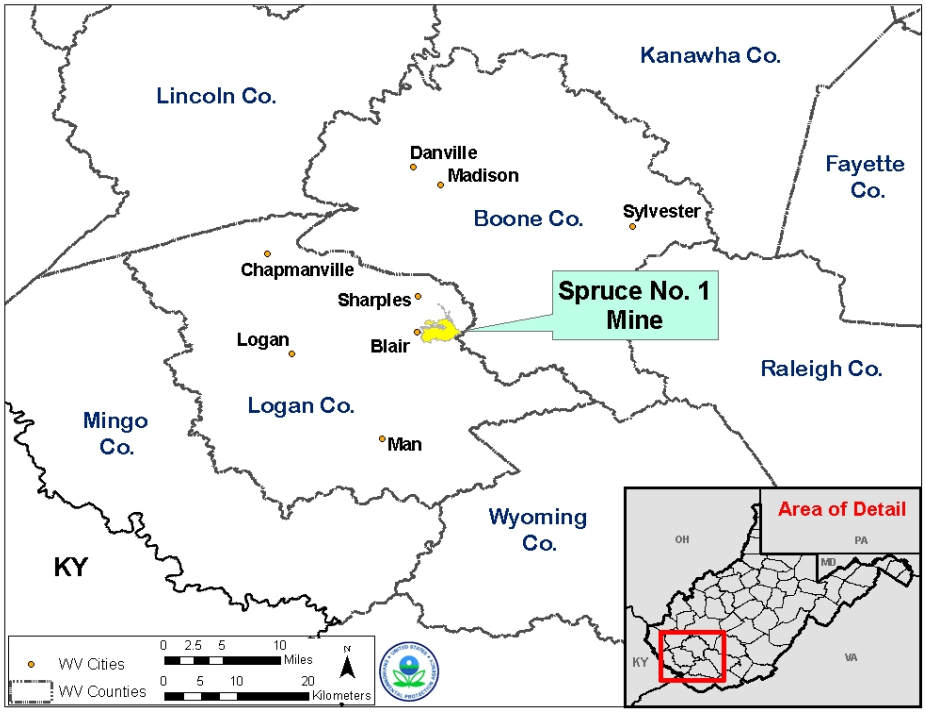

Figure 1. Spruce No. 1 Mine location

The Spruce No. 1 Mine as authorized by DA Permit No. 199800436-3 (Section 10: Coal River), is one of the largest mountaintop mining projects ever authorized in West Virginia. As authorized, it will disturb approximately 2,278 acres (about 3.5 square miles) and bury approximately 7.48 miles of streams. By way of comparison, the project area would take up a sizeable portion of the downtown area of Pittsburgh, PA (Figure 2).

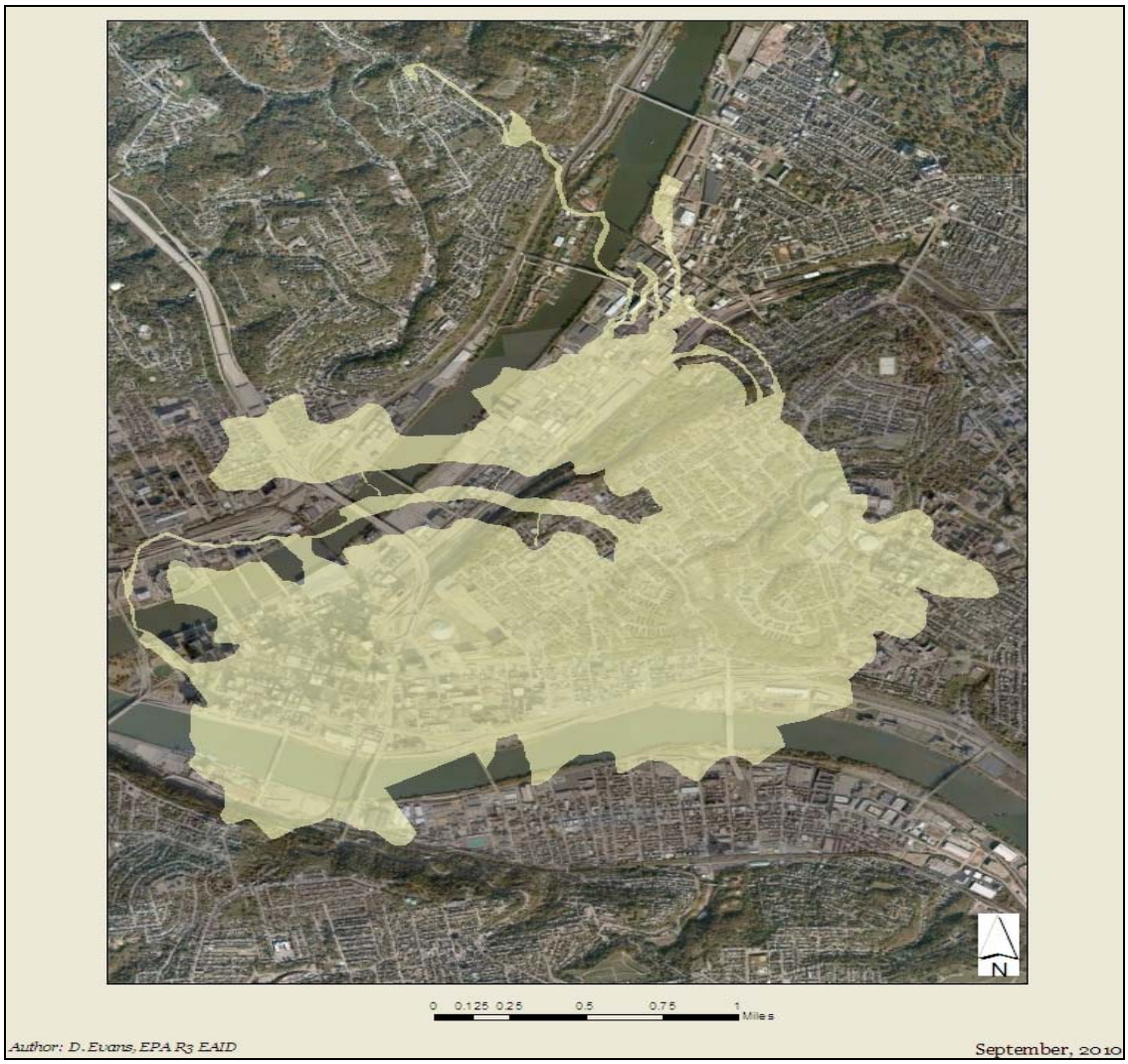

Figure 2. Spruce No. 1 Mine compared to downtown Pittsburgh, PA

Mountaintop mining involves removing the top of a mountain to recover coal seams contained within the mountain. Explosives are used to break apart the mountain's bedrock and earth-moving equipment is used to remove the excess rock, topsoil and debris, called “spoil”, which formerly had composed the portions of the mountain above and immediately below the coal seam. The fractured material is larger in volume than when it was consolidated bedrock within the mountain. The amount of spoil that may be placed back on the mined area is limited by this “swell” in volume, as well as by stability concerns. As a result, mountaintop mining generates large quantities of "excess spoil" that cannot be placed back in the mined area. The “spoil” is then typically deposited in adjacent valleys, thereby burying streams that flow through those valleys.

The Spruce No. 1 Mine EIS describes the project impacts as a disturbance of a total of 2,278 acres to recover seventy-five percent (75%) of the coal reserve targeted for extraction within the project area during fifteen (15) phases. The mining process would remove 400 to 450 vertical feet from the height of the mountain, or approximately 501 million cubic yards of overburden material. Nearly 391 million cubic yards of spoil

would be placed within the mined area (i.e., back onto the mountains) and the remaining 110 million cubic yards of excess spoil would be placed in six valley fills, burying all or portions of the Right Fork of Seng Camp Creek, Pigeonroost Branch, and Oldhouse Branch and their tributaries (hereafter, references to Seng Camp Creek, Pigeonroost Branch, and Oldhouse Branch also include all tributaries to those waters that will be impacted by the project as authorized). Specifically, the permit authorizes construction of Valley Fills 1A and 1B in Seng Camp Creek; Valley Fills 2A, 2B, and 3 in Pigeonroost Branch; and Valley Fill 4 in Oldhouse Branch, and numerous sediment ponds, mined-through areas and other fills in waters of the U.S. (Figure 3). A detailed discussion of Spruce No. 1 Mine can be found in the Spruce No. 1 EIS on pages 2-35 through 2-61.

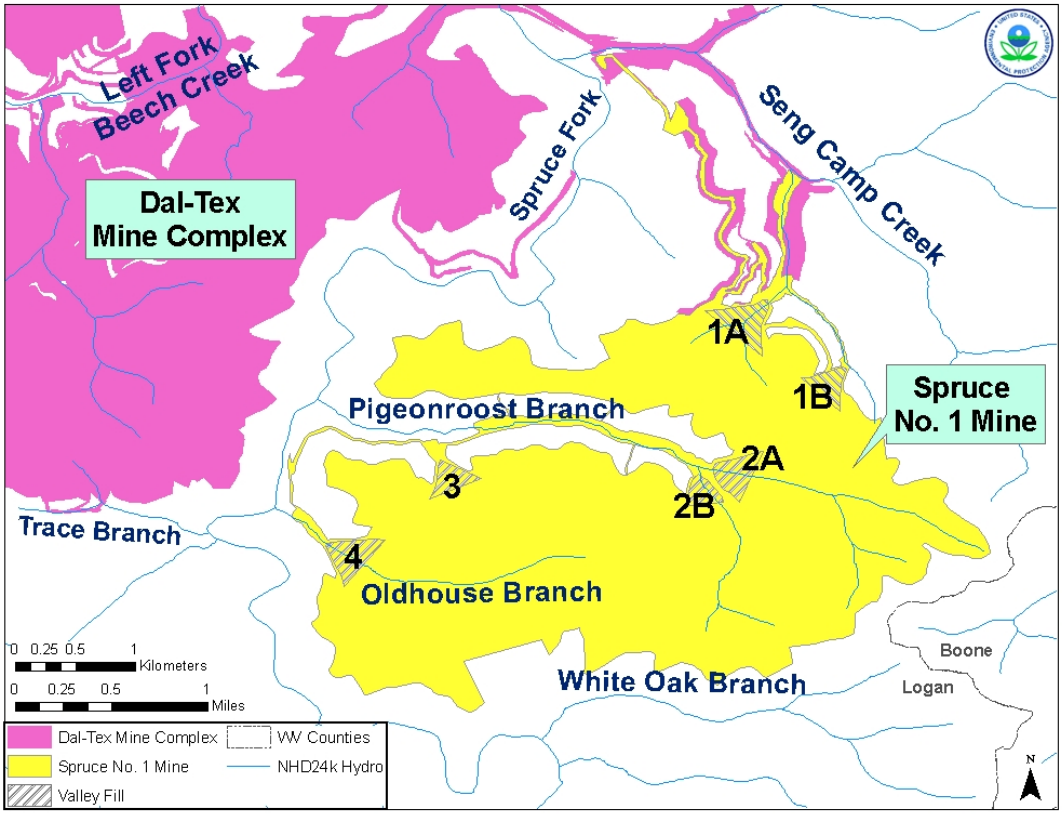

Figure 3. Spruce No. 1 Mine and associated valley fills

The Spruce No.1 Mine Surface Mining Control and Reclamation Act (SMCRA) Permit S-5013-97, Incidental Boundary Revision (IBR4, Modification 11) describes impacts from the project as including placement of dredged and fill material into approximately:

- 0.12 acre of emergent wetlands
- 10,630 linear feet (2.01 miles) of ephemeral stream channels
- 28,698 linear feet (5.44 miles) of intermittent stream channels
- 165 linear feet (0.03 miles) of perennial stream channel

While EPA is providing the foregoing summary from the SMCRA Permit S-5013-97 IBR for descriptive purposes, EPA believes that the description provided in the Spruce No. 1 Mine SMCRA Permit and in the Spruce No. 1 EIS incorrectly characterizes over 5 miles of stream resources that will be impacted, as set forth in more detail in Section V.E.3.b. and in Appendix 3.

III.B. Project History

The Spruce No. 1 Mine has a lengthy and complex regulatory history. The project was originally proposed by Hobet Mining Inc., a subsidiary of Arch Coal, Inc. The project as originally proposed in 1998 was larger than the authorized project and would have directly impacted a total surface area of 3,113 acres and 57,755 linear feet (more than ten miles) of streams. At that time, the Corps tendered and ultimately withdrew a nationwide permit for the project, and Hobet Mining, Inc. advised the Corps it would submit an individual permit application. An EIS was prepared for the Spruce No. 1 Mine by the Army Corps of Engineers Huntington District pursuant to the National Environmental Policy Act, 42 U.S.C. 4332(C). The original project application was also a primary impetus for the Interagency Mountaintop Mining/Valley Fills in Appalachia Programmatic Environmental Impact Statement (PEIS), which was finalized in October 2005. The PEIS is available at www.epa.gov/Region3/mtntop/eis2005.htm.

An initial 2002 Spruce No. 1 Mine Draft EIS considered a proposed project that was similar in scope and size to the original project described above. EPA's review of the 2002 Draft Environmental Impact Statement found gaps in the analyses of the mine and related adverse environmental impacts. EPA was particularly concerned by the lack of information regarding the nature and extent of impacts to the high quality streams that would be buried under valley fills, and recommended additional evaluation to support the analysis of less environmentally damaging alternatives. In a letter dated August 12, 2002, EPA Region III indicated the EIS contained inadequate information for public review and for decision-makers.

Following the transfer of the Spruce No. 1 Mine holdings and responsibilities by Arch Coal, Inc. to its Mingo Logan Coal Company (hereafter Mingo Logan or "permittee") in late 2005, a revised Spruce No. 1 Mine Draft EIS was prepared in 2006. At that time, the project was reconfigured to reduce impacts. The mine plan was revised to eliminate construction of a valley fill in White Oak Branch, a State-designated reference stream (see Section IV.A.) and the project area was reduced from 3,113 to 2,278 acres with direct stream impacts reduced to 7.48 miles.

In EPA's June 16, 2006, comment letter on the 2006 Draft EIS, EPA recognized that impacts from the mine had been reduced and the quality of EIS information had improved. However, the letter also noted that EPA had remaining environmental concerns associated with the Spruce No. 1 Mine. These concerns included potential adverse impacts to water quality (specifically, the potential to discharge selenium and the known association of similar mining operations with degradation of downstream aquatic communities); uncertainties regarding the proposed mitigation; the need for additional

analysis of potential environmental justice issues; and the lack of a study related to the cumulative effects of multiple mining operations within the Little Coal River watershed. EPA continued to stress its belief that corrective measures should be required to reduce environmental impacts and that other identified information, data, and analyses should be included in the final EIS.

Concerns regarding the Spruce No. 1 Mine were also raised by the USFWS, Ecological Services West Virginia Field Office in a letter dated May 30, 2006 from the Department of Interior, Philadelphia to the Huntington District Army Corps of Engineers. In that letter, the USFWS expressed concerns over the permittee's compensatory mitigation plan. The USFWS stated there was inadequate compensatory mitigation for the project because the assessment methodology used by the permittee to evaluate stream impacts considered only the physical characteristics of the impacted streams, without considering the equally important biological or chemical characteristics. The USFWS expressed concern the project would impact healthy, biologically functional streams and the mitigation included erosion control structures that were designed to convey water but would not replace the streams' lost ecological services.

The Corps issued the Spruce No. 1 Mine Final EIS on September 22, 2006. On October 23, 2006, EPA commented on the Final EIS, noting that many of EPA's comments had not been adequately addressed. On January 22, 2007, the Corps issued Clean Water Act § 404 Permit, DA Permit No. 199800436-3 (Section 10: Coal River), to Mingo Logan for the Spruce No. 1 Mine. That permit specified the Right Fork of Seng Camp Creek, Pigeonroost Branch and its tributaries, and Oldhouse Branch and its tributaries as disposal sites for the discharge of dredged or fill material from the Spruce No. 1 Mine. In addition to its DA Permit No. 199800436-3 (Section 10: Coal River), the project has received the following authorizations from the West Virginia Department of Environmental Protection (WVDEP): authorization pursuant to the State's surface mining program approved under SMCRA, 30 U.S.C. 1201-1328 (SMCRA permit); a National Pollutant Discharge Elimination System (NPDES) permit for discharges of pollutants pursuant to § 402 of the Clean Water Act (33 U.S.C. 1342); and a Clean Water Act § 401 water quality certification (33 U.S.C. 1341).

On January 30, 2007, a number of environmental groups, represented by Ohio Valley Environmental Coalition, filed a complaint against the Corps in federal district court challenging its decision to issue the permit. In early 2007, Mingo Logan commenced limited operations at Spruce No. 1 Mine pursuant to DA Permit No. 199800436-3 (Section 10: Coal River), subject to an agreement with the environmental groups who are plaintiffs in the litigation. Pursuant to that agreement, Mingo Logan has been operating in a portion of the project site in the Seng Camp Creek drainage area, and has been constructing one valley fill in that area (valley fill 1A). Under the agreement, Mingo Logan must give plaintiffs 20 days' notice before expanding operations beyond the area subject to the agreement, and has done so once without objection from the plaintiffs. Mingo Logan's operations in the Seng Camp Creek watershed have generated data related to impacts from the project as constructed, including discharge monitoring reports submitted to WVDEP. The litigation filed by the environmental groups was stayed for a

period of time pending the U.S. Court of Appeals for the Fourth Circuit's decision in *Ohio Valley Environmental Coalition v. Aracoma Coal Co.*, 556 F. 3d 177 (4th Cir. 2009).

During this period, the scientific literature reflected a growing consensus of the importance of headwater streams; a growing concern about the adverse ecological effects of mountaintop removal mining; and concern that impacted streams cannot easily be recreated or replaced. This Final Determination cites to nearly 100 articles and studies developed since the time the Spruce No. 1 Mine DA permit was issued. Many studies now point to the role headwater streams play in the transport of water, sediments, organic matter, nutrients, and organisms to downstream environments; their use by organisms for spawning or refugia; and their contribution to regional biodiversity (Meyer et al. 2007). Additionally, destruction or modification of headwater streams has been shown to affect the integrity of downstream waters, in part through changes in hydrology, chemistry and stream biota (Freeman et al. 2007, Wipfli et al. 2007).

The literature specifically documenting the effects of mountaintop removal mining has also grown, and additional studies have increased EPA's understanding of the effects of elevated levels of total dissolved solids (TDS) discharged through mining operations on downstream aquatic ecosystems (Pond et al. 2008, Simmons et al. 2008, Palmer et al. 2010, Fritz et al. 2010). EPA's understanding of adverse effects from selenium associated with surface coal mining likewise has expanded since issuance of the permit. In February 2009, WVDEP issued out a report entitled: 'Selenium bioaccumulation among select stream and lake fishes in West Virginia.' The WVDEP report confirmed that significant environmental harm due to selenium was a problem in West Virginia. A January 2010 WVDEP report to the West Virginia legislature outlined the issues with selenium in West Virginia watersheds. Other studies that have contributed to a greater understanding of the adverse effects of selenium include additional investigations and discussions have continued increased selenium concerns including: (Chapman et al. 2009, Diehl et al. 2005, Ferreri et al. 2004, Lemly 2009, Palmer et al. 2010, Neuzil et al. 2005, Vesper et al. 2008).

In addition to the growing body of literature documenting the importance of headwater streams and the effects of mountaintop removal mining, additional information on the efficacy of mitigation has also been published. For example, recent research has shown that stream restoration projects based upon channel design can be problematic (Slate et al. 2007, Simon et al. 2007) and are not effective in restoring ecological function and biodiversity (Tullos et al. 2009, Palmer et al. 2009, Fritz et al. 2010). In a study on streams impacted by mountaintop mining and valley fills, Fritz et al. (2010) found that habitat features and aquatic assemblages were very different in constructed channels than natural channels, and suggested that constructed channels should not be used for mitigation on-site. In the 2008 Mitigation Rule, EPA and the Corps acknowledged that headwater streams are a difficult to replace resource and stream creation is among the more difficult and least successful forms of mitigation.

In light of this growing body of scientific data documenting the environmental impacts associated with surface coal mining, EPA and other federal agencies discussed opportunities to reduce those impacts under existing statutory and regulatory authorities. On June 11, 2009, EPA, the Department of the Army, and the Department of the Interior entered into a *Memorandum of Understanding Implementing the Interagency Action Plan on Appalachian Surface Coal Mining,* in which the agencies agreed to take steps to reduce the harmful environmental consequences of Appalachian surface coal mining.

On September 3, 2009, EPA Region III requested that the Corps suspend, modify or revoke DA Permit No. 199800436-3 (Section 10: Coal River) for discharges associated with the Spruce No. 1 Mine. On September 30, 2009, the Corps stated that it would not reconsider the permit authorization. As a result, EPA Region III initiated the Clean Water Act § 404(c) process on October 16, 2009. EPA Region III communicated with representatives of Mingo Logan and the Corps in person, by telephone, and by electronic mail on several occasions to determine whether corrective action would be taken to address EPA Region III's concerns. Earlier in 2009, litigation by the environmental groups had reactivated following the decision in *Ohio Valley Environmental Coalition v. Aracoma Coal Co.,* 556 F. 3d 177 (4th Cir. 2009). The litigation was then stayed until November 3, 2009, a deadline that would be further extended by the Court as EPA's CWA § 404(c) process proceeded.

On April 2, 2010, EPA Region III published in the Federal Register a Proposed Determination to withdraw specification of Pigeonroost Branch and Oldhouse Branch pursuant to CWA § 404(c). EPA Region III solicited public comments on the Proposed Determination and held a public hearing in Charleston, West Virginia on May 18, 2010 that was attended by 520 people, during which 121 oral comments were communicated to EPA. EPA Region III received over 50,000 comments on the Proposed Determination. Of these, approximately 70% of comment letters submitted on the Proposed Determination generally supported EPA's Proposed Determination while 65% of public hearing participants generally opposed EPA's Proposed Determination.

USFWS, in its comments on EPA Region III's Proposed and Recommended Determinations, supported the withdrawal of specification for discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch. Its June 2, 2009 comment letter on the Proposed Determination expressed concerns about potential impacts of the project on fish and wildlife resources, including macroinvertebrate genera. In addition, the letter stated

> "[T]he preponderance of available scientific information strongly suggests that construction of the project as authorized would cause or contribute to significant degradation of waters of the United States, both on-site and in receiving waters downstream of the proposed mine."
>
> "Some adverse impacts of the proposed project include:

- the likely loss of macroinvertebrate genera (diversity and abundance) and the cascading biological consequences of that loss on other aquatic and terrestrial wildlife;
- the direct loss of a significant number of salamanders, indirect effects to perhaps as many more, and the effects of these losses on other aquatic and terrestrial wildlife;
- degraded fish communities, including reduced diversity and abundance;
- direct loss of habitat, and direct and indirect loss of food resources for forest interior and riparian-obligate species of migratory birds, including six species the Service considers Birds of Conservation Concern (cerulean, Kentucky, Swainson's, and worm-eating warblers; Louisiana Waterthrush; wood thrush); and
- direct loss of habitat, and direct and indirect loss of food resources, for a variety of bat species, many of which are already threatened by the spread of white-nose syndrome in West Virginia and which may require additional protection in the near future."

EPA's regulations require that the Regional Administrator either withdraw the Proposed Determination or prepare a Recommended Determination within 30 days after the conclusion of the public hearing, in this case by June 16, 2010 (40 CFR 231.5(a)). However, in order to allow full consideration of the extensive record, including the over 50,000 public comments received, EPA Region III extended the time period provided in 40 CFR 231.5(a) for the preparation of the Recommended Determination until no later than September 24, 2010 (75 FR 39691). This time extension was made under authority of 40 CFR 231.8, which allows for such extensions upon a showing of good cause. EPA Region III reviewed the information provided during the public comment period, and completed its review within the extended time period.

The Recommended Determination was signed by the Regional Administrator and submitted to EPA Headquarters along with the complete administrative record on September 24, 2010, concluding EPA Region III's § 404(c) review of the Spruce No. 1 Mine. This action initiated the period for review and final action by EPA's Assistant Administrator for Water.

III.C. EPA Headquarters' Actions

Recognizing the role for EPA Headquarters in taking any final action to withdraw or restrict specification from the project, EPA Headquarters has been engaged in the § 404(c) review since it was initiated on October 16, 2009. Staff from EPA Headquarters attended the public hearing in Charleston, West Virginia, and heard first-hand the testimony provided by those who live and work in the region.

Following receipt of the Recommended Determination, § 404(c) regulations require EPA Headquarters to provide an opportunity for the project's proponents to propose corrective actions intended to prevent the unacceptable adverse environmental impacts presented in the Recommended Determination. EPA Headquarters provided the Region III

Recommended Determination to Arch Coal Inc., the United States Department of the Army, the Corps, WVDEP and four land and mineral rights owners and notified these stakeholders that they would have 15 days to present any corrective actions to EPA Headquarters, consistent with EPA's § 404(c) regulations.

EPA received a response from Hunton & Williams, LLP, on behalf of Arch Coal (i.e., Mingo Logan), Inc. requesting a 30-day extension of this period, to November 29, 2010, in order to review the Recommended Determination. Provided in 40 CFR 231.8, EPA may, upon showing of good cause, extend the time requirements in the § 404(c) regulations. EPA believed it was appropriate to grant the permittee's request for a 30-day extension to the consultation process, and an announcement was published in the Federal Register on November 10, 2010, announcing the deadline for proposing corrective actions was extended to November 29, 2010.

EPA's § 404(c) regulations provide that the Assistant Administrator for Water shall issue a Final Determination within 60 days of receiving the Regional Administrator's Recommended Determination. This 60-day period was scheduled to expire on November 23, 2010. As the consultation period with the permittee was extended to November 29, 2010, EPA believed it was necessary to extend the deadline for issuing a Final Determination until February 22, 2011. This extension was published in the same Federal Register announcement as the extension of the consultation period, and was intended to enable EPA to more carefully consider the Region's Recommended Determination, as well as the public comments received, and information on possible corrective actions presented during the consultation process. In addition, this date was consistent with an order issued by the U.S. District Court for the Southern District of West Virginia on November 2, 2010, granting a continued stay in litigation over the Spruce No. 1 permit until February 22, 2011.

EPA also received a response from one of the land and mineral rights owners, the United Company. In his November 9, 2010 letter to EPA, James McGlothlin, President of the United Company, expressed his opposition to the EPA Region III Recommended Determination and his belief that such an action would represent a "regulatory taking." Mr. McGlothlin's letter included a copy of a May 10, 2010, letter he had submitted to EPA Region III and a request that he be included in any consultation meeting organized by EPA Headquarters regarding EPA Region III's Recommended Determination on the Spruce No. 1 Mine.

On November 16, 2010, a consultation meeting was held at EPA Headquarters in Washington, DC to discuss the Region III Recommended Determination and potential corrective actions that could be undertaken to avoid the unacceptable adverse impacts that were of concern to EPA. Participants at the meeting included the EPA Assistant Administrator for Water, the EPA Region III Regional Administrator and Regional management, Office of Water staff, managers, and legal counsel, representatives from Arch Coal, Inc. and their legal counsel, United Company and their legal counsel, WVDEP, and the Corps' Huntington District.

At the beginning of the meeting, EPA Region III gave an overview of the Recommended Determination, stating that discharges of fill material into Pigeonroost Branch and Oldhouse Branch associated with the Spruce No.1 Mine would likely result in unacceptable adverse effects on wildlife. The EPA Assistant Administrator for Water then stated that a major purpose of the consultation process is to explore corrective actions that might avoid the need for a final § 404(c) action. He noted that while the Agency's regulations make clear that the consultation process is an opportunity for the project's proponents to propose corrective actions, EPA was willing and prepared to discuss potential actions that may effectively reduce anticipated environmental and water quality impacts.

In response, the permittee stated that revisions to the mine plan that Arch Coal, Inc. had previously proposed would be effective in reducing these potential water quality and environmental impacts. These actions included improved best management practices, eliminating two small valley fills at Seng Camp Creek and Pigeonroost Branch, and increased monitoring. The permittee also indicated that other approaches previously discussed, such as "sequencing" or "phasing" of valley fills, remained unacceptable to Arch Coal, Inc., due primarily to economic considerations. In the meeting, the permittee did not propose new or additional corrective actions for EPA's consideration.

As part of the follow-up from the consultation meeting, on November 22, 2010, the Assistant Administrator for Water sent a letter to Arch Coal, Inc. indicating that EPA was prepared to continue discussions regarding corrective actions that effectively reduce anticipated environmental and water quality impacts. The letter noted that EPA's focus in evaluating these alternatives would be on whether they would effectively protect the streams at Pigeonroost Branch and Oldhouse Branch. Noting that the consultation period was set to expire on November 29, 2010, the letter requested a response as soon as possible. On November 29, 2010, EPA received notification via email from Hunton & Williams, LLP, on behalf of Arch Coal, Inc. While this response did not request any further opportunity for consultation, it did include extensive comments, a Technical Evaluation Document and supporting information in response to the Recommended Determination.

EPA reviewed the additional comments, evaluation, and supporting documents provided by Hunton & Williams and, where necessary, clarified the relevant information and analysis in the Final Determination. EPA's detailed responses to the issues raised by Hunton & Williams are contained in Appendix 6. After an EPA Region has submitted a Recommended Determination to the Assistant Administrator for Water, EPA's regulations governing the § 404(c) process allow the company to submit information on corrective actions they intend to take to address the unacceptable adverse effects, but those regulations do not explicitly provide an additional opportunity to submit comments on EPA's action. In addition, EPA's Final Determination is an informal adjudication and unlike the Administrative Procedure Act's (APA) requirements for notice and comment rulemaking to respond to all significant comments, the APA contains no such requirement for adjudications. Nonetheless, consistent with the Agency's transparency goals, EPA has voluntarily chosen to draft responses to many of comments received

throughout this process, including those comments received on the Recommended Determination during the consultation process.

In his November 29, 2010 letter to EPA, Colonel Robert Peterson, District Engineer for the Corps' Huntington District, responded on behalf of LTG Robert Van Antwerp, Commanding General for the Corps. Colonel Peterson noted that after reviewing the Recommended Determination, the Corps continued to believe it has no basis to take any corrective actions regarding DA Permit No. 199800436-3 (Section 10: Coal River) and that this position is consistent with the Corps' response to EPA Region III's September 3, 2009 request that Huntington District suspend, modify or revoke this permit.

In a November 29, 2010 letter to EPA, Randy Huffman, the Secretary of WVDEP, provided comments on the Recommended Determination. The letter raised concerns regarding a number of issues in the Recommended Determination including its analysis of the project's potential effects on water chemistry, the project's likely impacts to wildlife and the conclusions drawn regarding the proposed compensatory mitigation. In response to these comments, a number of clarifications have been made to the information and analysis in the Final Determination and detailed responses to Secretary Huffman's comments have been included in Appendix 6.

Finally, on December 16, 2010, the USFWS sent a letter to EPA in support of the Recommended Determination. In the letter, USFWS states that the available scientific information supports the EPA Region III recommendation and that USFWS concurs with EPA Region III's conclusion that construction of the Spruce No. 1 Mine, as authorized, would result in unacceptable adverse effects on wildlife. The letter highlights the fact that the USFWS has consistently expressed concerns regarding the loss of headwater streams and adjacent riparian and terrestrial habitats associated with the Spruce No. 1 Mine, as well as its likely impacts on downstream water quality, aquatic organisms, and terrestrial and aquatic wildlife that depend on those resources.

IV. Site Characteristics and Ecological Functions

The resources that will be impacted by the Spruce No. 1 Mine include Central Appalachian headwater stream ecosystems in Pigeonroost Branch and Oldhouse Branch. These waters connect via surface flow directly to Spruce Fork, which in turn flows to the Little Coal River and eventually to the Coal River. Because of the connectivity between headwater systems and downstream waters, Spruce Fork, the Little Coal River and the Coal River would be adversely impacted by discharges to Pigeonroost Branch and Oldhouse Branch because such discharges would transform these streams into sources that contribute contaminants to these downstream waters. Accordingly, the characteristics and functions of the resources that will be adversely impacted by discharges of dredged or fill material associated with the Spruce No. 1 Mine are best viewed from the perspective of the ecological functions performed by Appalachian headwater stream ecosystems and within the context of the larger Headwaters Spruce Fork sub-watershed and Coal River sub-basin.

Information on the aquatic and terrestrial ecosystem and the predicted impacts of the project comes from several sources. The Final (October 2005) Interagency Mountaintop Mining/Valley Fills in Appalachia PEIS represents important inter-agency efforts designed to inform more environmentally sound decision-making for future permitting of mountaintop mining and associated valley fills. The PEIS had a geographic focus of 12 million acres encompassing most of eastern Kentucky, southern West Virginia, western Virginia, and scattered areas of eastern Tennessee; and included the Spruce No. 1 Mine project area and the Coal River sub-basin. EPA also incorporated information gathered by the WVDEP, including an assessment of the Coal River sub-basin conducted in 1997, data collected to support the 2006 Coal River sub-basin total maximum daily load (TMDL), and WVDEP and nationally available GIS data. EPA also reviewed the 2006 Spruce No.1 EIS, and other sources of site-specific data including studies conducted by EPA scientists and discharge monitoring reports generated by Mingo Logan. In addition, EPA consulted a wide range of peer reviewed studies and literature. EPA Region III also communicated with the US Fish and Wildlife Service Elkins Field Office on impacts to fish and wildlife resources in the project area.

Headwater streams play an important role in the ecosystem far beyond the mere transport of water from one point to another. In many ways, headwater streams are similar to capillaries, the smallest blood vessels within the human circulatory system. In the same way capillaries are critical to the movement of carbon dioxide, oxygen, water and other essential compounds between the blood and surrounding tissues, small headwater streams, which make up over two-thirds of the total stream length in a stream network (Leopold et al. 1964), are critically important to the movement of water, sediments, organic matter, and nutrients from within their watersheds to downstream environments (Ensign and Doyle 2006). And just as a loss of blood flow through capillaries can lead to organ failure, alteration of headwater streams has the potential to affect the ecological integrity of aquatic ecosystems at broad spatial scales (Freeman et al. 2007). Thus, headwater streams, as the early stages of the river continuum, provide the most basic and fundamental building blocks to the remainder of the aquatic environment.

Appalachian headwaters provide habitat for wildlife including a wide variety of macroinvertebrates, amphibians, reptiles, birds, fish and mammals. They also are a significant interface between the river system and the terrestrial environment. Appalachian headwater streams and their wildlife inhabitants, such as macroinvertebrates, convert organic matter (e.g., leaf litter) from the surrounding landscape and transform it into nutrients and energy that can be transported and consumed by downstream ecological communities. They also play an important role in storing, retaining and transporting nutrients, organic matter and sediment. In addition they perform hydrologic functions related to downstream flow regimes, moderating flow rate and temperature (USEPA 2003, Fischenich 2006).

As authorized, the Spruce No. 1 Mine will bury under valley fills or impact through construction of sediment ponds nearly all of Oldhouse Branch and its tributaries and a substantial portion of Pigeonroost Branch and its tributaries. Oldhouse Branch and Pigeonroost Branch support healthy ecosystems consistent with least-disturbed conditions in the Coal River sub-basin. As such, they are valuable in and of themselves and for the functions they perform within the context of the Headwaters Spruce Fork sub-watershed and the Coal River sub-basin.

IV.A. Watershed and Stream Conditions

The Spruce No. 1 Mine is located within the Headwaters Spruce Fork sub-watershed (12-digit hydrologic unit code (HUC)) and the Coal River sub-basin (8-digit HUC) (Figure 4). Pigeonroost Branch and Oldhouse Branch flow to Spruce Fork, which in turn flows into the Little Coal River and then into the Coal River. The Coal River sub-basin encompasses nearly 891 square miles within West Virginia. Major tributaries within the Coal River sub-basin include Marsh Fork, Clear Fork, Pond Fork, Spruce Fork, and Little Coal River. Marsh Fork and Clear Fork join at Whitesville, WV to form the Big Coal River. Pond Fork and Spruce Fork join at Madison, WV to form the Little Coal River. The Little Coal and Big Coal Rivers join to form the Coal River at Forks of the Coal, WV.

The Coal River sub-basin has been impacted by past and present surface mining. Based upon the National Land Cover Database (NLCD) Retrofit Land Cover Change Product for 1992-2001 and the WVDEP's Geographic Information System (GIS) mine permit data, more than 257 past and present surface mining permits have been issued in the Coal River sub-basin, and the corresponding mines collectively occupy more than 13% of the land area. Some sub-watersheds in the Coal River sub-basin have more than 55% of the land occupied by historic, ongoing or permitted surface mines.

Spruce Fork is a fourth order tributary that combines with Pond Fork to form the Little Coal River, which in turn flows into the Coal River. Spruce Fork is located in the southwestern portion of the Coal River sub-basin and drains approximately 126.4 square miles. The dominant land cover in the Headwaters Spruce Fork sub-watershed is forest. Other significant land cover types include urban/residential and barren/mining land.

According to the WVDEP Division of Mining and Reclamation permit maps, more than 34 surface mine permits have been issued within the Headwaters Spruce Fork sub-watershed, and the resulting mines do or will collectively occupy more than 33% of the land area. Assuming full construction of these projects along with projects associated with known future surface mining permits, more than 40% of the land area of the sub-watershed will be occupied by surface mining permits.

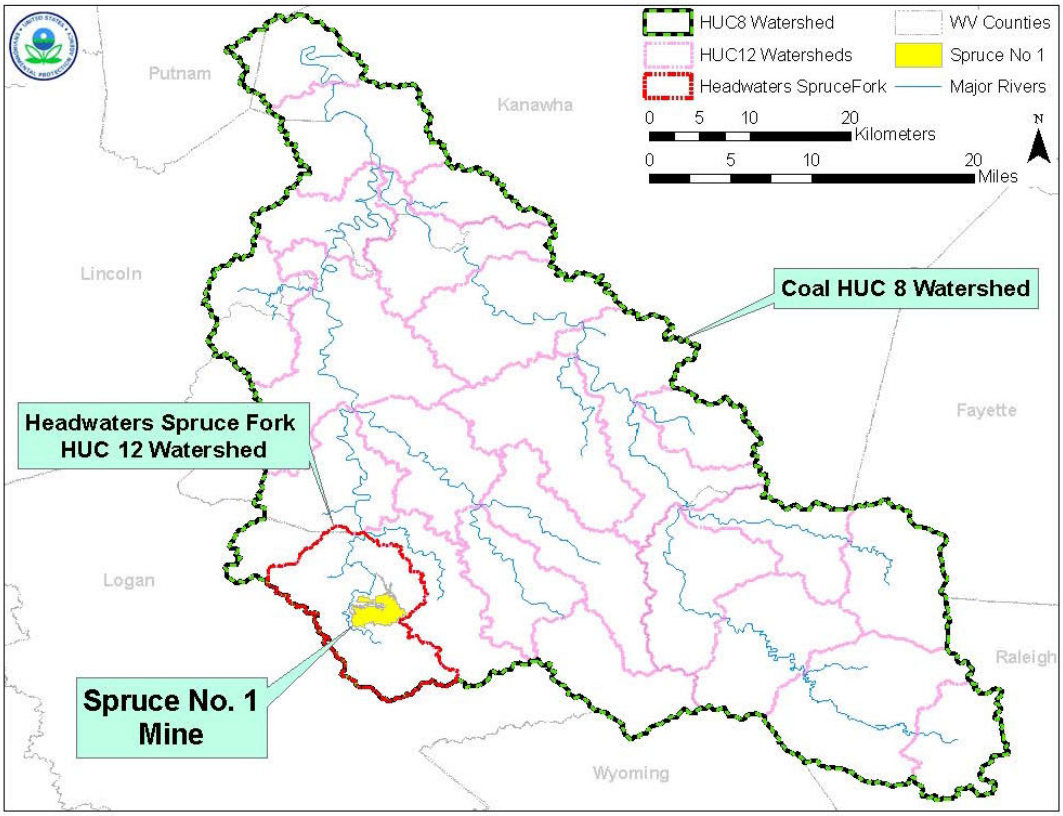

Figure 4. Headwaters Spruce Fork sub-watershed (12-digit hydrologic unit code (HUC)) and the Coal River sub-basin (8-digit HUC)

In 1997, the WVDEP performed its first comprehensive ecological assessment of the Coal River sub-basin.[6] The WVDEP assessed three major aspects of watershed health: water quality, habitat condition, and benthic macroinvertebrate community status. The subsequent report, *An Ecological Assessment of the Coal River Watershed* (1997), indicated that sediments, coal mining and inadequate sewage treatment were the major stressors on streams in this watershed. The WVDEP report also noted the importance and paucity of reference-quality streams in the watershed, stating

> [s]ince reference sites reflect least-disturbed conditions, it is vital that the WVDEP do its part in fulfilling the mission of preserving the high quality of these rare and important streams. It is also important that the agency make a concerted

[6] Report can be found at http://www.dep.wv.gov/WWE/watershed/wqmonitoring/Documents/EcologicalAssessments/EcoAssess_Coal_1997.pdf

> effort to find the apparently few remaining streams within the watershed that have not been significantly impacted by human disturbances.

Further the report indicated that because the sub-basin is becoming increasingly impaired due to stressors such as mining, there is a need to protect the remaining quality resources, highlighting the need to "[l]ocate and protect the few remaining high quality streams in the Coal River watershed…" (WVDEP 1997a).

Out of approximately 250 stations sampled by the WVDEP in the Coal River sub-basin since 1996, only 3 (~1%) are designated as reference sites. One of these three reference sites is White Oak Branch, which flows into Spruce Fork immediately upstream of Oldhouse Branch and Pigeonroost Branch. The WVDEP defines reference conditions as those conditions that "describe the characteristics of waterbody segments least impaired by human activities and are used to define attainable biological and habitat conditions. Final selection of reference sites depends on a determination of minimal disturbance, which is derived from physio-chemical and habitat data collected during the assessment of the stream sites." Reference sites are used to determine the score that represents the threshold between impaired and non-impaired sites. As discussed in detail below, Oldhouse Branch and Pigeonroost Branch are important within the context of the larger Coal River sub-basin and Headwaters Spruce Fork sub-watershed because, like White Oak Branch, they represent some of the few stream systems supporting least-disturbed conditions within those watersheds.

The stream systems that are the subject of this Final Determination, Pigeonroost Branch and Oldhouse Branch, are high quality stream systems supporting diverse aquatic communities, as measured by their benthic macroinvertebrate populations (see Section IV.B.1. and Appendix 2). Macroinvertebrates are used by West Virginia and other states in the Mid-Atlantic region and across the U.S. to assess the quality of their waters and are good indicators of stream health. While Pigeonroost Branch and Oldhouse Branch are not WVDEP-designated reference sites, their quality is comparable to White Oak Branch, a WVDEP-designated reference site, and their macroinvertebrate communities rank highly in comparison to other central Appalachian streams and streams throughout the state of West Virginia (see Section IV.B.1). Accordingly, Oldhouse Branch and Pigeonroost Branch reflect least-disturbed conditions and represent some of the few remaining streams within the Coal River sub-basin that have not been significantly adversely impacted by human disturbances.

Water chemistry data for Pigeonroost Branch and Oldhouse Branch also reflect healthy streams with little human disturbance. Data from the WVDEP indicate that average conductivity values for the unmined streams on the Spruce No. 1 Mine project area are very low.[7] Based on the WVDEP dataset (2002-2003), Oldhouse Branch had an average

[7] Specific conductance, or conductivity, is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salt) in the water, and typically measured as microsiemens per centimeter (µS/cm). Pure water, such as distilled water, will have a very low specific conductance, and seawater will have a high specific conductance. Conductivity is an important water quality measurement because it gives a good idea of the amount of dissolved material in the water.

conductivity level of 90 µS/cm, which is below that of White Oak Branch, a WVDEP-designated reference site, which had an average conductivity level of 118 µS/cm. Conductivity levels described above in Oldhouse Branch and White Oak Branch indicate excellent water quality, comparable to reference-quality streams for this ecoregion. Sulfate concentrations in these streams are also low (28 mg/l in Oldhouse Branch and 24 mg/l in White Oak Branch). Pigeonroost Branch had a conductivity level of 199 µS/cm and sulfate level of 99 mg/l. The slightly elevated average conductivity and sulfate values reflect the relatively small amount of historical mining land use in the Pigeonroost watershed.

During the December 2008 to March 2010 time frame, monitoring reports submitted by the permittee indicate 15 of the 16 selenium measurements at both Pigeonroost Branch and Oldhouse Branch were below the detection limit of 0.6 µg/L. The single detection of selenium on Oldhouse Branch was 0.9 µg/L during July 2009. The single detection of selenium on Pigeonroost Branch was 1.9 µg/L during August 2009. By way of comparison, these readings are far below 5 µg/L, which is the concentration associated with West Virginia's chronic water quality criterion for selenium.[8] These levels are also significantly lower than levels documented immediately downstream of adjacent mining operations (see Section V.D.1.a.).

The relatively high quality of Oldhouse Branch and Pigeonroost Branch also can be demonstrated by comparison to other streams in the Headwaters Spruce Fork sub-watershed that have been impacted by mining operations similar to the Spruce No. 1 Mine, located directly northwest of the Spruce No. 1 Mine, on the west side of Spruce Fork. These streams, in part, are impacted by the Mingo Logan Dal-Tex Mining Operation (Dal-Tex). Section V.D.2.a. compares the health of the relatively unimpacted macroinvertebrate communities in Pigeonroost Branch and Oldhouse Branch with the macroinvertebrate communities in these streams that have been impacted by mining activity. This comparison demonstrates that Oldhouse Branch and Pigeonroost Branch support a much healthier and more diverse assemblage of benthic macroinvertebrates than do the four comparison streams that are impacted by the Dal-Tex operation.

IV.B. Wildlife

The Spruce No. 1 Mine is located in the Central Appalachian ecoregion, which encompasses most of the central Appalachian coalfields (Bryce et al. 1999) (Figure 5). This ecoregion has some of the greatest aquatic animal diversity of any area in North America, especially for species of amphibians, fishes, mollusks, aquatic insects, and crayfishes. Individual watersheds and peaks in the Appalachian chain, isolated for millions of years with benign environmental conditions, provided a perfect setting for the evolution of many unique species of plants and animals. The Nature Conservancy has identified this region as one of North America's prominent biodiversity hotspots of rarity and richness (Figure 6) (Stein et al. 2000). Salamanders, in particular, reach some of the highest levels of North American diversity in the Central Appalachian ecoregion, and are

[8] The West Virginia numeric chronic water quality criterion for selenium defined as a four-day average concentration not to be exceeded more than once every three years

often abundant enough to account for the greatest vertebrate biomass in a given patch of forest (Stein et al. 2000). It has also been documented that other specialized wildlife such as some neotropical migrant birds and forest amphibians rely on the natural headwater stream conditions and adjacent forest types exhibited by Pigeonroost Branch and Oldhouse Branch for maintenance of their populations (Stein et al., 2000).

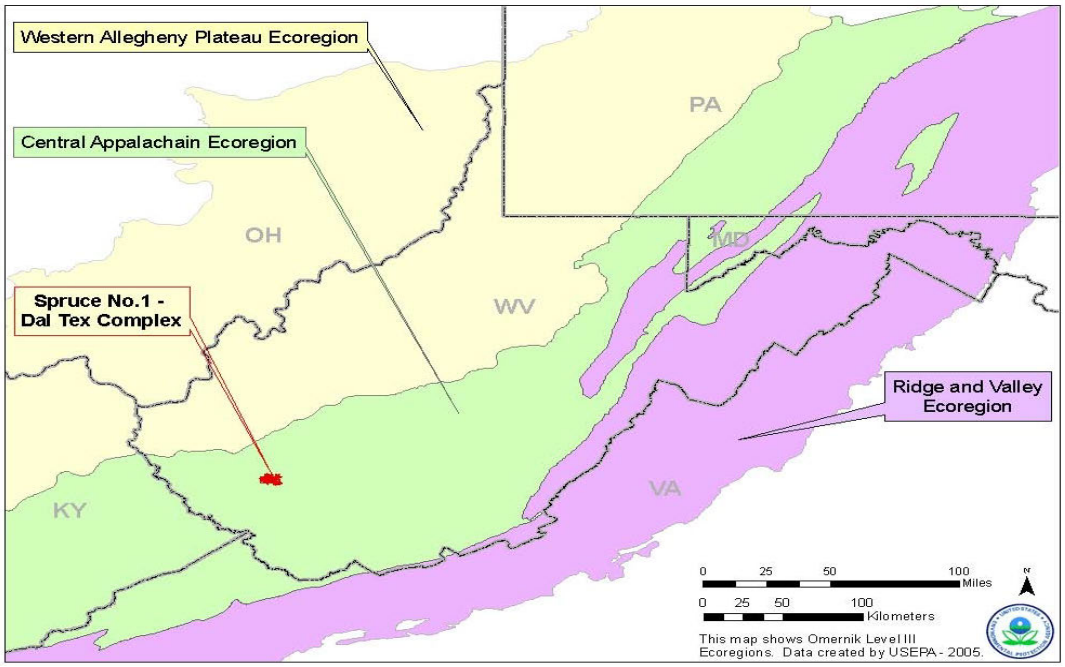

Figure 5. Map of Central Appalachian ecoregion showing Spruce No. 1 Mine location

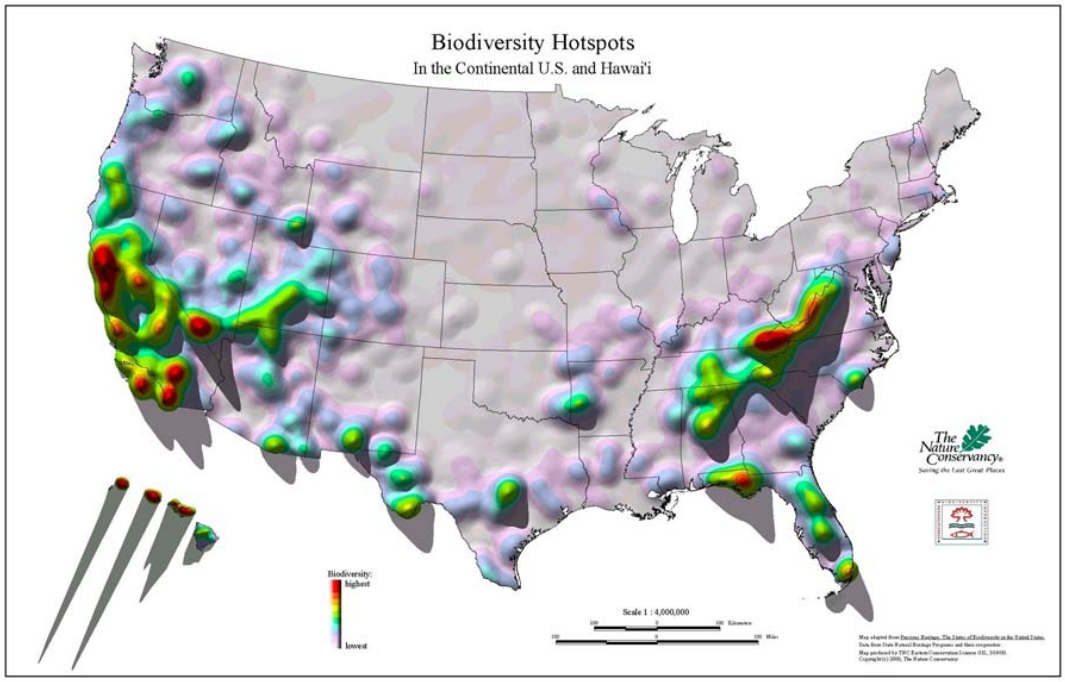

Figure 6. Biodiversity Hotspots in the Continental United States and Hawaii
Map adapted from Precious Heritage: The Status of Biodiversity in the United States.
© The Nature Conservancy http://www.nature.org/wherewework/northamerica/states/westvirginia/science/

IV.B.1. Macroinvertebrates

In a body of water, benthic macroinvertebrates are the bottom-dwelling (benthic) organisms that are large enough to be seen without the aid of microscopes (macro), and do not have backbones (invertebrate). As stated in EPA's Wadeable Stream Assessment (EPA 841-B-06-002 December 2006), macroinvertebrates are good indicators of biological integrity "because of their inherent capacity to integrate the effects of the stressors to which they are exposed, in combination and over time. Stream macroinvertebrates generally cannot move very quickly or very far; therefore, they are affected by, and may recover from, a number of changes in physical conditions (e.g., habitat loss), chemical conditions (e.g., excess nutrients), and biological conditions (e.g., the presence of invasive or non-native species). Some types of macroinvertebrates are affected by these conditions more than others." In addition to their role as indicators of biological integrity or ecosystem health, stream macroinvertebrates, which include aquatic insects, mollusks and crayfishes, play a vital role in food webs and in the processing and transfer of energy and nutrients in river systems. Because of these functions, macroinvertebrates are essential wildlife within the food web, supporting the health of the entire aquatic ecosystem (Figure 7).

Freshwater macroinvertebrates are a critical component of aquatic and riparian food webs, and the loss of these taxa can lead to cascading effects on other trophic levels, with implications for downstream stream ecosystems and sport fisheries. Aquatic macroinvertebrates feed on algae and leaf litter, and this consumption not only cleans excess living and nonliving organic material from stream systems, but the processing of this organic matter makes essential nutrients available to organisms downstream. Additionally, conversion of plant material into nutrient-rich biomass, in the form of fats and proteins, makes these invertebrates a major food source for the fish and amphibian populations within the stream ecosystem. In addition to their role in the aquatic food web, emerging adult aquatic insects are important prey for foraging terrestrial vertebrates, including birds, bats, reptiles, amphibians, and small mammals (Baxter et al. 2005). Many of these terrestrial vertebrates, including ducks and water shrews, have also been known to consume aquatic insect larvae from the stream before emergence as adults (Baxter et al. 2005). Macroinvertebrates, therefore, are necessary components of a functioning aquatic and riparian food web; and they fulfill a critical ecological niche by delivering nutrients along the stream continuum to both aquatic and terrestrial members of the food chain.

EPA recognizes macroinvertebrates as wildlife, along with many other organizations, including the USFWS, USDA Forest Service, The Nature Conservancy, State Natural Heritage programs, and the West Virginia Division of Natural Resources (WVDNR). Currently, within the U.S., the USFWS lists 50 species of insects as endangered under the Endangered Species Act (ESA), and another 10 species as threatened under the ESA. The State of West Virginia also includes insects, mollusks and crayfishes on its list of rare, threatened and endangered species, including 12 species of stoneflies, two species of mayflies, and 73 species of dragonflies and damselflies (West Virginia Natural Heritage

Program 2007). Several States, including West Virginia and Virginia, require a permit to collect macroinvertebrates for scientific sampling.

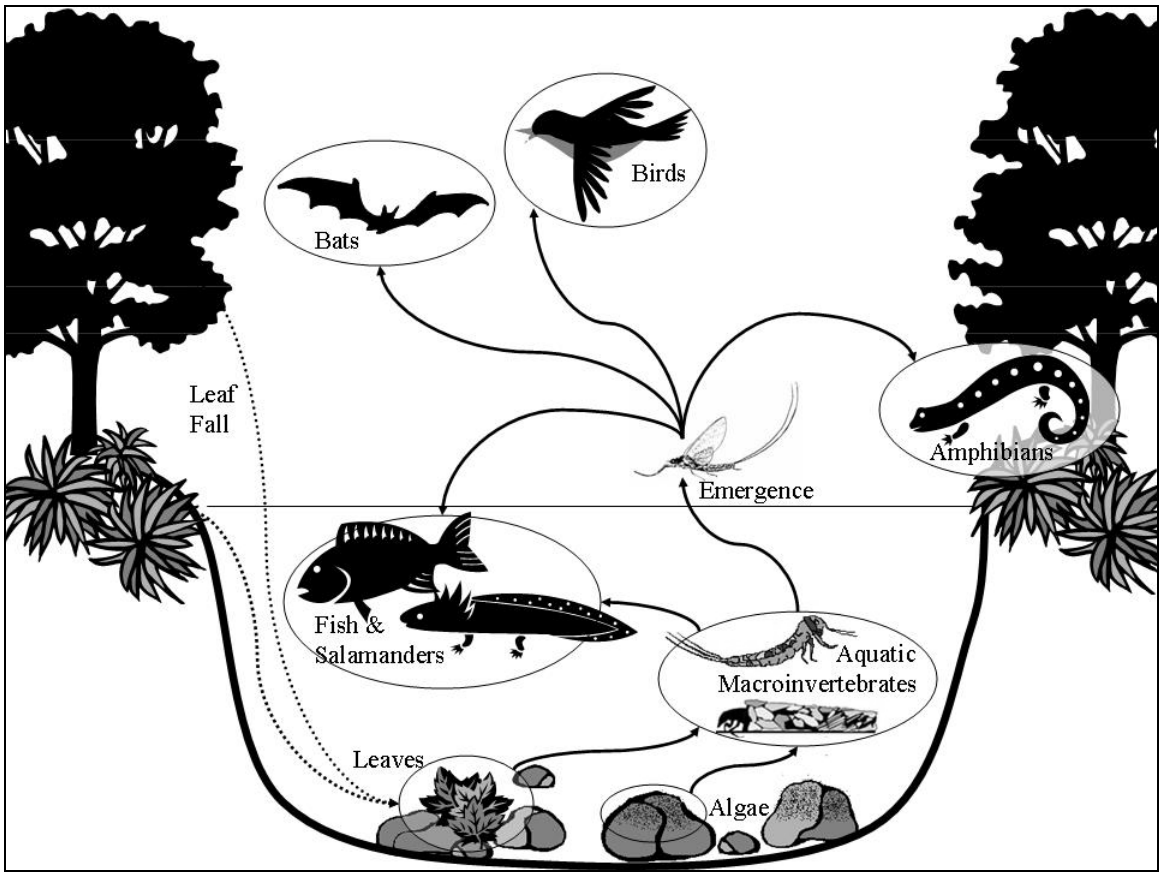

Figure 7: Illustration of a simplified stream food web, highlighting the importance of aquatic macroinvertebrates to other stream and riparian wildlife (adapted from Baxter et al. 2005).

According to Morse et al. (1997), the Central Appalachian ecoregion has many endemic and rare species of benthic macroinvertebrates in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).[9] This diversity and unique assemblage has been attributed to the unique geological, climatic, and hydrological characteristics of this region. The Spruce No. 1 Mine project area has been found to be very rich in macroinvertebrate species. Data from the PEIS, the Spruce No. 1 EIS and from the WVDEP monitoring database indicate that high macroinvertebrate diversity exists in Pigeonroost Branch and Oldhouse Branch. Species diversity boosts ecosystem productivity, maintains ecosystem functionality, and is typically seen as an indicator of overall health.

Mayflies are most popularly known among fly-fishermen, where anglers rely on the seasonal hatches of mayflies that coincide with catching trout and other game fish species. Not only do trout rely on mayflies and stoneflies, but a group of colorful benthic fishes known as Darters (Percidae) also feed on mayflies. Darters are an important part of

[9] The orders Ephemeroptera, Plecoptera and Trichoptera (EPT taxa) contain pollution sensitive groups and are used by natural resource agencies such as the WVDEP to assess watershed health.

the fish assemblage and many are hosts for mussel larvae. Five darter species inhabit Spruce Fork in the immediate vicinity of the project area.

Stoneflies also represent an important group of aquatic insects in the structure and functioning of stream ecosystems, filling important trophic roles in stream ecosystems, including detritivory (consumption of dead or decaying organic matter) and predatory functional feeding group designations. As with mayflies, stoneflies are valued and imitated by fly-fishermen and serve as an abundant food source for many salamanders and fishes. Stoneflies are primarily stenothermic, meaning they inhabit cool to cold waters that provide the higher dissolved oxygen concentrations required for their survival.

Pigeonroost Branch and Oldhouse Branch support diverse and healthy communities of benthic macroinvertebrates, which are comparable to WVDEP reference sites. Macroinvertebrate data collected in Oldhouse Branch and Pigeonroost Branch indicate that the quality of the mayfly (Ephemeroptera) and stonefly (Plecoptera) communities in these streams ranks very high in the Central Appalachia ecoregion and statewide. In 1999-2000, EPA collected eighty-four (84) macroinvertebrate genera in riffle complexes of Pigeonroost Branch and Oldhouse Branch (see Table 11 for a complete taxa list by genus).[10] Collectively, Pigeonroost Branch and Oldhouse Branch contain a high number of mayfly and stonefly taxa and individuals (Tables 1 and 2). A total of 19 genera of mayflies and 16 genera of stoneflies have been identified from these headwater streams indicating these systems offer high water quality and optimal habitat.

Based on a comparison of macroinvertebrate communities, Oldhouse Branch and Pigeonroost Branch are of comparable quality to White Oak Branch, a neighboring WVDEP-designated reference site. Using the West Virginia Stream Condition Index (WVSCI), an assessment method developed for use in West Virginia to help evaluate the health of benthic macroinvertebrate communities at the family level in wadeable streams (and used as a measure of the health of stream communities overall), both Oldhouse Branch and White Oak Branch scored comparably well.[11] Oldhouse Branch and White Oak Branch also scored comparably well at the more sensitive genus level (as opposed to family), sharing 55 total genera, many of which are intolerant of pollution, indicating a diverse and healthy aquatic community in Oldhouse Branch similar to the high quality communities of White Oak Branch. The WVSCI assessment of Pigeonroost Branch indicates water quality is relatively good despite the presence of localized historic mining in the watershed. Pigeonroost Branch and White Oak Branch also share many pollution-intolerant macroinvertebrate genera, indicating that the health of Pigeonroost Branch's aquatic community is similar.

Oldhouse Branch and Pigeonroost Branch contain 19 genera of mayflies (Table 1). As many as nine genera of mayflies have been collected in Oldhouse Branch in any one

[10] Riffle and pool complexes are considered special aquatic sites under 40 CFR 230.1(d) and as such the degradation or destruction of these sites is considered to be among the most severe environmental impacts covered by the § 404(b)(1) Guidelines.
[11] For a more detailed discussion of WVSCI, see Section V.B.2.a.iii.

season-specific sample, with an average of seven genera across multiple samples. This observation ranks in the 95th percentile of all samples taken in the Central Appalachian ecoregion (937 samples) by the WVDEP. Out of more than 4000 samples collected statewide in West Virginia, Oldhouse Branch ranks in the 90th percentile. Pigeonroost Branch contained eight mayfly genera in a season-specific sample, ranking it in the 90th percentile in the Central Appalachian ecoregion and 83rd percentile statewide from among more than 4000 single-sample observations.

Table 1. Presence/absence of mayfly (Ephemeroptera) genera in the permit area (Compiled from EPA, WVDEP, and the applicant's consulting firms (Sturm Environmental Services, BMI, Inc.))

Order	Family	Genus	Oldhouse	Pigeonroost
Ephemeroptera	Ameletidae	*Ameletus*	X	X
Ephemeroptera	Baetidae	*Acentrella*	X	X
Ephemeroptera	Baetidae	*Baetis*	X	X
Ephemeroptera	Baetidae	*Diphetor*		X
Ephemeroptera	Baetiscidae	*Baetisca*		X
Ephemeroptera	Ephemerellidae	*Attanella*		X
Ephemeroptera	Ephemerellidae	*Dannella*		X
Ephemeroptera	Ephemerellidae	*Drunella*	X	X
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	X
Ephemeroptera	Ephemerellidae	*Eurylophella*	X	X
Ephemeroptera	Ephemeridae	*Ephemera*	X	X
Ephemeroptera	Heptageniidae	*Cinygmula*	X	X
Ephemeroptera	Heptageniidae	*Epeorus*	X	X
Ephemeroptera	Heptageniidae	*Heptagenia*		X
Ephemeroptera	Heptageniidae	*Maccaffertium*	X	X
Ephemeroptera	Heptageniidae	*Stenacron*	X	
Ephemeroptera	Isonychiidae	*Isonychia*		X
Ephemeroptera	Leptophlebiidae	*Choroterpes*	X	
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	X	

Note: Siphlonurus and Pseudocloeon reported by Sturm Environmental Services are likely erroneous identifications. These genera have been excluded from this list.

Oldhouse Branch and Pigeonroost Branch contain 11 genera of stoneflies (Table 2). A single collection in Oldhouse Branch by EPA (Spring 2000) included 9 genera of stoneflies, which ranks greater than the 98th percentile of all Central Appalachian streams sampled by the WVDEP (937 samples). This means that only 2% of stream samples in this ecoregion had more stonefly taxa than Oldhouse Branch within a single sampling event. Pigeonroost Branch had as many as six stonefly genera in any one season-specific sample, ranking it at the 83rd percentile among 937 Central Appalachian streams, and 72nd percentile statewide.

Table 2. Presence/absence of stonefly (Plecoptera) genera in the permit area (Compiled from EPA, WVDEP, and the applicant's consulting firms (Sturm Environmental Services, BMI, Inc.))

Order	Family	Genus	Oldhouse	Pigeonroost
Plecoptera	Capniidae	*Allocapnia*	X	X
Plecoptera	Chloroperlidae	*Alloperla*		X
Plecoptera	Chloroperlidae	*Haploperla*	X	

Plecoptera	Chloroperlidae	*Sweltsa*	X	
Plecoptera	Leuctridae	*Leuctra*	X	X
Plecoptera	Nemouridae	*Amphinemura*	X	X
Plecoptera	Nemouridae	*Ostrocerca*	X	X
Plecoptera	Nemouridae	*Paranemoura*		X
Plecoptera	Peltoperlidae	*Peltoperla*	X	
Plecoptera	Perlidae	*Acroneuria*	X	X
Plecoptera	Perlodidae	*Isoperla*	X	
Plecoptera	Perlodidae	*Remenus*		X
Plecoptera	Perlodidae	*Yugus*	X	
Plecoptera	Pteronarcyidae	*Pteronarcys*	X	X
Plecoptera	Taeniopterygidae	*Taenionema*		X
Plecoptera	Taeniopterygidae	*Taeniopteryx*		X

Note: Podmosta, Paraleuctra, Megaleuctra,and Beloneuria reported by Sturm Environmental Services are likely erroneous identifications. These genera been excluded from this list.

Two Cambarus species of crayfish were collected incidentally during the macroinvertebrate sampling events. Although crayfish were not specifically sampled for, a list of crayfish species potentially present within the Headwaters Spruce Fork sub-watershed can be found in Table 3. Other macroinvertebrates, including mollusks and flatworms (plathyelminthes), are fairly rare in these systems, as aquatic insects make up the majority of the macroinvertebrate taxa in these streams.

Table 3: List of potential crayfish species occurring within permit area

Common Crayfish (*Cambarus bartonii bartonii*)	Upland Burrowing Crayfish (*Cambarus dubius*)
Appalachian Brook Crayfish (*Cambarus b. cavatus*)	Big Water Crayfish (*Cambarus robustus*)

IV.B.2. Salamanders & Other Herpetofauna

There are 46 species of herpetofauna that have been documented as occurring on the project site or in Logan or Boone County, WV, including a wide variety of salamanders (Table 4). The Central Appalachian ecoregion contains one of the richest concentrations of salamander fauna in the world (Petranka 1998, Stein et al. 2000). Nearly ten percent of global salamander diversity is found within streams in the ecoregion (Green and Pauley 1987). Salamanders are a diverse and unique form of Appalachian wildlife that depend on forested headwater habitat and that decline or disappear from surface mined areas. Many species of salamanders are aquatic or semi-aquatic and utilize headwater streams at some point in their life histories. Most of the species found in the project area are water-dependent and belong to the family Plethodontidae, the lungless salamanders, which require high moisture retaining leaf-litter, dense shade, and cool flowing streams to survive and reproduce. Typically, salamanders occupy small, high-gradient headwater streams while fish occur farther downstream.

Salamanders are an important ecological component in the temperate hardwood forests of the ecoregion and are often the most abundant group of vertebrates in both biomass and number (Burton and Lykens 1975, Hairston 1987). Ecologically, salamanders are intimately associated with forest and adjacent aquatic ecosystems acting as predators of

small invertebrates and serving as prey to larger aquatic and terrestrial predators, including fish, birds, mammals and reptiles (Pough et al. 1987, Davic and Welsh 2004). Because of their low energy demand, long life span, slow growth rates, and large abundance, salamanders help to maintain long-term ecosystem function and resilience by providing abundant biomass and nutrients for top predators in forest and adjacent aquatic ecosystems (Davic and Welsh 2004). As such, salamanders play a large role in the cycling of nutrients and transfer between terrestrial and aquatic systems via trophic pathways (Davic and Welsh 2004). Some species of salamanders split their lives between forests and headwaters and depend on a close connection to move between the two (Petranka, 1998). The PEIS identified thirty-one species of salamanders in the West Virginia portion of the study area. Of these, twenty-five species are known to occupy mixed mesophytic hardwood forests, like those present within portions of the Spruce No. 1 Mine site.

Table 4: List of documented herpetofauna species occurring in Logan County or Boone County, WV. Source: Spruce EIS and WV Biological Survey, Marshall University, 2010

Eastern hognose snake (*Heterodon platirhinos*)*	Five-lined skink (*Eumeces fasciatus*)*
American toad (*Bufo americanus*)*	Spring peeper (*Hyla crucifer*)*
Spring salamander (*Gyrinophilus porphyriticus*)*	Southern two-lined salamander (*Eurycea cirrigera*)*
Seal salamander (*Desmognathus monticola*)*	Northern dusky salamander (*Desmognathus fuscus*)*
Mountain dusky salamander (*Desmognathus ochrophaeus*)*	Mole salamander (*Ambystoma*)*
Red-spotted newt (*Notophthalmus viridescens*)*	Green salamander (*Aneides aenus*)*
Red salamander (*Pseudotriton ruber*)*	Mountain Chorus Frog (*Pseudacris brachyphona*)
Ring-necked Snake (*Diodophus punctatus*)	Fowler's Toad (*Bufo fowleri*)
Eastern Wormsnake (*Carphophis amoenus*)	Mudpuppy (*Necturus maculosus*)
Box Turtle (*Terrapene carolina*)	Spiny Soft-shelled Turtle (*Apalone spinifera*)
Timber Rattlesnake (*Crotalis horridus*)	Eastern Racer (*Coluber constrictor*)
Northern Slimy Salamander (*Plethodon glutinosus*)	Gray Treefrog (*Hyla versicolor*)
Eastern Fence Lizard (*Sceloporus undulatus*)	Rough Green Snake (*Opheodrys aestivus*)
North American Bullfrog (*Rana catesbeiana*)	Northern Two-lined Salamander (*Eurycea bislineata*)
Painted Turtle (*Chrysemys picta*)	Pickerel Frog (*Rana palustris*)
Snapping Turtle (*Chelydra serpentina*)	Little Brown Skink (*Scincella lateralis*)
Common Garter Snake (*Thamnophis sirtalis*)	Green Frog (*Rana clamitans*)
Northern Water Snake (*Nerodia sipedon*)	Ravine Salamander (*Plethodon richmondi*)
Spotted Salamander (*Ambystoma maculatum*)	Cope's Gray Treefrog (*Hyla chrysoscelis*)
Queen Snake (*Regina septemvittata*)	Coal Skink (*Eumeces anthracinus*)
Black Mountain Salamander (*Desmognathus welteri*)	Marbled Salamander (*Ambystoma opacum*)
Mud Salamander (*Pseudotriton montanus*)	Copperhead (*Agkistrodon contortix*)
Long-tailed Salamander (*Eurycea longicauda*)	Four-toed Salamander (*Hemidactylium scutatum*)
* Documented within the permit area	

With respect to areas in or immediately adjacent to the project area, stream-dwelling salamanders have been surveyed in White Oak Branch (see Appendix B in Patnode et al. 2005). White Oak Branch had good numbers of Northern Dusky (9 adult, 7 larvae), Appalachian Seal (15 adult, 12 larvae), Northern Spring (4 adult), and Two Lined salamanders (1 adult and 15 larvae). These samples were recorded from a 12 square-meter plot that includes dry and wetted portions of the stream channel. Because Oldhouse Branch and Pigeonroost Branch are very close geographically and have similar

features as White Oak Branch, salamander populations in Pigeonroost Branch and Oldhouse Branch can be expected to be similar to those in White Oak Branch. Williams (2003) found mean densities within reference reaches of Pigeonroost Branch, Bend Branch (another tributary of Spruce Fork), and Ash Fork (a tributary of the Gauley River) to be more than six salamanders per square meter. In the Williams' study, the majority of the total salamanders were found in Pigeonroost Branch. Using these numbers from White Oak Branch and Pigeonroost Branch, EPA estimates aquatic salamanders are abundant (~5-6 per square meter) along stream channels in Pigeonroost Branch and Oldhouse Branch.

IV.B.3. Fish

Five fish species have been sampled in Pigeonroost Branch, Oldhouse Branch, and White Oak Branch, and the assemblages are typical of small streams in the Coal River sub-basin (Table 5). As fish diversity generally increases with stream order (Meyer et al. 2007), the low diversity in these streams is typical of low order headwater streams. The fish populations are good quality, and are not indicative of impairment. Based upon several sampling efforts, it has been found that Pigeonroost Branch supports a fish assemblage that includes blacknose dace, creek chub mottled sculpin, stonerollers and smallmouth bass; and Oldhouse Branch supports a fish assemblage of blacknose dace and creek chub. The presence of smallmouth bass in Pigeonroost Branch indicates at least seasonal, and possible spawning use of this stream by smallmouth bass.

Fish species collection in Oldhouse Branch, Pigeonroost Branch and White Oak Branch has been variable, likely due to a drought that occurred in 1999. It is likely that perennial reaches of Pigeonroost Branch and Oldhouse Branch were dewatered during this drought period, and thus provided only ephemeral or intermittent habitat at that time. As discussed in Stauffer and Ferreri (2002), drought can act as a major perturbation on fish communities. While fish can recolonize an area after a drought, recolonization rates vary between fish species, and it may take years before the community resembles that which was in place before the drought.

As outlined in the PEIS (Stauffer and Ferreri 2002), a study that was conducted by the U.S. Fish and Wildlife Service in 1998 recorded sculpin (Cottus spp.) in benthic invertebrate samples from White Oak Branch, as well as many fishes in the pools of Oldhouse Branch. Subsequent sampling in May 2000 revealed only blacknose dace (Rhinichthys atratulus) in White Oak Branch, and none in Oldhouse Branch. Stauffer and Ferreri (2002) attributed this to the effects of the drought in 1999. Sampling for the PEIS occurred in 1999, the same year as the drought. When sampled for the PEIS, only blacknose dace and creek chubs were present in Pigeonroost Branch. Similarly, White Oak Branch was also drought-affected and it contained only blacknose dace at the time of sampling. No samples were collected in Oldhouse Branch for the PEIS. Blacknose dace are typically a headwater species that are tolerant of disturbance and can recolonize an area quickly after a drought. Sculpins (Cottus spp.), however, are bottom-dwelling species that typically have a restricted home range, which hinders the dispersal rate and makes it more difficult for them to recolonize an area after a drought.

Additional fish sampling data were collected in 2008 and 2009 by Decota Consulting and revealed a fish assemblage similar to that found by the U.S. Fish and Wildlife Service prior to the drought. Mottled sculpin, as well as sporadic populations of smallmouth bass and stonerollers were collected in Pigeonroost Branch. Similarly, creek chubs and mottled sculpin were collected from White Oak Branch. Data from Oldhouse Branch indicate that blacknose dace and creek chubs are the only species present.

In an analysis of fish community data from Spruce Fork, EPA assessed the small streams impacted by the Spruce No. 1 Mine and three reaches of Spruce Fork: 1) Upstream of Seng Camp Creek, 2) Seng Camp Creek to Spruce Laurel, and 3) Downstream of Spruce Laurel. Other data analyzed included data collected for the PEIS, unpublished data included in the West Virginia Department of Natural Resources (WVDNR) database (including USEPA, WVDNR, and consulting firm data), and data from Decota Consulting supplied to the WVDNR collecting permit program. The data consisted of samples that were intended to assess community composition and were judged to have sufficient numbers of individuals to render a fair assessment.

Table 5: List of fish species occurring within Spruce Fork from samples in 2007 and 2010 (WVDNR unpublished data) (*) represents species also present in Pigeonroost Branch and Oldhouse Branch within the project area

rock bass (Ambloplites rupestris)	striped shiner (Luxilus chrysocephalus)
central stoneroller (Campostoma anomalum)*	smallmouth bass (Micropterus dolomieu)*
mottled sculpin (Cottus bairdii)*	golden redhorse (Moxostoma erythrurum)
greenside darter (Etheostoma blennioides)	silverjaw minnow (Notropis buccatus)
rainbow darter (Etheostoma caeruleum)	silver shiner (Notropis photogenis)
johnny darter (Etheostoma nigrum)	rosyface shiner (Notropis rubellus)
variegate darter (Etheostoma variatum)	sand shiner (Notropis stramineus)
banded darter (Etheostoma zonale)	mimic shiner (Notropis volucellus)
bigeye chub (Hybopsis amblops)	bluntnose minnow (Pimephales notatus)
northern hog sucker (Hypentelium nigricans)	western blacknose dace (Rhinichthys obtusus)
American brook lamprey (Lampetra appendix)	brown trout (Salmo trutta)
green sunfish (Lepomis cyanellus)	creek chub (Semotilus atromaculatus)*
bluegill (Lepomis macrochirus)	blacknose dace (Rhinichthys atratulus)*

For the PEIS, Fulk et al. (2003) used the Mid-Atlantic Highlands (MAHA) Index of Biotic Integrity (IBI), a multi-metric index used to assess biotic health, with some minor modification, to assess the impacts of mountaintop mining and valley fills to fish assemblages. Using this same index, the assemblage upstream of Seng Camp Creek ranged from fair to excellent condition.

The fish assemblage in the main stem of Spruce Fork is in relatively good condition (Table 5) and is made up of 26 species. Spruce Fork is a locally important rock bass and smallmouth bass fishery. Rock Bass and Smallmouth Bass are moderately sensitive gamefish species. While sampling Spruce Fork in 2010, recreational fishing was observed in the lower reaches of the stream and there was evidence of fishing in the upper reaches as well. Species present in Spruce Fork upstream and downstream of Seng Camp Creek are typical of streams of this size within the Coal River sub-basin.

IV.B.4. Birds[12]

Many bird species depend on headwater streams like those of the Spruce Fork for their survival. The ecotone, or transition area, between terrestrial and aquatic habitats results in diverse flora and fauna. This phenomenon is particularly noticeable among bird species. For example, unique avifauna assemblages can be found along the riparian zone of headwater streams, and are often attracted to headwater streams for breeding areas because of the diversity of the habitat and the availability of emergent aquatic insects. Hence Appalachian headwater streams, like Pigeonroost Branch and Oldhouse Branch, support a wide array of sensitive bird species (Table 6) and are an important natural habitat for supporting these species' breeding populations.

Table 6: List of potential bird species occurring within permit area

Ruffed Grouse (*Bonasa umbellus*)	Whip-poor-will (*Caprimulgus vociferous*)
Red-tailed Hawk (*Buteo jamaicensis*)	Hairy Woodpecker (*Picoides villosus*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	Pileated Woodpecker (*Dryocopus pileatus*)
Chimney Swift (*Chaetura pelagica*)	Acadian Flycatcher (*Empidonax virescens*)
Belted Kingfisher (*Megaceryle alcyon*)	Yellow-throated Vireo (*Vireo flavifrons*)
Downy Woodpecker (*Picoides pubescens*)	Red-eyed Vireo (*Vireo olivaceus*)
Northern Flicker (*Colaptes auratus*)	American Crow (*Corvus brachyrhynchos*)
Eastern Wood-Pewee (*Contopus virens*)	Carolina Chickadee (*Poecile carolinensis*)
Eastern Phoebe (*Sayornis phoebe*)	White-breasted Nuthatch (*Sitta carolinensis*)
White-eyed Vireo (*Vireo griseus*)	Blue-gray Gnatcatcher (*Polioptila caerulea*)
Blue Jay (*Cyanocitta cristata)*	Wood Thrush (*Hylocichla mustelina*)
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	Gray Catbird (*Dumetella carolinensis*)
Tufted Titmouse (*Baeolophus bicolor*)	European Starling (*Sturnus vulgaris*)
Carolina Wren (*Thryothorus ludovicianus*)	Brewster's Warbler (hybrid) (*Vermivora cyanoptera x V. chrysoptera*)
Eastern Bluebird (*Sialia sialis*)	Northern Parula (*Parula Americana*)
American Robin (*Turdus migratorius*)	Yellow-throated Warbler (*Dendroica dominica*)
Blue-winged Warbler (*Vermivora cyanoptera*)	Cerulean Warbler (*Dendroica caerulea*)
Golden-winged Warbler (*Vermivora chrysoptera*)	American Redstart (*Setophaga ruticilla*)
Yellow Warbler (*Dendroica petechia*)	Swainson's Warbler (*Limnothlypis swainsonii*)
Prairie Warbler (*Dendroica discolor*)	Louisiana Waterthrush (*Parkesia motacilla*)
Black-and-white Warbler (*Mniotilta varia*)	Common Yellowthroat (*Geothlypis trichas*)
Worm-eating Warbler (*Helmitheros vermivorum*)	Yellow-breasted Chat (*Icteria virens*)
Ovenbird (*Seiurus aurocapilla*)	Chipping Sparrow (*Spizella passerina*)
Kentucky Warbler (*Oporornis formosus*)	Song Sparrow (*Melospiza melodia*)
Hooded Warbler (*Wilsonia citrina*)	Scarlet Tanager (*Piranga olivacea*)
Eastern Towhee (*Pipilo erythropthalmus*)	Indigo Bunting (*Passerina cyanea*)
Field Sparrow (*Spizella pusilla*)	Brown-headed Cowbird (*Molothrus ater*)
Northern Cardinal (*Cardinalis cardinalis*)	House Sparrow (*Passer domesticus*)
Red-winged Blackbird (*Aegelaius phoeniceus*)	Northern Bobwhite (*Colinus virginianus*)

[12] Much of the discussion related to avian and bat species is based upon communications with the U.S. Fish and Wildlife Service.

American Goldfinch (*Spinus tristis*)	Yellow-billed Cuckoo (*Coccyzus americanus*)
Mourning Dove (*Zenaida macroura*)	Wild Turkey (*Meleagris gallopavo*)
Woodcock (*Scolopax minor*)	Red-bellied Woodpecker (*Melanerpes carolinus*)

Among the many migratory birds likely to breed in the project area, there are six species that the USFWS has designated as Birds of Conservation Concern (BCC) within the Appalachian Mountains Bird Conservation Region (AMBCR). These include the Cerulean Warbler (*Dendroica caerulea*), Kentucky Warbler (*Oporornis formosis*), Swainson's Warbler (*Lymnothlypis swainsonii*), Worm-eating Warbler (*Helmitheros vermivorus*), Wood Thrush (*Hylocichla mustelina*), and the Louisiana Waterthrush (*Seiurus motacilla*). The first five of these are also designated as BCC species within the USFWS's Northeast Region as a whole and nationally (U.S. FWS 2008). The first four are also considered to be among the 100 most at-risk bird species in North America (Wells 2007).

The Louisiana Waterthrush, a neotropical migrant song bird, is considered an obligate headwater riparian songbird (an example of water-dependent wildlife) because its diet is comprised predominantly of immature and adult aquatic macroinvertebrates found in and alongside headwater streams and because it builds its nest in the stream banks. Breeding waterthrushes nest and forage primarily on the ground along medium- to high-gradient, first- to third-order, clear, perennial headwater streams flowing through closed-canopy forest. Good water quality is a key component of the species' breeding habitat. By these criteria, headwater streams like Pigeonroost Branch and Oldhouse Branch that support healthy macroinvertebrate communities provide excellent foraging and breeding habitat for species such as the Louisiana Waterthrush.

The West Virginia population of the Louisiana Waterthrush may serve as a source population within the species' breeding range. The Appalachian Mountain Bird Conservation Region (AMBCR), which extends from southeastern New York south to northern Alabama, is thought to support as much as 45 percent of the Louisiana Waterthrush's breeding population (Mattson and Cooper 2009, Smith, USFWS 2010, personal communication). West Virginia, the only state that lies entirely within the AMBCR, encompasses the largest contiguous area of high relative breeding abundance over the species' entire breeding range, based on North American Breeding Bird Survey (BBS) data from 1994-2003.

The Louisiana Waterthrush is also an area-sensitive species, requiring undisturbed forest tracts of at least 865 acres to sustain a population (Robbins, C.S., J.R. Sauer, R.S. Greenburg**,** and S. Droege. 1989). The most effective management protocol for the Louisiana Waterthrush includes the protection of forest tracts and water systems that it inhabits in its breeding range. The protection of moderate- to high-gradient headwater streams, which compose 75-80% of stream length in a typical watershed, is therefore of particular importance for this species.

Bird species that rely on mature forest habitats and that are on the Audubon watch list as declining species include the Swainson's Warbler, Kentucky Warbler, and Cerulean Warbler. According to the West Virginia Breeding Bird Atlas, all of these species are likely breeders in and around the project area (Buckelew and Hall 1994).

The Cerulean Warbler is considered to be particularly sensitive to landscape-level changes in habitat, more so than most other North American bird species. A canopy-foraging insectivorous neotropical migrant songbird, the Cerulean Warbler breeds in mature deciduous forests with broken, structurally diverse canopies across much of the eastern United States and winters in middle elevations of the Andes Mountains of northern South America. Robbins (1989) noted that Cerulean Warblers prefer large-blocks of mature interior forest habitat with tall trees and a dense upper canopy.

Important among a number of stressors to the Cerulean's breeding populations are the loss of mature deciduous forest, particularly along stream valleys, and the fragmentation and increasing isolation of remaining mature deciduous forest. The USFWS has designated the Cerulean Warbler a Species of Management Concern and a Species of Conservation Concern throughout its range. It has also been preliminarily designated by the Appalachian Mountains Joint Venture as a Species of Highest Conservation Priority within the Appalachian Mountains Bird Conservation Region, which encompasses West Virginia. The AMBCR is thought to support about 80 percent of the Cerulean Warbler's entire breeding population and as a comprehensive four-year study of the species' breeding population shows, West Virginia is an important source population for Cerulean Warblers (Rosenberg et al.2000).

The Acadian Flycatcher (*Empidonax virescens*) is another bird species that is primarily restricted to forested tracts with understory vegetation along small headwater streams. Acadian flycatchers feed primarily on emergent aquatic insects in riparian forest habitat like Spruce Fork and its tributaries. In addition, many other neotropical migrant songbird species are also often attracted to headwater streams for breeding areas because of the diversity of the habitat and the availability of emergent aquatic insects. Hence Appalachian headwater streams, like Pigeonroost Branch and Oldhouse Branch, support a wide array of sensitive bird species and are an important natural habitat for supporting these species' breeding populations.

IV.B.5. Bats & Other Mammals

Thirteen species of bats are found in West Virginia; and all of these species are insectivorous and either capture their prey by foraging in flight, catch flying insects from a perch, or collect insects from plants. Species that have potential to occur in the area of south-Central West Virginia that encompasses the Spruce No. 1 Mine include the Northern Bat (*Myotis septentrionalis*), Big Brown Bat (*Eptesicus fuscus*), Red Bat (*Lasiurus borealis*), Eastern Small-footed Bat (*Myotis leibii*), Virginia Big-eared Bat (*Corynorhinus townsendii virginianus*), Northern Long-eared Bats *(Myotis septentrionalis)* and the Indiana Bat (*Myotis sodalis*) (Table 7).

Both the Indiana Bat and Virginia Big-eared Bat are listed as endangered under the Endangered Species Act (ESA). The USFWS was also recently petitioned to list the Eastern Small-footed Bat and the Northern Long-eared Bat under the ESA. Both of these species have been documented in the Spruce No. 1 Mine project area. In 2004, five Eastern Small-footed Bats and 16 Northern Long-eared Bats were captured during mist net surveys conducted at the Spruce No. 1 Mine site, representing 7.6 and 24.2 percent, respectively, of all bats captured (U.S. Army Corps of Engineers Huntington District 2006, DEIS Spruce No. 1 Mine. Appendix M).

Indiana Bats are found over most of the eastern half of the United States. Between 1960 and 2001, biologists have documented a 56% population decline in Indiana Bats (Clawson 2002). Indiana Bats feed solely on emerged aquatic and terrestrial flying insects. They are habitat generalists and their selection of prey reflects the environment in which they forage. In a study in the Allegheny Mountains, activity in non-riparian upland forest and forests in which timber harvest had occurred was low relative to forested riparian areas (Owen et al. 2004). This evidence suggests that the forested riparian zones of the project area would be more suitable habitats for Indiana Bat populations than active or restored mining sites.

Mist net surveys were conducted in the project area in 2000 and 2004, and no federally listed bats were captured. Although the capture of bats confirms their presence, failure to catch bats does not absolutely confirm their absence (U.S. Fish and Wildlife Service 2007). The project area occurs roughly halfway between known hibernacula (shelters used for hibernation) in northeastern Kentucky and southeastern West Virginia. Since the most recent surveys at the Spruce No. 1 Mine site, maternity roosts have been documented in central and north-central Boone County within 15 miles of the project area (WVDNR 2010, USFWS 2005).

Table 7: List of potential mammal species occurring within permit area

hoary bat (*Lasiurus cinereus*)	Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)
eastern small-footed bat (*Myotis leibii*)	big brown bat (*Eptesicus fuscus*)
little brown bat (*Myotis lucifugus*)	silver-haired bat (*Lasionycteris noctivagans*)
Northern long-eared bat (*Myotis septentrionalis*)	eastern red bat (*Lasiurus borealis*)
Eastern pipistrelle bat (*Pipistrelle subflavus*)	evening bat (*Nycticeius humeralis*)
Indiana bat (*Myotis sodalist*)	Virginia big-eared bat (*Corynorhinus townsendii virginianus*)
tri-colored bat (*Perimyotis subflavus*)	showshoe hare (*Lepus americanus*)
woodland jumping mouse (*Napaeozapus insignis*)	raccoon (*Procyon lotor*)
deer mouse (*Peromyscus maniculatus*)	red fox (*Vulpes vulpes*)
gray fox (*Urocyon cinereoargenteus*)	bobcat (*Lynx rufus*)
mink (*Mustela vison*)	white-tailed deer (*Odocoileus virginianus*)
opossum (*Didelphis virginiana*)	eastern cottontail (*Sylvilagus floridana*)
muskrat (*Ondatra zibethicus*)	Appalachian cottontail (*Sylvilagus obscures*)
black bear (*Ursus americanus*)	white-footed mouse (*Peromyscus leucopus*)
striped skunk (*Mephitis mephitis*)	southern red-backed vole (*Clethrionomys gapperi*)
woodchuck (*Marmota monax*)	meadow vole (*Microtus pennsylvanicus*)

masked shrew (*Sorex cinereus*)	pine vole (*Microtus pinetorum*)
northern short-tailed shrew (*Blarina brevicauda*)	eastern chipmunk (*Tamias striatus*)
hairy-tailed mole (*Parascalops breweri*)	eastern gray squirrel (*Sciurus carolinensis*)
least Weasel (*Mustela nivalis*)	fox squirrel (*Sciurus niger*)
long-tailed weasel (*Mustela frenata*)	red squirrel (*Tamiasciurus hudsonicus*)
wild boar/ feral pig (*Sus scrofa*)	southern flying squirrel (*Glaucomys volans*)
american beaver (*Castor canadensis*)	

IV.C. Summary

Based on the foregoing information, EPA finds that Pigeonroost Branch and Oldhouse Branch contain high quality, important wildlife resources and habitat. EPA bases this conclusion on several factors including the similarity of macroinvertebrate communities in Pigeonroost Branch and Oldhouse Branch to the reference-quality White Oak Branch; the high-ranking mayfly and stonefly diversity, both within the Central Appalachian ecoregion and statewide; and the use of these streams and associated riparian ecotone by numerous salamander, bird, and mammal species. These streams support least-disturbed conditions and represent some of the last remaining high quality stream and riparian resources within the Headwaters Spruce Fork sub-watershed and the Coal River sub-basin.

V. Basis for Final Determination

V.A. Section 404(c) Standards

CWA § 404(c) provides

> The Administrator is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site, and he is authorized to deny or restrict the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever he determines, after notice and opportunity for public hearings, **that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas**. Before making such determination, the Administrator shall consult with the Secretary. The Administrator shall set forth in writing and make public his findings and his reasons for making any determination under this subsection. [emphasis added]

While EPA strongly prefers to initiate the § 404(c) process prior to issuance of a permit, § 404(c) and EPA's implementing regulations authorize EPA to initiate the § 404(c) process after a permit has been issued by withdrawing specification of a disposal site (See 40 CFR 231.1(a); see also definition of "withdraw specification," 40 CFR 231.2(a)). In this case, Pigeonroost Branch and Oldhouse Branch were specified as disposal sites in DA Permit No. 199800436-3.

§ 404(c) does not define the term "unacceptable adverse effect." EPA's regulations at 40 CFR 231.2(e) define "unacceptable adverse effect" as

> Impact on an aquatic or wetland ecosystem which is likely to result in significant degradation of municipal water supplies or **significant loss of or damage to** fisheries, shellfishing, or **wildlife habitat** or recreation areas. In evaluating the unacceptability of such impacts, consideration should be given to the relevant portions of the § 404(b)(1) Guidelines (40 CFR 230). [emphasis added]

V.B. Evaluation of Impacts

To evaluate the impacts of the Spruce No. 1 Mine, EPA has reviewed the DA Permit No. 199800436-3 (Section 10: Coal River), the Spruce No. 1 Mine EIS, the PEIS, peer-reviewed literature, and available data documenting impacts from similar projects. In addition, EPA communicated with the US Fish and Wildlife Service on impacts to fish and wildlife resources in the project area. EPA also has examined impacts caused by the portion of the Spruce No. 1 Mine that has already been constructed in the Seng Camp Creek watershed (specifically, Valley Fill 1A). In addition, EPA reviewed the nearby Mingo Logan Dal-Tex operation. The data indicate that for the most part, the formations are repeated from the Dal-Tex mine complex to the proposed Spruce No. 1 mine location and all of the formations in the Dal-Tex complex that had in the past showed high

selenium levels and have led to environmental releases are present at the Spruce No. 1 Mine. EPA is, therefore, on sound technical footing to use existing data from the Dal-Tex complex as a basis to predict what may happen when mining occurs at Spruce No. 1 Mine. This was acknowledged by the Corps in the Spruce No. 1 EIS, which stated "[t]he past and present impacts to topography, geology, and mineral resources of the previous mining along the western side of Spruce Fork are similar to the anticipated impacts of the Spruce No. 1 Mine, as mining is to occur in the same strata."

EPA completed a review of rock cores and corresponding cross sections for the Dal-Tex mines including the Gut Fork mine, which lies immediately to the west across Spruce Fork from Spruce No.1 (Figure 8) and compared them to those from the Spruce No. 1 Mine. This review, which is set forth in Appendix 4, indicates that the formations are essentially repeated from the Dal-Tex mine complex to the Spruce No. 1 Mine location. According to the EIS, the same coal beds are to be developed for the Spruce No. 1 Mine as for the Dal-Tex mine. These coal bed sequences are also similar to those described in the literature for southern West Virginia coal bed sequences and the geologic column for the Spruce No. 1 Mine.

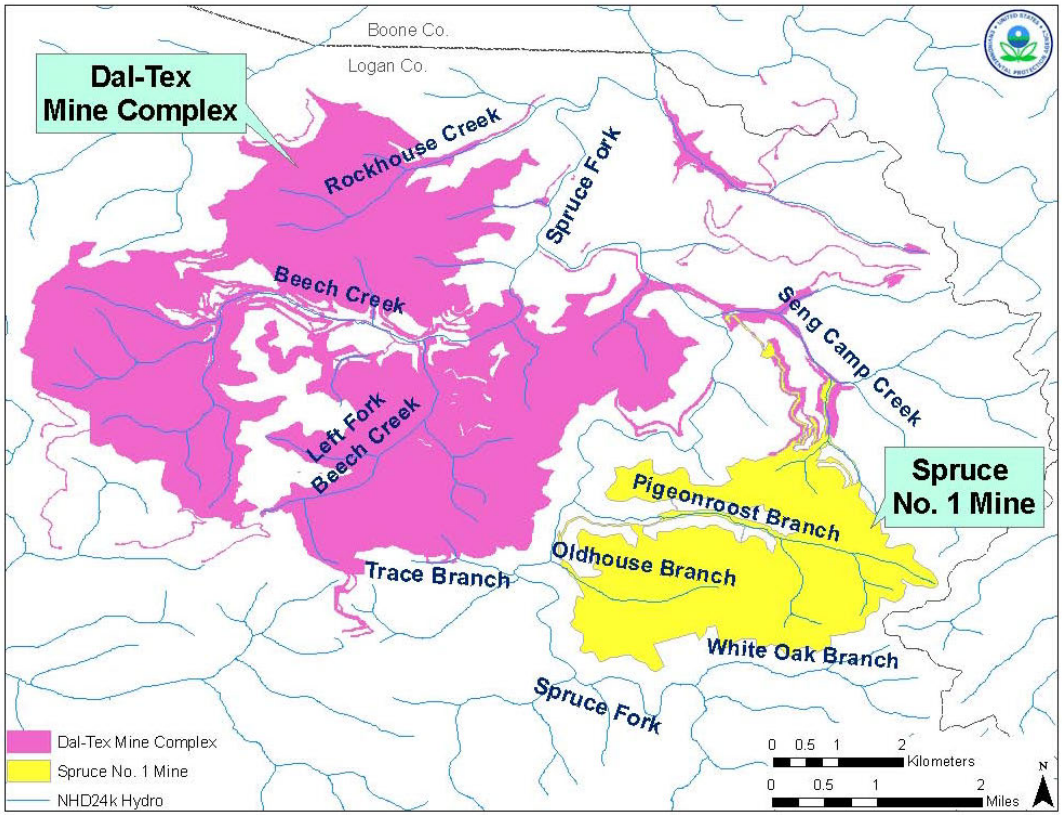

Figure 8. Spruce No. 1 Mine and the Dal-Tex Mine Operation

V.C. Unacceptable Adverse Impacts on Wildlife within the Spruce No. 1 Mine Project Area

The unacceptable adverse impacts from the specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for the discharge of dredged or fill material from the Spruce No. 1 Mine will occur through several different pathways. This section discusses the direct impacts to wildlife and wildlife habitat.

Direct impacts will occur as a result of the discharges of dredged or fill material from the construction of valley fills and sediment ponds that will bury much of Pigeonroost Branch and Oldhouse Branch, including all wildlife living in these streams, their tributaries, and associated riparian areas. Burial of Pigeonroost Branch and Oldhouse Branch also will eliminate habitat for wildlife that depend upon those streams. The loss of these portions of Pigeonroost Branch and Oldhouse Branch will also adversely impact wildlife within this watershed that depend on headwater streams for all or part of their life cycles.

Construction of valley fills and other discharges of dredged or fill material associated with the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch will result in a significant loss of wildlife habitat. The direct effects of the Spruce No. 1 Mine, as authorized, include permanent placement of fill in approximately 6.6 miles of stream in Pigeonroost Branch and Oldhouse Branch. Based on stream information from the National Hydrography Dataset, this loss represents 5.6% of the total stream length in the Headwaters Spruce Fork sub-watershed. The destruction of 6.6 miles of high quality stream habitat in a watershed where there is little remaining high quality stream habitat, and the subsequent loss of many populations of macroinvertebrates, salamanders, fish and other wildlife dependent upon that aquatic habitat area for survival, including water-dependent birds, will result in a loss of regional biodiversity and the broader ecosystem functions these populations provide.

V.C.1. Macroinvertebrates

Construction of valley fills and other discharges of dredged or fill material authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will impact the native macroinvertebrate community directly through loss of stream habitat as a result of fill. Because the macroinvertebrate assemblages in these streams represent least-disturbed conditions within the Coal River sub-basin, the loss of these communities and their habitat will adversely impact regional native biodiversity.

As set forth in Section IV.B.1. above, benthic macroinvertebrates are diverse and healthy in the Spruce No. 1 Mine area and represent an important component of the aquatic community in Pigeonroost Branch and Oldhouse Branch. Also, direct burial of these populations will likely affect food webs and the processing and transfer of energy and nutrients downstream. As primary consumers, macroinvertebrates play an important role in the breakdown of organic matter, allowing for the transport of fine particulate organic matter to downstream organisms, and converting algal and terrestrial plant matter into energy (biomass). Invertebrates are at the base of the faunal food web, and thus they also play a critical role in the delivery of energy and nutrients to downstream reaches (in aquatic life stages) as well as to upland terrestrial habitats (in winged adult life stages), most notably through food web pathways.

V.C.2. Salamanders & Other Herpetofauna

As stated in IV.B.2., the Central Appalachian ecoregion has one of the highest concentrations of salamander fauna in the world. Impacts from the activities authorized will have a significant adverse impact on this form of wildlife located within the project area. Based on literature values (Williams 2003) for mean densities within reference reaches of Pigeonroost Branch, Bend Branch (another tributary of Spruce Fork), and Ash Fork (a tributary of Gauley River) and a 2004 USFWS study in White Oak Branch, EPA estimates aquatic salamander density in Pigeonroost Branch and Oldhouse Branch at approximately 5-6 individuals per square meter along stream channels. The loss of this density over 6.6 miles of stream reflects a substantial loss.

It is not expected that stream salamanders will return to the site due to the burial of their existing habitat. Gingerich (2009) found no expected stream salamanders inhabiting 3-20 year-old sedimentation ditches (5 out of 5 mines) in West Virginia mountaintop mining areas. Furthermore the USFWS has indicated that, to its knowledge, it has not been demonstrated that salamanders return to mined areas at densities similar to those that occurred prior to mining. USFWS also indicated that while range-wide populations of common species may not be significantly impacted, the salamander communities in individual headwater systems behave essentially as isolated populations because there is limited interaction (immigration and emigration) with communities in adjacent watersheds (personal communication with Dr. Thomas Pauley, Marshall University and with Jim Zelenak USFWS West Virginia Field Office).

Because salamanders represent the main vertebrate predator in these headwater streams, and will be eradicated under the project, EPA believes that a key component of the aquatic food web will be lost or significantly reduced from the ecosystem within Pigeonroost Branch and Oldhouse Branch portions of the Spruce No. 1 Mine area. Additionally, the loss of these salamanders will have broader food web implications, as they also serve as prey for numerous terrestrial and aquatic species found within the Spruce No. 1 Mine site, including fish, snakes, birds, mammals, turtles, frogs, crayfish and other salamanders (Davic and Welsh 2004).

V.C.3. Fish

Pigeonroost Branch and Oldhouse Branch are considered least-disturbed streams within the Coal River sub-basin, and as such, they have good water quality and support good quality fish assemblages. While these assemblages have a naturally low diversity, consistent with low order headwater streams within the Coal River sub-basin, they are healthy and productive. Construction of valley fills and other discharges of dredged or fill material authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will lead to the total loss of over six miles of high quality, least-disturbed in-stream habitat and thus the total loss of five naturally occurring fish populations within the project area. Fish species that will be directly impacted include blacknose dace, creek chub mottled sculpin, stonerollers and smallmouth bass. Moreover, the permitted fill will reduce the

habitat available for fishes within the watershed that use these streams as refugia and seasonal foraging or spawning habitat, including smallmouth bass. Additionally, species like the mottled sculpin, a bottom-dwelling species that has a restricted home range, have a low dispersal rate, which makes it more difficult for them to recolonize an area following disturbance.

V.C.4. Water-dependent Birds

The Spruce No. 1 Mine will impact the Louisiana Waterthrush, a water-dependent bird that requires forested headwater streams for foraging on insects and nesting, by eliminating the headwater areas associated with Pigeonroost Branch and Oldhouse Branch. The Louisiana Waterthrush has been designated by USFWS as a Bird of Conservation Concern (BCC) within the Appalachian Mountains Bird Conservation Region (AMBCR) because of potential impacts from surface coal mining activities.

According to USFWS, the Louisiana Waterthrush is an area-sensitive riparian-obligate species that nests and forages along headwater streams of intact interior forests. Because it requires riparian woodland habitat to forage for macroinvertebrates along streams, approximately 6.6 miles of Louisiana Waterthrush stream and riparian habitat will be lost due to fill being placed in Pigeonroost Branch and Oldhouse Branch and their tributaries. For water-dependent birds like the Louisiana Waterthrush, preservation of large tracts of forest containing headwater streams is needed for the conservation of this species in the central Appalachians. The Waterthrush is particularly vulnerable to degradation of water quality and aquatic insect communities (Mattsson and Cooper 2006, Mulvihill et al. 2008).

V.C.5. Summary

Pigeonroost Branch and Oldhouse Branch and their tributaries are some of the last remaining streams within the Headwaters Spruce Fork sub-watershed and the larger Coal River sub-basin that represent “least-disturbed” conditions and habitat that is essential for many species in the watershed. As such, they perform critical hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role within the context of the overall Headwaters Spruce Fork sub-watershed and Coal River sub-basin. Within the streams and riparian areas of the project area, over 84 taxa of macroinvertebrates are documented to exist, as well as up to 46 species of reptiles and amphibians, 4 species of crayfish, 5 species of fish and at least one water-dependent bird species.

Construction of valley fills, sediment ponds, and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) will eliminate the headwater stream ecosystems in Pigeonroost Branch and Oldhouse Branch. The direct impacts to these headwater stream systems, through burial of these diverse and healthy wildlife communities and their habitat, will result in unacceptable adverse effects on wildlife, particularly to macroinvertebrate, amphibian, fish, and water-dependent bird populations. Through the loss of stream macroinvertebrate and salamander communities, there will be,

in turn, substantial effects to both aquatic and terrestrial vertebrate populations that rely on these communities as a food source.

In the preamble to EPA's final rules implementing § 404(c), EPA stated "[t]he term 'unacceptable' in EPA's view refers to the significance of the adverse effect -- e.g. is it a large impact and is it one the aquatic and wetland ecosystem cannot afford" (44 FR at 58078). The filling in and complete destruction of the 6.6 miles of streams at issue here is a large impact and clearly adverse to the wildlife that will be buried under thousands of tons of excess spoil. These adverse impacts are particularly large in context of the evidence that these streams are some of the last, rare and important high quality streams in the watershed. That context also leads EPA to the conclusion that this adverse impact is one that the aquatic ecosystem cannot afford. Based on this information, EPA has concluded that the discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) will have unacceptable adverse effects on wildlife in Pigeonroost Branch and Oldhouse Branch.

V.D. Unacceptable Adverse Impacts on Wildlife Downstream of the Discharge of Dredged or Fill Material from the Spruce No. 1 Mine

Unacceptable adverse impacts will also occur to wildlife downstream of the footprint of the fills and sediment ponds. These unacceptable adverse impacts will be caused by removing Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution and converting them to sources of pollution. Water quality downstream of valley fills and in sediment ditches in mined areas is typically degraded due to high concentrations of solutes, primarily because it has percolated through mine spoil. Mine spoil, made up of fragmented mine rocks, has higher rates of rock weathering than bedrock because of its exposure to air and water, and percolation of water through these exposed rocks leads to increased concentrations of solutes, including total dissolved solids and selenium, in downstream receiving waters. In turn, this will adversely affect the delivery of headwater stream ecosystem functions to downstream waters. Studies have shown a strong correlation between the construction of valley fills for surface coal mining in Appalachia and significant adverse impact on downstream macroinvertebrate communities.

EPA believes that the discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch will transform those areas into sources of contaminants (particularly TDS and selenium) contributing to degradation of downstream waters. The project as authorized also will create areas of pooled water and increased conductivity, both of which are among the conditions known to be necessary to support harmful blooms of golden algae.

V.D.1. Increases in Pollutants Harmful to Wildlife

This section identifies increased loads of selenium and TDS (measured as conductivity) that are expected to occur as a result of the discharges of coal overburden as authorized and the unacceptable adverse impacts to wildlife that will occur as a result of these increases. These impacts to water chemistry are identified because they will adversely

affect the native aquatic and water-dependent wildlife communities in the Spruce Fork watershed as discussed further below.

V.D.1.a. Selenium

Discharges from the Spruce No. 1 Mine Complex project are expected to increase selenium loading to the immediate receiving streams and downstream waters. Selenium (Se) is a naturally occurring chemical element that is an essential micronutrient, but can also have toxic effects following exposure to excessive amounts. For aquatic animals, the concentration range between essential nutrient and toxin is very narrow, being only a few micrograms per liter in water. Adverse impact of selenium residues in aquatic food chains results not just from the direct toxicity to the organisms themselves, but also from the dietary source of selenium these organisms contribute to fish and wildlife species in the food web that feed on them.

Selenium toxicity is primarily manifested as reproductive impairment and birth defects due to maternal transfer, resulting in embryotoxicity and teratogenicity in egg laying vertebrates (e.g., fish and ducks). The most sensitive toxicity endpoints in fish larvae are teratogenic deformities such as skeletal, craniofacial, and fin deformities, and various forms of edema. Embryo mortality and severe development abnormalities can result in impaired recruitment of individuals into populations (Chapman et al. 2009). The State of West Virginia has established a numeric chronic water quality criterion for selenium (5 μg/L four-day average not to be exceeded more than once every three years) to protect in-stream aquatic life. EPA's conclusion that the Spruce 1 Mine as authorized would cause unacceptable adverse effects on wildlife is not dependent on a conclusion that West Virginia's water quality standards will be violated at or downstream of the site. Rather, reference to this water quality standard provides information and context.

In West Virginia, coals that contain the highest selenium concentrations are found in a region of south-central West Virginia where the Allegheny and Upper Kanawha Formations of the Middle Pennsylvanian are mined (WVGES 2002). The WVDEP reports that some of the highest coal selenium concentrations are found in the central portion of the Coal River sub-basin in the immediate vicinity of the Spruce No. 1 Mine where significant active mining and selenium impaired streams are located. Selenium is discharged when selenium-bearing material exposed by surface mining activities comes in contact with water and contaminated water drains from the mining area to surface waters. The sediment ponds that are the usual form of water treatment at mining sites generally are not effective at treating selenium before effluent is discharged from ponds to downstream waters. The coal beds to be targeted by the Spruce No. 1 Mine include 5-Block of the Allegheny Group and down to the Upper Stockton coal bed in the eastern portion of the project area. In the western portion of the project area, the mine plan includes extraction of coal through the Middle Coalburg coal bed. These coal beds are rich in Se as evidenced by Se distribution data in the Spruce No. 1 column (DT0417) provided by the applicant for the NPDES permit application.

Total Maximum Daily Loads to address impairment from elevated concentrations of selenium have been developed for six other streams affected by mining in the Coal River sub-basin. These include nearby White Oak Creek, a tributary to the Coal River, the left Fork of White Oak Creek, Seng Creek, also a tributary to the Coal River; and Casey Creek, James Creek, and Beaver Pond Branch, all tributaries to Pond Fork. These elevated levels of selenium demonstrate that the geology in the vicinity of the Spruce No. 1 Mine will release selenium during mining activities. See Appendices 1 and 4 for further details.

To evaluate the impact of discharges into Pigeonroost Branch and Oldhouse Branch as authorized by the DA permit, EPA has compared selenium levels in Pigeonroost Branch and Oldhouse Branch with selenium levels in waters that have been impacted by the nearby Dal-Tex operation.[13] In addition, EPA has reviewed data from a mining outlet that drains, among other things, discharges from a portion of the Spruce No. 1 Mine that has been constructed in the Seng Camp Creek watershed (Figure 9).

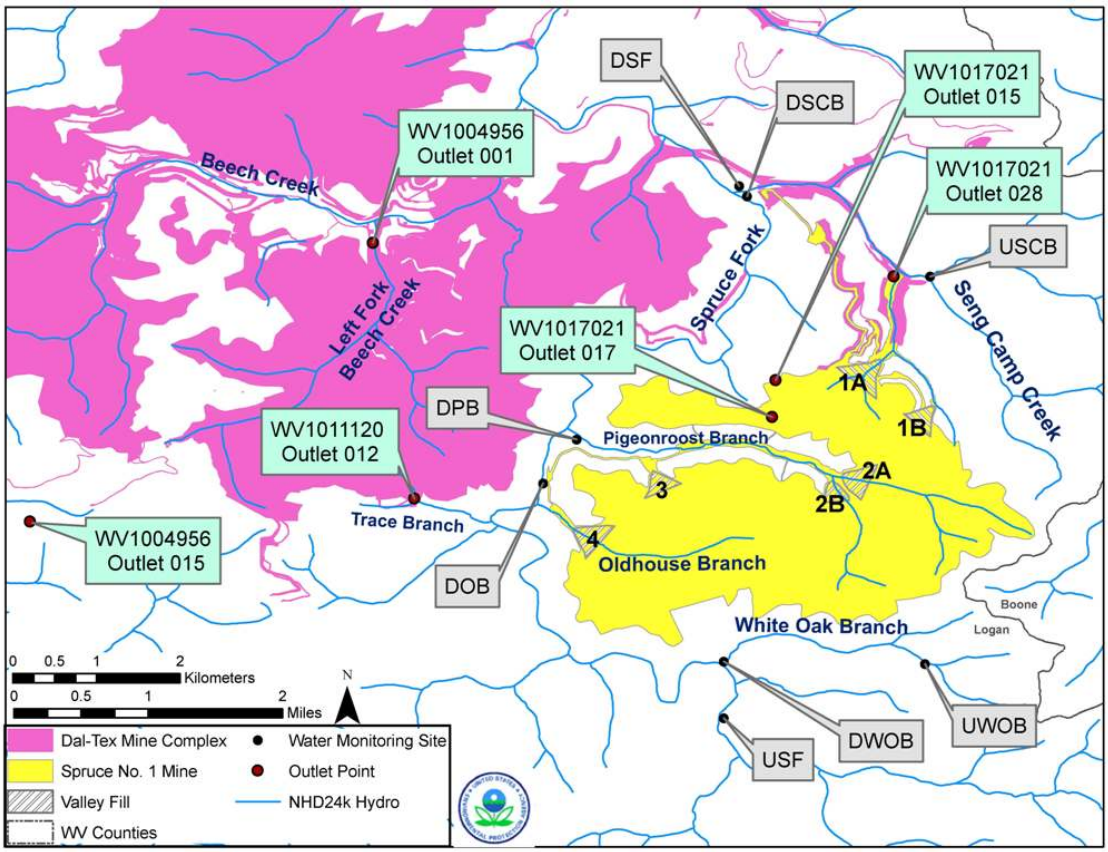

Figure 9. Spruce No. 1 Mine and the Dal-Tex Mine Outlet Locations

[13] Levels of selenium in other nearby waters that have been impacted by surface coal mining activity and generally have similar geology also support a prediction that construction of the Spruce No. 1 Mine as currently authorized will result in elevated levels of selenium in downstream waters.

EPA scientists completed a review of rock cores and corresponding cross sections for the Dal-Tex mines including the Gut Fork mine compared to the Spruce No. 1 Mine. For the most part, the formations are repeated from the Dal-Tex mine complex to the Spruce No. 1 Mine location. Table 8 provides a summary of selenium averages and ranges for Pigeonroost Branch and Oldhouse Branch and streams draining the nearby Dal-Tex operation (Left Fork Beech Creek, Beech Creek, and Trace Branch). The table also contains data for White Oak Branch (upstream of Spruce No. 1 Mine) and Seng Camp Creek (prior to 2007, when the DA permit was issued and filling associated with Spruce No. 1 commenced in that watershed). Summarizing the data in the following table, streams draining the nearby Dal-Tex operation have selenium concentrations in excess of 5 µg/L.

Table 8. Selenium Concentrations (µg/L) near Spruce No. 1 Mine

Stream Name	Sub-basin	Source and time period of data					
		PEIS (2000-2001)		WVDEP (2002-2003)		WVDEP (2005-2007)	
		Se (Avg.)	Se (Range)	Se (Avg.)	Se (Range)	Se (Avg.)	Se (Range)
Average and Range of Se in Tributaries to Spruce Fork that drain Spruce No. 1 Mine area							
White Oak Branch	Spruce Fork	<3 ND		<5 ND		NS	
Oldhouse Branch	Spruce Fork	<3 ND		<5 ND		NS	
Pigeonroost Branch	Spruce Fork	<3 ND		<5 ND		NS	
Seng Camp Creek	Spruce Fork	NS		<5 ND		NS	
Average and Range of Se in Tributaries to Spruce Fork draining Dal-Tex Operation							
Beech Creek[14]	Spruce Fork	7.5	5.6-9.5	6	5.0-9.0	12.3	6.0-22.0
Left Fork of Beech Creek	Spruce Fork	22.7	15.3-31.1	22	5.0-53.0	NS	
Trace Branch	Spruce Fork	NS	NS	7	5.0-10.0	NS	
Rockhouse Branch	Spruce Fork	5.3	3.8-8.0	< 5 ND	< 5 ND	NS	

ND: Se not detected. Detection limit shown.
NS: Not sampled. Stream was not sampled for the study shown.

The data from the Dal-Tex mine complex do not indicate any decrease in selenium concentrations over a period of several years. These data strongly suggest the construction of valley fills and other discharges of dredged or fill material (e.g., associated sediment ponds) from the Spruce No. 1 Mine into Pigeonroost Branch and

[14] In the WVDEP study on selenium bioconcentration factors, selenium was also found in fish tissue in Beech Creek (average 7.55 mg/kg).

Oldhouse Branch will result in elevated levels of selenium in the receiving waters, and lead to degradation of water quality of the receiving and downstream waters. EPA believes such degraded water quality will impact wildlife populations in the receiving and downstream waters, including fish populations.

Graphical trends of selenium concentrations from Discharge Monitoring Report (DMR) records for January 2007 to June 2010 from three outfalls from the Dal-Tex Mine operations demonstrate that the discharges from those outfalls consistently exceed 5 µg/L (Figures 10, 11 and 12).

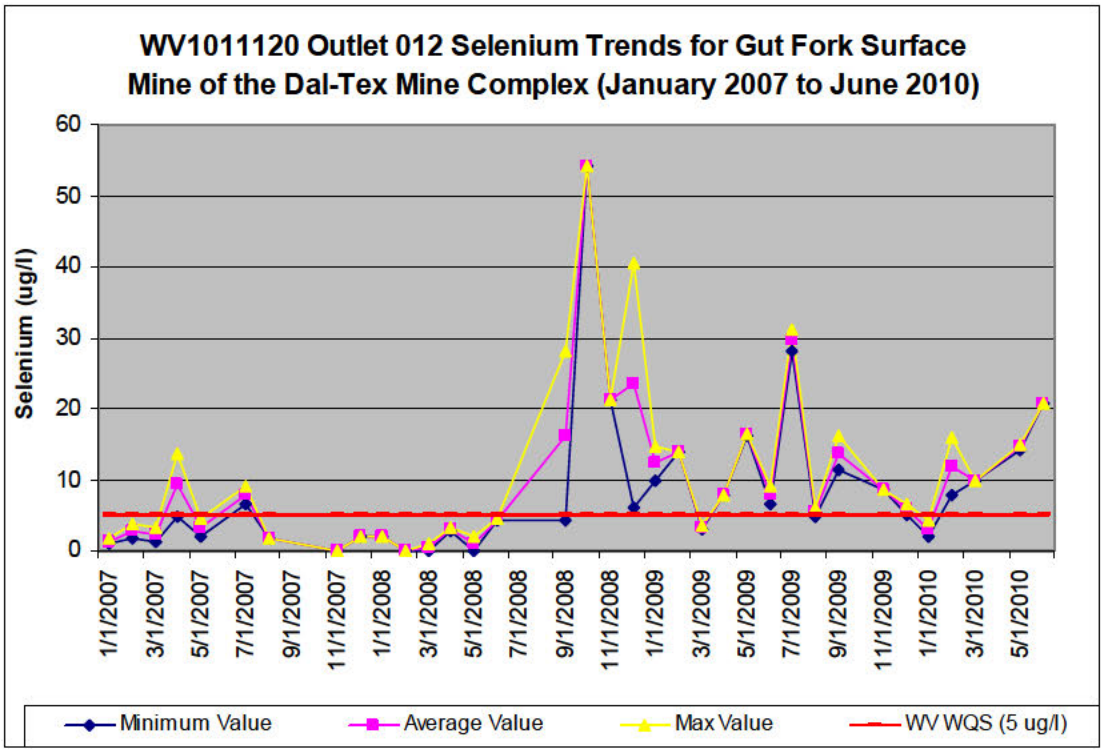

Figure 10. Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1011120 – Outlet 012 (Mingo Logan Coal Company's Gut Fork Surface Mine of the Dal-Tex Mine Complex)

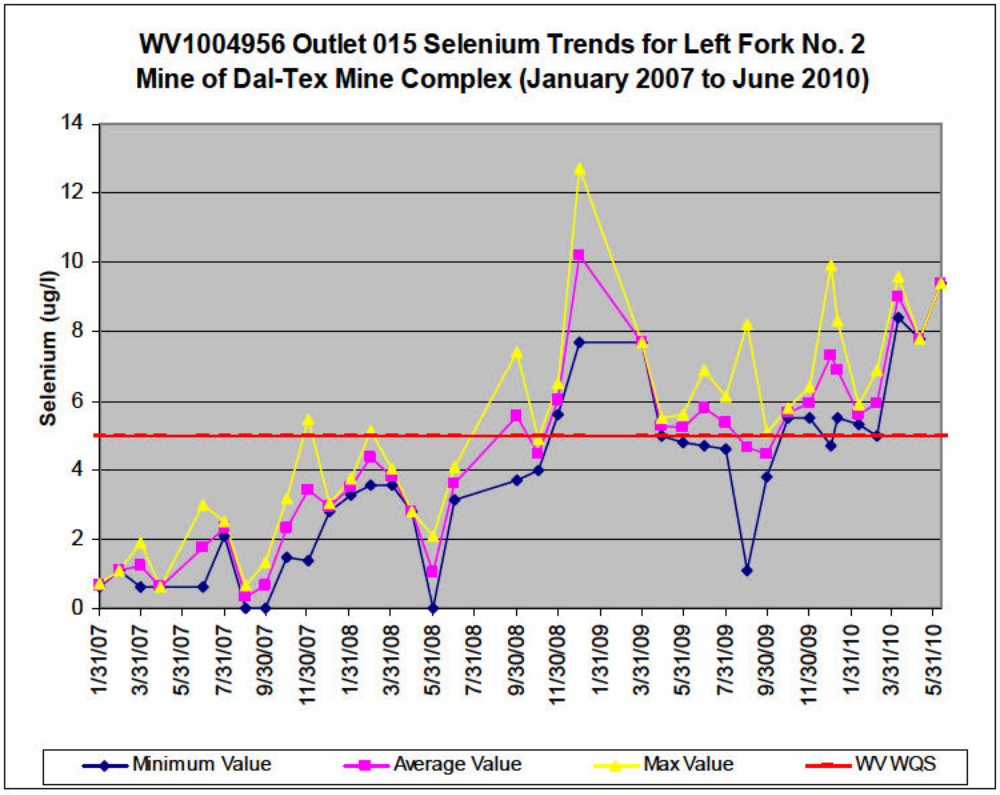

Figure 11. Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1004956 – Outlet 015 (Mingo Logan Coal Company's Left Fork No. 2 Mine of the Dal-Tex Mine Complex)

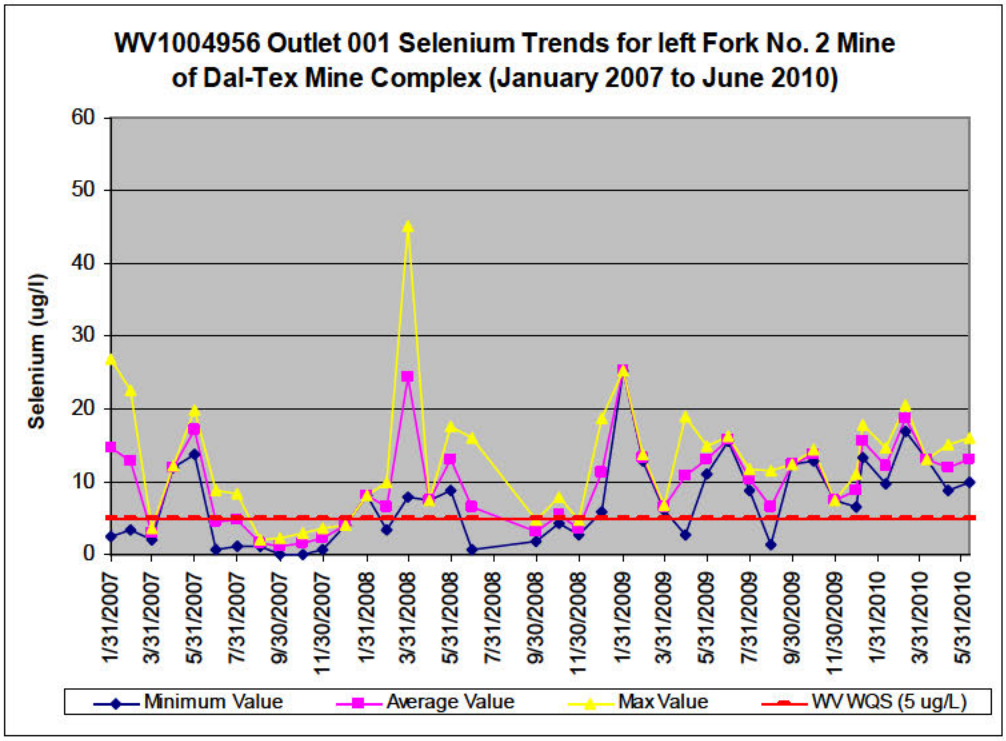

Figure 12. Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1004956 – Outlet 001 (Mingo Logan Coal Company's Left Fork No. 2 Mine of the Dal-Tex Mine Complex)

EPA also reviewed data from the portion of the Spruce No. 1 Mine that is already operational in Seng Camp Creek (Figure 13), including active mining activities in the Right Fork of the Seng Camp Creek sub-watershed. Recent NPDES discharge monitoring reports (DMRs), submitted by the permittee, over a 16-month period (December 2008 to September 2010) show that Outfall 028, which handles, among other things, discharges from Valley Fill 1A, is discharging selenium at average monthly concentrations above 5 µg/L (Table 9, Figure 13).[15] It is also noted that the September 2009 value from Outfall 017 also is elevated. These data support EPA's prediction that construction of valley fills in Pigeonroost Branch and Oldhouse Branch will result in discharges of elevated levels of selenium.

Table 9. Total Recoverable Selenium (µg/L) for Outfalls 015, 017 and 028 for NPDES Permit WV1017021, Mingo Logan Coal Company Spruce No. 1 Mine. Note: Shaded areas indicate selenium concentrations exceeding 5 µg/L.

Site Code	Site Location	Report Date	Min Value	Avg. value	Max value
015	Outlet 015	12/31/2008	0.00	0.00	0.00
017	Outlet 017	12/31/2008	0.00	0.00	0.00
017	Outlet 017	9/30/2009	19.20	19.20	19.20
028	Outlet 028	12/31/2008	5.70	5.70	5.70
028	Outlet 028	1/31/2009	9.80	9.80	9.80
028	Outlet 028	2/28/2009	3.90	3.90	3.90
028	Outlet 028	3/31/2009	0.60	1.00	1.40
028	Outlet 028	4/30/2009	1.70	1.70	1.70
028	Outlet 028	5/31/2009	2.50	2.50	2.50
028	Outlet 028	6/30/2009	3.20	3.30	3.40
028	Outlet 028	8/31/2009	1.25	3.48	5.70
028	Outlet 028	9/30/2009	4.60	6.05	7.50
028	Outlet 028	10/31/2009	3.00	3.00	3.00
028	Outlet 028	11/30/2009	1.40	1.85	2.30
028	Outlet 028	12/31/2009	1.80	1.85	1.90
028	Outlet 028	1/31/2010	3.40	3.80	4.20
028	Outlet 028	2/28/2010	3.80	4.50	5.20
028	Outlet 028	3/31/2010	4.70	6.10	7.50
028	Outlet 028	4/30/2010	3.8	4.40	5.00
028	Outlet 028	5/31/2010	4.70	7.60	10.50
028	Outlet 028	6/30/2010	11.40	11.50	11.60
028	Outlet 028	7/31/2010	6.40	8.50	10.40
028	Outlet 028	8/31/2010	4.80	10.65	14.80
028	Outlet 028	9/30/2010	4.80	9.40	11.00

[15] While Outfall 028 receives discharges from other portions of the site, it handles the discharges from valley fill 1A. EPA notes that WVDEP sampling from 2002-2003 (prior to construction of Spruce No. 1 Mine in Seng Camp Creek) found selenium levels in Seng Camp Creek to be below detection levels.

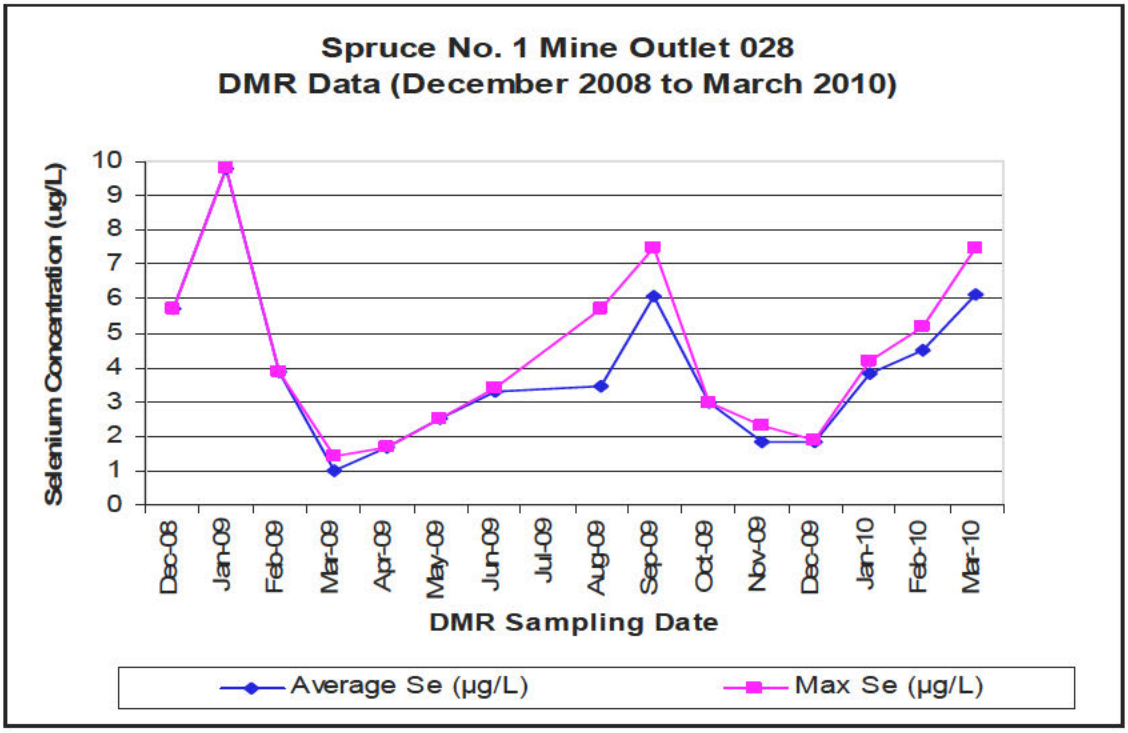

Figure 13. Selenium concentrations in discharge from outlet 028.

In addition to discharges of elevated concentrations of selenium, the project also will have the effect of increasing selenium concentrations in downstream waters by removing Pigeonroost Branch and Oldhouse Branch as sources of dilution that moderate downstream selenium concentrations. EPA evaluated the in-stream DMR monitoring data from December 2008 to March 2010 from several ambient monitoring stations associated with the Spruce No. 1 mine as authorized project: Stations DSCB (Downstream Seng Camp Creek, located at the mouth of Seng Camp Creek), USCB (Upstream Seng Camp Creek), USF (Upstream Spruce Fork), DSF (Downstream Spruce Fork, located downstream of Seng Camp Branch), DPB (downstream Pigeonroost Branch, at mouth of Pigeonroost Branch) and DOB (Downstream Oldhouse Branch, at mouth of Oldhouse Branch). As explained below, this analysis shows that Pigeonroost Branch and Oldhouse Branch are providing dilution that is helping to maintain reduced selenium concentrations in Spruce Fork.

The Spruce Fork watershed upstream of Pigeonroost Branch and Oldhouse Branch (Station USF) has average monthly selenium concentrations ranging from 0.9 µg/L to 10.90 µg/L (August 2010), with nine monthly average concentrations greater than 5 µg/L based on the in-stream DMR data for the December 2008 to September 2010 time period. It should be noted that the last 6 months of available DMR data (April 2010 to September 2010) for USF had monthly selenium concentrations above the 5 µg/L potentially indicating new selenium contamination sources. The downstream Spruce Fork (DSF) site has concentrations that are significantly lower, and does not have any average monthly selenium concentrations above 5 µg/L, with the highest monthly average selenium concentration during the time period (December 2008 to September 2010) being 2.50 µg/L (May 2010). This suggests that Pigeonroost Branch and Oldhouse

Branch (along with other tributaries that enter Spruce Fork between the monitoring stations) provide clean dilution water to the main stem of Spruce Fork. This conclusion is supported by the very low levels of selenium in Pigeonroost Branch and Oldhouse Branch. During the same December 2008 to September 2010 time frame, the DMR reports indicate almost all of the average monthly selenium measurements at both Pigeonroost Branch and Oldhouse Branch were below the detection limit of 0.6 µg/L. The single detection of selenium during the time period in Oldhouse Branch was 0.9 µg/L during July 2009 (a maximum value). All monthly average selenium concentrations in Pigeonroost Branch were below the detection limit from December 2008 through June 2010 except the monthly average in August 2009 which had a value of 1.3 µg/L (maximum value was 1.9 µg/L). However, the monthly average selenium concentrations for the July 2010 to September 2010 time period documented a developing selenium problem in Pigeonroost Branch. The monthly average selenium concentration in July 2010 was 2.7 µg/L, August 2010 was 2.6 µg/L and September 2010 was 1.4 µg/L.

By way of example, the average monthly selenium concentration at the USF monitoring location for the month of April 2010 is reported on the DMR as 10.60 µg/L. The average monthly concentration at the DSF location for April 2010 is reported on the DMR as 0.90 µg/L. For April 2010, the DMR reports average monthly selenium concentrations at Pigeonroost Branch and Oldhouse Branch as below the detection level of 0.60 µg/L. While Pigeonroost Branch and Oldhouse Branch are not the only contributing tributaries between the USF and DSF stations, this data strongly suggests that they are contributing dilution.

In summary, water quality from streams and discharges draining both the Dal-Tex Mine Complex and the current operational portions of the Spruce No. 1 Mine confirm EPA's concern that the Spruce No. 1 Mine, if constructed as authorized, would contribute additional loads of selenium to downstream waters at concentrations that, as a monthly average, will exceed 5 µg/L.

V.D.1.b. Total Dissolved Solids

To understand the water quality impacts from increased total dissolved solids (TDS), it is helpful to understand the relationship between salinity, TDS, and specific conductivity. For purposes of this action, when this document discusses increased conductivity or TDS, it refers to an increase in salinity in otherwise dilute freshwater, an increase that is inconsistent with background levels in central Appalachian streams.

Salinity is the amount of dissolved salt in a given body of water. TDS is a measure of the combined content of all inorganic and organic substances contained in a solution in molecular, ionized or micro-granular (colloidal) suspended form and is normally reported in the unit mg/l. Because the majority of TDS in many waters consist primarily of salts, salinity effectively reflects the amount of TDS in water.

Salinity is often expressed in terms of specific conductivity (hereafter referred to as conductivity). Conductivity is the ability of a solution to carry an electric current at a

specific temperature (normally 25º C) and is normally reported as microsiemens per centimeter (µS/cm). Whereas "salinity" refers to the environmental property that is being measured, "conductivity" refers to the *measure* of salinity. Conductivity and TDS both increase as the concentration of ions in a solution increase and are very strongly correlated. Conductivity itself is not a pollutant, but is an excellent indicator of the total concentration of all ions, and is typically reported by state and federal monitoring agencies because it is an instantaneous measurement that can be collected in situ with a meter, does not require a laboratory analysis, and is precise and accurate.

Data from the WVDEP indicate that average conductivity values for Pigeonroost Branch and Oldhouse Branch are very low and are consistent with dilute background conditions in central Appalachian headwater streams. Construction of valley fills and other discharges of dredged or fill material from the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch will cause an increase in conductivity and TDS in those receiving waters downstream of such discharges. These discharges will have two effects: first, they will eliminate Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution to downstream waters, including Spruce Fork; and second, they will transform Pigeonroost Branch and Oldhouse Branch into sources of increased conductivity and TDS to downstream waters. Sediment ponds, which are a typical form of water treatment for surface coal mines, appear to be ineffective in removing TDS and decreasing conductivity. For example, average conductivity and sulfate levels are highly elevated in other tributaries to Spruce Fork where historical mining has occurred compared with Pigeonroost Branch and Oldhouse Branch (Table 10) (see Appendix 1).

Table 10. Average conductivity and sulfate values for streams in project area

Stream	**Conductivity Values (µS/cm)**	**Sulfate Values (mg/l)**
Rockhouse Creek	1012	407
Left Fork of Beech Creek	2426	1019
Beech Creek	1432	557
Trace Branch	971	569
Oldhouse Branch	90	28
Pigeonroost Branch	199	99

Average conductivity and sulfate concentrations in the main stem of Spruce Fork into which Pigeonroost Branch and Oldhouse Branch flow are elevated to as much as ten times above natural background levels in Oldhouse Branch. Average conductivity at almost every monitoring site on the main stem Spruce Fork exceeded 500 µS/cm. Only one site had an average conductivity of less than 500 µS/cm, which was located upstream of the project area, upstream of Adkins Fork, and southeast of Blair, WV.

EPA expects that these additional conductivity increases will have significant adverse effects on native aquatic macroinvertebrates and other wildlife that are not tolerant to increased conductivity. Invertebrate health depends upon an organism's ability to maintain certain concentrations of ions in their blood and tissues, which they pull from the water via specialized cells on their gills and body surfaces and lose through

defecation/urination and diffusion. Native headwater invertebrates are adapted to streams with low dissolved solids (i.e., conductivity). In Central Appalachian surface coal mining, the ionic mixture emanating from valley fills is fairly predictable, and tends to be alkaline or circumneutral (pH 5.5-7.4), have highly elevated concentrations of four major ions (SO_4, HCO_3, Mg, Ca) and have only slightly elevated concentrations of K, Na, and Cl. Elevated levels of ions can be individually toxic, but mixtures of these ions can be more toxic than the individual ions, since more than one ion is a potential toxicant. Elevated ion concentrations can also create a general osmoregulatory stress on organisms that are adapted to environments with low dissolved solids (i.e., conductivity) (Pond et al. 2008). Elevated conductivity can have a toxic effect because the ions, regardless of type, can overwhelm the respiratory system and other physiological processes leading to impaired breathing, dehydration, and decreased survival or reproduction. Thus, native Appalachian taxa adapted to naturally dilute streams can be harmed by elevated conductivity for these physiological reasons. See Appendix 1 for further detail on water quality and wildlife.

EPA modeled post-mining conductivity levels in Spruce Fork downstream of the project area using a watershed area weighted deterministic model with two post-mining average (500 and 1000 µS/cm) and maximum (1000 and 1500 µS/cm) conductivity values for Oldhouse Branch, Pigeonroost Branch and Seng Camp Creek. These values likely underestimate the post-mining conductivity values. For example, when compared to Left Fork Beech Creek, which is completely mined and filled, the average and maximum conductivity values are 2425 and 3000 µS/cm respectively. In Beech Creek, which is partially mined and filled, the respective average and maximum conductivity values are 1432 and 1776 µS/cm based on 2002-2003 WVDEP data. In every case, since the measured average and maximum conductivity levels in Spruce Fork are currently greater than 500 µS/cm pre-mining, the modeled post-mining conductivity values are also greater than 500 µS/cm. When using the maximum post-mining values identified above, EPA predicts that average conductivity in Spruce Fork downstream of Seng Camp Creek could increase from 552 µS/cm pre-mining to 748 µS/cm post-mining and maximum conductivity could increase from 960 µS/cm pre-mining to 1228 µS/cm post-mining.

Thus, EPA has determined that that the construction of the Spruce No. 1 Mine will cause changes to water quality downstream of the mine site, particularly with regard to selenium and total dissolved solids. The following subsections discuss the adverse impacts on specific fauna caused by these changes in water quality.

V.D.2. Macroinvertebrates

Construction of valley fills and other discharges of dredged or fill material authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will impact the native macroinvertebrate community downstream of the fill due to adverse changes in water quality. These adverse changes, such as increased selenium and conductivity, will result in subsequent changes in the aquatic community. Sensitive species of mayflies, stoneflies, and caddisflies currently inhabiting downstream waters will be extirpated following increasing chemical loading of contaminants, and the remaining taxa will likely serve as vectors for selenium bioaccumulation in higher trophic levels. Vertebrates

dependent upon macroinvertebrates as a food source, including salamanders, fish, birds and bats, will be subsequently affected, not only by the bioaccumulation of selenium, but also by the reduction in prey availability. Additionally, shifts in macroinvertebrate communities will likely affect important stream ecosystem functions, including organic matter breakdown (Fritz et al. 2010).

V.D.2.a. Impacts Due to Changes in Water Chemistry

Construction of valley fills and other discharges of dredged or fill material associated with the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch will result in altered and degraded macroinvertebrate communities in downstream environments (Appendix 2). The downstream effects of mining on macroinvertebrate communities include non-lethal effects and bioaccumulation of selenium, and extirpation of native, sensitive taxa. These effects can be significant, and are largely influenced by degraded water quality conditions downstream of valley fills. If the Spruce No. 1 Mine is constructed as authorized, these effects will occur in the receiving waters, including the unfilled portions of Pigeonroost Branch and Oldhouse Branch, and also further downstream in Spruce Fork. This conclusion is supported by numerous peer-reviewed studies, as well as empirical data collected and analyzed for the PEIS and permit application and discussed below.

Although there is little research on the direct effects of increased selenium loading on aquatic macroinvertebrates, some studies indicate the potential for macroinvertebrate populations to be adversely affected by selenium, even at concentrations below water quality thresholds established to protect fish and bird populations. For example, a review by Debruyn and Chapman (2007) found that the range of selenium water quality thresholds established to protect higher trophic levels consuming selenium-contaminated invertebrates could, in some cases, have substantial toxic effects on invertebrates, including reduced growth, reduced abundance, and mortality. Similarly, this review estimated that sublethal toxic effects can be associated with a range of water concentrations of 1-30 μg Se/L, which is consistent with experimental studies that found that some macroinvertebrate taxa exhibited approximately 50% reduction in abundance at Se water concentrations in the range of 5-10 μg Se/L. The remaining individuals that do survive accumulate the contaminants, thus exposing higher trophic levels (e.g., fish and amphibians) to concentrations that have the potential to cause population-level effects. Both the lethal and non-lethal effects on macroinvertebrate prey will result in significant impacts to higher trophic level organisms and food webs in the downstream ecosystem.

As outlined in Section V.D.1.b above, construction of valley fills and other discharges from the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch will cause an increase in salinity and TDS in receiving waters immediately downstream of valley fills. Bryant et al. (2002) found substantially higher average measurements of alkalinity, calcium, sulfate and total dissolved solids in nearby streams affected by mining than in streams unaffected by mining streams in the Spruce No. 1 project area. Increased concentrations of TDS can have significant implications for native wildlife. While many

of the elements that comprise mineral salts are essential nutrients, aquatic organisms are adapted to specific ranges of salinity and experience toxic effects from excess salinity.

Due to the sensitivity of native macroinvertebrate wildlife to elevated and increasing levels of conductivity, the predicted levels of these contaminants will have significant adverse effects on these biological communities. While changes in community composition downstream of mined sites are likely due to a combination of factors, it is likely that water quality changes, including water quality degradation from valley fills and in-stream mining impoundments, are the primary cause of aquatic life impacts below valley fills (Appendix 2). EPA's draft report, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (USEPA 2010a), also recognizes stream aquatic life impacts associated with conductivity, concluding that impacts to the biological community can occur at conductivity levels as low as 300 µS/cm.

The effects of mining on macroinvertebrate communities are evident when comparing the least-disturbed streams in the project area (Oldhouse Branch and Pigeonroost Branch) with nearby streams directly affected by valley fills (Beech Creek and Left Fork Beech Creek). Collectively, Pigeonroost Branch and Oldhouse Branch support 84 unique macroinvertebrate genera, in contrast with Beech Creek and Left Fork Beech Creek, which only support 56 unique macroinvertebrate genera. Additionally, many Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) genera (collectively known as EPT taxa)[16] were extirpated from these nearby streams affected by mining (Table 11). Pigeonroost Branch and Oldhouse Branch support 42 EPT genera (14 mayfly genera, 12 stonefly genera and 14 caddisfly genera), in contrast with Beech Creek and Left Fork Beech Creek, which only support 12 EPT genera (2 mayfly genera, 3 stonefly genera, and 7 caddisfly genera).

At Beech Fork and Left Fork Beech Fork, in addition to the presence of relatively pollution-tolerant mayfly and stonefly genera, there were also several tolerant taxa that were not found in the Spruce project area. These taxa, which are indicative of altered environmental conditions (i.e., atypical of Appalachian headwater streams), include highly tolerant snails (Lymnaeidae, *Physella*, *Helisoma*), as well as other tolerant beetles and fly larvae (Table 11). Similar patterns of taxonomic loss were observed at 20 other West Virginia sites downstream of valley fills when conductivity was greater than 500 µS/cm (Pond et al. 2008) and in the eastern Kentucky coalfields (Pond 2010), and it is likely that these effects on wildlife taxa and their habitat will occur following the Spruce No. 1 Mine operations (Appendix 2).

[16] EPA focused on genus-level taxa richness (i.e., the number of genera) of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa (EPT taxa), as it can be used to detect shifts in community composition and extirpation of sensitive taxa (Appendix A2.7).

Table 11. Comparison of macroinvertebrate taxa identified on the Spruce No. 1 Mine site and Dal-Tex site.

			Oldhouse +Pigeonroost	Beech + Left Fork Beech
Order	**Family**	**Genus**	**Spruce No. 1 Mine**	**Dal-Tex Mine**
Oligochaeta	Oligochaeta	Oligochaeta	X	X
Nematoda	Nematoda	Nematoda		X
Proseriataoela	Plagiostomidae	*Hydrolimax*	X	
Tricladida	Planariidae	Planariidae	X	
Basommatophora	Lymnaeidae	Lymnaeidae		X
Basommatophora	Physidae	Physella		X
Basommatophora	Planorbidae	*Helisoma*		X
Coleoptera	Dryopidae	*Helichus*	X	
Coleoptera	Elmidae	*Dubiraphia*		X
Coleoptera	Elmidae	*Macronychus*		X
Coleoptera	Elmidae	*Microcylloepus*		X
Coleoptera	Elmidae	*Optioservus*	X	X
Coleoptera	Elmidae	*Oulimnius*	X	X
Coleoptera	Psephenidae	*Ectopria*	X	
Coleoptera	Psephenidae	*Psephenus*	X	X
Decapoda	Cambaridae	*Cambarus*	X	
Diptera	Ceratopogonidae	*Atrichopogon*		X
Diptera	Ceratopogonidae	*Bezzia/Palpomyia*	X	X
Diptera	Ceratopogonidae	*Dasyhelea*	X	X
Diptera	Chironomidae	*Acricotopus*		X
Diptera	Chironomidae	*Chaetocladius*	X	X
Diptera	Chironomidae	*Corynoneura*	X	X
Diptera	Chironomidae	*Cricotopus*	X	X
Diptera	Chironomidae	*Diamesa*	X	X
Diptera	Chironomidae	*Eukiefferiella*	X	X
Diptera	Chironomidae	*Metriocnemus*		X
Diptera	Chironomidae	*Micropsectra*	X	X
Diptera	Chironomidae	*Microtendipes*	X	
Diptera	Chironomidae	*Orthocladius*	X	X
Diptera	Chironomidae	*Parachaetocladius*	X	
Diptera	Chironomidae	*Parametriocnemus*	X	X
Diptera	Chironomidae	*Paraphaenocladius*		X
Diptera	Chironomidae	*Paratanytarsus*		X
Diptera	Chironomidae	*Polypedilum*	X	X
Diptera	Chironomidae	*Rheotanytarsus*	X	X
Diptera	Chironomidae	*Smittia*		X
Diptera	Chironomidae	*Stempellinella*	X	
Diptera	Chironomidae	*Stenochironomus*		X
Diptera	Chironomidae	*Stilocladius*	X	
Diptera	Chironomidae	*Sympotthastia*	X	
Diptera	Chironomidae	*Tanytarsus*	X	
Diptera	Chironomidae	*Thienemanniella*		X
Diptera	Chironomidae	*Thienemannimyia*	X	X
Diptera	Chironomidae	*Tvetenia*	X	X
Diptera	Chironomidae	*Zavrelimyia*	X	
Diptera	Empididae	*Chelifera/Metachela*	X	X
Diptera	Empididae	*Clinocera*	X	
Diptera	Empididae	*Hemerodromia*		X
Diptera	Simuliidae	*Prosimulium*	X	
Diptera	Simuliidae	*Simulium*	X	X

Diptera	Tabanidae	Tabanidae		X
Diptera	Tipulidae	*Antocha*		X
Diptera	Tipulidae	*Cryptolabis*	X	
Diptera	Tipulidae	*Dicranota*	X	
Diptera	Tipulidae	*Hexatoma*	X	
Diptera	Tipulidae	*Limnophila*	X	
Diptera	Tipulidae	*Limonia*	X	X
Diptera	Tipulidae	*Pseudolimnophila*	X	
Diptera	Tipulidae	*Tipula*	X	X
Ephemeroptera	Ameletidae	*Ameletus*	X	
Ephemeroptera	Baetidae	*Acentrella*	X	
Ephemeroptera	Baetidae	*Baetis*	X	X
Ephemeroptera	Baetiscidae	*Baetisca*	X	
Ephemeroptera	Ephemerellidae	*Drunella*	X	
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	
Ephemeroptera	Ephemerellidae	*Eurylophella*	X	
Ephemeroptera	Ephemeridae	*Ephemera*	X	
Ephemeroptera	Heptageniidae	*Cinygmula*	X	
Ephemeroptera	Heptageniidae	*Epeorus*	X	
Ephemeroptera	Heptageniidae	*Stenacron*	X	
Ephemeroptera	Heptageniidae	*Maccaffertium/ Stenonema*	X	
Ephemeroptera	Isonychiidae	*Isonychia*	X	X
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	X	
Megaloptera	Corydalidae	*Corydalus*		X
Megaloptera	Corydalidae	*Nigronia*	X	X
Odonata	Aeshnidae	*Boyeria*		X
Odonata	Gomphidae	*Lanthus*	X	X
Plecoptera	Capniidae	Capniidae	X	
Plecoptera	Chloroperlidae	*Haploperla*	X	
Plecoptera	Leuctridae	*Leuctra*	X	
Plecoptera	Nemouridae	*Amphinemura*	X	X
Plecoptera	Nemouridae	*Ostrocerca*	X	
Plecoptera	Nemouridae	*Prostoia*		X
Plecoptera	Peltoperlidae	*Peltoperla*	X	
Plecoptera	Perlidae	*Acroneuria*	X	
Plecoptera	Perlodidae	*Isoperla*	X	
Plecoptera	Perlodidae	*Remenus*	X	
Plecoptera	Perlodidae	*Yugus*	X	
Plecoptera	Pteronarcyidae	*Pteronarcys*	X	
Plecoptera	Taeniopterygidae	*Taenionema*	X	
Plecoptera	Taeniopterygidae	*Taeniopteryx*	X	X
Trichoptera	Glossosomatidae	*Agapetus*	X	
Trichoptera	Glossosomatidae	*Glossosoma*	X	
Trichoptera	Goeridae	*Goera*	X	
Trichoptera	Hydropsychidae	*Ceratopsyche*	X	
Trichoptera	Hydropsychidae	*Cheumatopsyche*	X	X
Trichoptera	Hydropsychidae	*Diplectrona*	X	X
Trichoptera	Hydropsychidae	*Hydropsyche*	X	X
Trichoptera	Hydroptilidae	*Hydroptila*		X
Trichoptera	Limnephilidae	*Pycnopsyche/ Hydatophylax*	X	
Trichoptera	Philopotamidae	*Chimarra*	X	X
Trichoptera	Philopotamidae	*Dolophilodes*	X	
Trichoptera	Polycentropodidae	*Polycentropus*	X	
Trichoptera	Psychomyiidae	*Psychomyia*	X	X
Trichoptera	Rhyacophilidae	*Rhyacophila*	X	X

Trichoptera	Uenoidae	*Neophylax*	X	
		Total Distinct Taxa	**84**	**56**
		Total EPT Taxa	**42**	**12**

In order to support the determination that unacceptable adverse effects will occur downstream, EPA applied an accepted and peer reviewed approach, called an Observed/Expected index (O/E), where O/E ratios represent the number of the expected taxa that are observed in a sample (O), compared to the number of taxa expected in the sample (E), after predicting the probability that a sample site is a member of one or more fixed sets of reference site types (Hawkins 2006a, Van Sickle 2005) (Figure 14). This method uses a suite of regional reference sites to determine the number of expected taxa; and deviation from this number can be used to identify an degradation threshold (see Appendix 2 for detailed methods and results). A site that is a perfect match to the reference site O/E scores will score 1.0, while downward deviation from 1.0 indicates loss of expected taxa compared to regional reference (e.g., a score of 0.50 indicates a 50% loss of the expected taxa). Upward deviation (greater than 1.0) indicates that more taxa were collected than expected. EPA chose the 5th percentile of reference site O/E scores as a degradation threshold to correspond to the WVDEP's bioassessment threshold for aquatic life use impairment. This O/E 5th percentile was 0.64, indicating a loss of 36% of expected taxa would indicate degradation of the in-stream biota.

Based upon the O/E index, EPA found that the macroinvertebrate assemblages in Pigeonroost Branch, Oldhouse Branch and the upstream White Oak Branch are comparable to the regional reference sites, while nearby streams affected by valley fills (Dal-Tex sites) were well below the degradation threshold (O/E less than 0.64) (Table 12). Mean scores for the Dal-Tex sites were 0.26 in the summer and 0.32 in the spring, indicating they support, on average, 74% and 68% less taxa, respectively, than the regional reference sites. Thus, past mining has led to the estimated extirpation of ~70% of the native expected taxa in the adjacent Dal-Tex Mine operation.

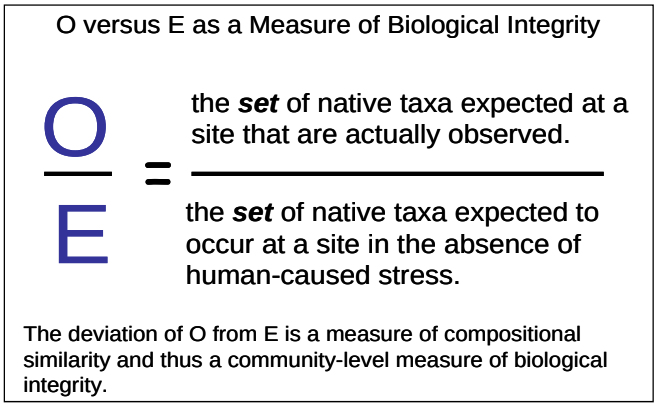

Figure 14. Measure of biological integrity; Observed vs. Expected (C.P. Hawkins, Utah State Univ.)

Extirpation of macroinvertebrate taxa, documented by the O/E index, is largely caused by water quality degradation. Using the regional reference sites and genus-level data from Pond et al. (2008), O/E scores showed a negative correlation with conductivity (R^2=0.63). Water quality degradation caused by elevated conductivity explained more than twice the

variance in O/E scores than did Rapid Bioassessment Protocol (RBP) habitat scores (R^2=0.28), confirming that conductivity is an excellent predictor of native taxa loss from Appalachian streams. Sediment deposition, substrate embeddedness, channel alteration, riparian zone width, pH, or temperature had no significant influence on O/E scores (see Appendix 2).

Table 12. Summary of West Virginia O/E null model results for the Spruce No. 1 Mine area. The biological degradation threshold is 0.64 (corresponding to the 5th percentile of WVDEP reference site distributions).

Mean (Standard Deviation) O/E			
	Spruce No. 1 Mine	**Dal-Tex**	
	Pigeonroost Branch, Oldhouse Branch, White Oak Branch	Beech Creek, Left Fork Beech Creek	Rockhouse
Spring	0.98 (0.20); n=9	0.26 (0.06); n=5	0.31 (0.10); n=3
Summer	0.85 (0.15); n=2	0.32 (0.08); n=2	0.38 (0.08); n=2

To provide additional support that aquatic life use degradation occur downstream of valley fills and that these impairments result from water quality degradation, streams that are affected by mining were compared to streams that are not affected by mining using the West Virginia Stream Condition Index (WVSCI), WVDEP's family-level multi metric index (see Appendix 2 for detailed methods and results). Currently, the WVDEP uses WVSCI index scores greater than 68 to indicate streams fully supportive of the aquatic life use.[17] Streams unaffected by mining within and near the project area, including White Oak Branch, Oldhouse Branch and Pigeonroost Branch, generally scored above the 68 threshold index value, indicating they are high quality streams that fully support the aquatic life use (see Appendix 2). The streams located in the historically mountaintop mined areas with valley fills located nearby (Rockhouse Branch, Beech Creek, and the Left Fork of Beech Creek) generally scored below the 68 threshold index value, indicating they do not fully support aquatic life use.

In Pond et al. (2008) elevated conductivity greater than 500 µS/cm caused by alkaline mine effluents was strongly associated with high probability of degradation of native biota, and 17 of the 20 mined study sites (85%) did not fully support aquatic life, based upon the family-level WVSCI index. In addition, WVDEP ambient monitoring macroinvertebrate data from the Cumberland Mountains of the Central Appalachians subecoregion, the subecoregion where the project is located, were analyzed to determine the potential effects of elevated conductivity levels on aquatic life use. When conductivity levels were elevated above 500 µS/cm, the analysis showed that a majority of the sites were not fully supportive of aquatic life use, even when accounting for the possible confounding effects of acidic pH and habitat degradation. For example, after removing low pH sites, only 100 sites out of 417 sites attained WVSCI scores greater than 68 when conductivity levels were greater than 500 µS/cm (76% of the sites reflected WVSCI scores less than 68). When the potential confounding effect of habitat

[17] This score represents the lower 5th percentile of the range of scores of the 107 reference site scores used in the 2000 report (Gerritsen et al. 2000). As noted elsewhere, in its 2008 Section 303(d) List, WVDEP identified a WVSCI score of 68 as the lowest score at which a waterbody was considered to "fully support" aquatic life. A score of less than 68 indicates degradation of the aquatic life use.

degradation was completely removed (this subset includes only sites with Rapid Bioassessment Protocol habitat scores greater than 140, indicating reference quality habitat), 62% of the sites still had WVSCI scores less than 68.

In addition to changes in community structure and loss of sensitive taxa, functional feeding group composition (based on WVDEP group designations) is also significantly altered below mountaintop mining operations with valley fills. An analysis of functional feeding groups revealed categorical dose-response for unmined, low (<500), medium (500-1000), and high (>1000) conductivity (Table 13; data from Pond et al. 2008). Functional feeding group relative abundance of scrapers (herbivorous grazers) and functional feeding group richness for scrapers, shredders, and collector-gatherers was higher at unmined sites and declined with increasing conductivity category, while the relative abundance of collector-filterers increased. In a comparison of sites with conductivity <500 µS/cm (n=17) to sites with conductivity >500 µS/cm (n=20), there were significant alterations of trophic composition, with increased %collector-filterer abundance and declines in genus-level scraper richness, shredder richness, collector-gatherer richness and %scraper abundance at sites with higher conductivity (Table 13). Further, several functional feeding group metrics were strongly correlated to specific conductance (Table 13).

Table 13. Mean richness and relative abundance of functional feeding groups among conductivity categories (data from Pond et al. 2008). Additional comparisons of sites (<500 µS/cm and >500 µS/cm) include P-values for Mann-Whitney U-tests shown. Spearman correlations of FFGs with conductivity are also shown. Bold values are significant (p<0.05).

FFG (Richness)	Unmined	Low	Medium	High	Combined Unmined + Mined (low)	Combined Mined (Medium+ High)	Mann-Whitney U-test	*P*	Correlation to Conductivity: Spearman *r*
# Scraper Genera	**7.4**	**5.0**	**2.1**	**0.9**	**6.4**	**1.4**	**333.5**	**0.000**	**-0.85**
# Shredder Genera	**4.5**	**3.4**	**2.0**	**2.0**	**4.1**	**2.6**	**244.0**	**0.021**	**-0.50**
# Coll-Gatherer Genera	**10.5**	**9.1**	**7.3**	**7.3**	**9.9**	**7.9**	**240.0**	**0.031**	**-0.48**
# Coll-Filterer Genera	3.0	4.7	3.6	3.6	3.7	3.9	143.0	0.389	0.10
# Predator Genera	7.2	4.7	3.7	3.7	6.2	4.3	232.0	0.057	**-0.44**
# Piercer-Herb Genera	0.1	0.0	0.0	0.1	0.1	0.1	171.5	0.907	-0.03

FFG (Rel. Abundance)	Unmined	Low	Medium	High	Combined Unmined +Mined (low)	Combined Mined (Medium+ High)	Mann-Whitney U-test	*P*	Correlation to Conductivity: Spearman *r*
% Scraper	**29.1**	**7.6**	**9.1**	**1.6**	**18.4**	**5.4**	**304.0**	**0.000**	**-0.79**
% Shredder	24.8	43.0	28.8	19.3	33.9	24.1	224.5	0.097	-0.23
% Coll-Gatherer	29.5	28.5	32.3	33.7	29.0	33.0	149.0	0.437	0.04
% Coll-Filterer	**7.7**	**14.6**	**17.5**	**41.2**	**11.2**	**29.4**	**78.5**	**0.005**	**0.60**
% Predator	8.4	6.0	11.9	3.9	7.2	7.9	199.0	0.376	-0.40
% Piercer-Herbivores	0.1	0.0	0.0	0.2	0.1	0.1	167.0	0.920	0.01

Construction of valley fills, sediment ponds, and other discharges of dredged or fill material into Pigeonroost Branch and Oldhouse Branch as authorized by the DA permit

will contribute increased loadings of TDS to downstream receiving waters within the Headwaters Spruce Fork sub-watershed and Coal River sub-basin, further exacerbating biological impairments. The WVDEP data from the Spruce Fork, Pond Fork and Little Coal River watersheds indicate that nearby streams affected by mines, as well as the main stem of Spruce Fork, Pond Fork and the Little Coal River currently do not fully support aquatic life use (see Appendix 1). The adverse impacts in the main stem of Spruce Fork, Pond Fork, and the Little Coal are likely due to a combination of stressors, including mining and residential stressors (WVDEP 1997a). Because these downstream waters have existing biological impairments, increased loading of TDS from this project will further reduce the ability of these waters to support aquatic life use.

V.D.2.b. Food Web Effects of Altered Macroinvertebrate Communities

The direct burial of streams and subsequent water quality changes downstream associated with the authorized project will significantly alter macroinvertebrate assemblages, as well as the overall abundance and productivity of macroinvertebrate communities; and thus, through cascading food web effects, likely adversely impact vertebrate species which depend upon the macroinvertebrate community within these streams for nourishment (Figure 7). Project impacts on these aquatic invertebrates will likely alter in-stream functions (e.g., organic matter processing and transport, and nutrient cycling and transport), in part because research has shown that processing rates of terrestrial plant material inputs are reduced in mine-affected streams with altered macroinvertebrate assemblages (Fritz et al. 2010). Also, it is likely that impacts to aquatic invertebrates will have adverse effects on animals dependent on insect larvae and emergent adults as prey, including fish, amphibians, bats, birds, reptiles and small mammals (Baxter et al. 2005). In particular, mayflies (Ephemeroptera) tend to be a preferred prey item for juvenile Smallmouth Bass (Easton et al. 1996), an important sport fish in Spruce Fork, and anticipated declines in mayfly immediately downstream of valley fills will have adverse effects on this sport fishery, as reduced mayfly populations will be present and there will be a reduced pool of colonizers to repopulate areas where populations were impacted.

In addition, research has shown that selenium often has non-lethal effects on macroinvertebrates, allowing them to act as vectors in the movement of selenium to higher levels of the food chain.

V.D.3. Salamanders & Other Herpetofauna

Impacts from the activities authorized will have a significant adverse impact on salamanders and other herpetofauna downstream of the project area due to changes in water chemistry, as well as subsequent food web effects. Adverse impacts to salamanders as a result of construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will not be localized to the area to be filled. Because construction of the valley fills and other discharges will increase conductivity and selenium levels in the downstream receiving waters (see Section V.D.1.), salamanders that are not directly buried and killed beneath the fills will also be impacted; directly via exposure to these contaminants and indirectly via impacts

of contaminants on food sources and reduced prey abundances. Studies have documented elevated selenium levels in salamander tissue downstream of valley fills and that salamander assemblages were more likely to be impaired downstream of valley fills than in other locations (Patnode, et al. 2005). Such impacts will occur as far downstream as elevated conductivity, selenium or other contaminants persist, and to affect any salamanders that spend some part of their life in the aquatic environment or in immediately adjacent riparian terrestrial habitats.

Furthermore, as set forth in Section V.D.4.a., the construction of valley fills, sediment ponds, and other discharges into Pigeonroost Branch and Oldhouse Branch will create conditions considered favorable to the growth of golden algae *(Prymnesium parvum)*, which can produce a toxin that is highly toxic to aquatic life and was associated with an extensive aquatic life kill of both fish and lungless salamanders in Dunkard Creek in West Virginia in September 2009.

V.D.4. Fish

The fish assemblages in Pigeonroost Branch and Oldhouse Branch downstream of the project area, as well as in Spruce Fork, are neither impaired nor representative of pristine or reference condition. Basin size is a particularly important factor when assessing the potential effects of valley fills on streams because small streams (less than 10 square kilometer) have shown effects to the fish assemblage while larger streams have not (e.g., Fulk et al. 2003). Nevertheless, Fulk et al. (2003) found significant differences in total IBI scores between streams that are affected by mines and those that are not. This difference was attributed to changes in cyprinid species richness and the percent of the assemblage composed of benthic invertebrate feeders.

Studies have shown that mountaintop mining for coal and construction of valley fills has had a harmful effect on the composition of stream fish communities (Fulk et al., 2003, Stauffer and Ferreri, 2002). Comparison of streams without mining in the watershed and sites downstream of valley fills in Kentucky and West Virginia indicate that streams affected by mining had significantly fewer total fish species and fewer benthic fish species than streams without mining in the same areas (Stauffer and Ferreri, 2002), likely due to changes in water quality. Surface coal mining and associated increases in conductivity and total dissolved solids and construction of sediment ponds have been shown to create conditions considered favorable to the growth of golden algae (*Prymnesium parvum)*, which has caused large aquatic life kills; and conditions favorable to golden algae growth will occur in Pigeonroost Branch and Oldhouse Branch. Fish also will be exposed to increases in selenium concentrations, which will lead to bioaccumulation in fish tissues and to reproductive effects (see Section V.D.1.a.). Additionally, increases in conductivity and total dissolved solids will have a significant adverse effect on aquatic macroinvertebrates, some of which are preferential prey items for the fish species present in these streams, and, as a result, these fish will likely be similarly adversely affected (see Section V.D.2.b.).

V.D.4.a. Potential to Promote the Growth of Golden Algae

Construction of valley fills and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch as authorized will create in-stream conditions in or near Spruce Fork favorable to the growth of golden algae (*Prymnesium parvum),* which releases toxins that kill fish and other gill-breathing aquatic organisms. *P. parvum* is a haptophyte (flagellated) algae now distributed worldwide. This alga has been known to occur in North America since the 1980s (Baker et al., 2007) and has since become established in rivers and reservoirs in several states. *P. parvum* is responsible for harmful algal blooms that have killed millions of fish in Texas and Oklahoma, and has been implicated in kills from North Carolina to Arizona.

P. parvum has also been associated with an extensive and severe aquatic life kill in the central Appalachians, in which thousands of fish, mussels and other aquatic organisms were destroyed in Dunkard Creek in West Virginia and Pennsylvania (Roelke et al.2010, Sager et al.2008). During September 2009, biologists reported observations of thousands of dead fish, mussels and salamanders in Dunkard Creek (Hambright 2010). Mud puppies, an aquatic salamander that lives its entire life underwater, crawled out of the water and onto rocks and the shoreline in an attempt to escape from the toxic water. Field biologists observed numerous individuals as dried up carcasses on rocks and along the shoreline. Fish were observed avoiding the main stem of Dunkard Creek by practically "stacking up" in the mouths of tributaries, subjecting themselves to feeding by blue heron rather than remaining in the toxic water of main stem Dunkard Creek. The identification of *P. parvum* in 2009 in Dunkard Creek was the first identification of this invasive aquatic species in the Mid-Atlantic States (Roelke et al.2010).

The factors that are most closely associated with supporting growth of *P. parvum* are believed to be:

1. Proximity to a known source of *Prymnesium parvum*.
2. TDS in high enough concentrations to support *P. parvum* (estimated to be between 500 and 1000 mg/L (conductivity 714-1428 μS/cm).
3. Nutrients in concentrations high enough to initiate a bloom of *P. parvum* (Baker et al. 2009)
4. pH greater than 6.5. Risk increases with increasing pH (Baker et al. 2009).
5. Areas of habitat that are pooled (large beaver dams, natural residual pools, or manmade ponds)

EPA believes that the Spruce No. 1 Mine will increase the probability that all five factors are met within the Headwaters Spruce Fork sub-watershed, as outlined below.

Proximity to Known Source: P. parvum was identified (in very high numbers) in Cabin Creek of the Kanawha drainage, only 25 miles to the East. Because these algae can easily move with waterfowl, the risk of introducing *P. parvum* in the Spruce Fork drainage is high. Although not currently found in Spruce Fork, the WVDEP has identified Spruce Fork as a "water of concern" because of its potential (due to already

high levels of TDS/conductivity) to support *P. parvum* blooms consistent with the factors shown above.

High TDS: The lower TDS limits for the growth of *P. parvum* appears to be ~500 mg/l TDS, or ~700µS/cm conductivity for the ion mixtures typical of alkaline mine drainage (Hambright 2010). Recent data indicate that growth of *P. parvum* increases 200-300% when conductivity increases from 500 µS/cm to 1000 µS/cm (unpublished data, WVDEP, 2010, Hambright 2010). The waters draining the nearby Dal-Tex Mine operation have conductivity levels greater than these values. Many of the sampling sites on the main stem of Spruce Fork, Pond Fork and the Little Coal River also have conductivity levels exceeding these endpoints. Other waters of concern near the Spruce No. 1 Mine include the Little Coal River and West Fork/Pond Fork. As described in SectionV.D.1.b., construction of valley fills and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch is expected to increase levels of TDS/conductivity in Spruce Fork, thus creating conditions more favorable to *P. parvum*.

Suitable Nutrient Levels: Nutrient levels in the Spruce Fork are very similar to those in Dunkard Creek and other watersheds with *P. parvum* algae present (e.g. Whitely Creek, PA). Phosphorous in Spruce Fork was over 100 µg/L on two sampling occasions during the PEIS.

High pH: Discharges from Spruce No. 1 Mine are likely to be alkaline, consistent with pH of discharges from Dal-Tex and other operations.

Existence of Pooled Habitats: Pooled habitats with little to no flow are common in streams like Spruce Fork in low flow conditions of September and October, when TDS is highest. In addition, DA Permit No. 199800436-3 (Section 10: Coal River) authorizes construction of numerous sediment ponds in Pigeonroost Branch and Oldhouse Branch which will create areas of pooled habitat more favorable to *P. parvum.* During low flows, conductivity is typically highest, increasing the possibility that blooms could occur in very slow moving residual pools within the channel.

V.D.4.b. Increased Exposure to Selenium

The construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will result in elevated levels of selenium in the receiving waters. While selenium is a naturally occurring chemical element that is an essential micronutrient, excessive amounts of selenium can have toxic effects on fish. Selenium toxicity is primarily manifested as reproductive impairment and birth defects due to maternal transfer, resulting in embryonic physical mutations and death in egg laying vertebrates such as fish and ducks.

Several nearby streams in the Coal River sub-basin have available data that indicate that construction of the Spruce mine and associated discharges can result in impacts to wildlife. According to the WVDEP's study, "Selenium Bioaccumulation among select

stream and lake fishes in West Virginia" (WVDEP 2009), Seng Creek had the highest average water column concentration (27.20 ppb) and a corresponding average fish tissue concentration of 8.16 ppm, while Beech Creek had a water concentration of 12.30 ppb with a corresponding average fish tissue concentration of 7.55 ppm. In Seng Creek, creek chub egg/ovary tissue (mean = 19.9 ppm; range = 16.4 - 23.7 ppm; n= 4) and water measurements (mean = 15.8 ug/L; range = 8-45 ug/L; n = 11) indicate that both fish tissue and water numbers would exceed 5 ug/L and these levels have been documented to resulted in unacceptable tissue concentrations in the reproductive tissue. Similarly, water and fish tissue samples from Mud River also show unacceptable impacts to fish. Creek chub egg ovary (composite measurement of 17.6 in egg/ovary tissue) and water measurements (mean = 9.5 ug/L; range = 4-22 ug/L; n = 21) in Mud River show that selenium concentrations exceed 5 ug/L and has resulted in unacceptably high tissue concentrations in fish.

As discussed in Section V.D.1.a., construction of the Spruce No. 1 Mine will disturb selenium bearing strata consistent with the strata disturbed by the Dal-Tex complex, will remove Pigeonroost Branch and Oldhouse Branch as sources of dilution, and will increase in-stream selenium concentrations to levels comparable with the Dal-Tex complex. The foregoing data supports EPA's view that the increased selenium resulting from the Spruce No. 1 Mine will elevate fish tissue concentrations to levels that will result in unacceptable adverse impacts in wildlife.

V.D.5. Water-dependent Birds

The indirect effects on Louisiana Waterthrush populations are attributable to the loss of aquatic macroinvertebrate food sources and water quality impacts associated with construction of the Spruce No. 1. Mine. As stated in Section IV.B.4. above, the Louisiana Waterthrush is an area-sensitive riparian-obligate species whose breeding success depends on the diverse and productive assemblage of aquatic insects supported by healthy headwater systems (Mattson and Cooper 2009). Birds dependent on aquatic insect larvae and emergent adults as prey, such as the Louisiana Waterthrush, will be adversely affected by the project due to food web effects associated with altered aquatic macroinvertebrate communities (see Section V.D.2.a.).

Studies indicate that breeding territory density and occupancy are reduced along streams where benthic macroinvertebrate communities had been degraded due to anthropogenic land uses including mining (Mulvihill 1999, 2008, Mattsson and Cooper 2009, O'Connell et al. 2003). For example, lower breeding territory densities have occurred along streams impacted by acid mine drainage more so than along circumneutral streams (Mulvihill 1999, 2008). The driver behind these lower densities is decreased food availability, as acid mine drainage has a similar effect on macroinvertebrate populations as alkaline drainage and salinity (Mulvihill 2008). Similarly, some indices of benthic macroinvertebrate integrity are shown to be higher where breeding Louisiana Waterthrushes are present than areas from which they are absent (O'Connell et al.2003). Stream reaches where breeding waterthrushes were present also had a greater proportion of pollution-sensitive benthic macroinvertebrates than reaches where waterthrushes were

absent, supporting the concept that good water quality is a key component of the species breeding habitat (Mulvihill 2008).

In addition to impacts resulting from the loss of macroinvertebrate food sources, studies also indicate that the Louisiana Waterthrush will be adversely affected by increased exposure to selenium through prey consumption. Since Waterthrush diet is comprised of aquatic and terrestrial insects, as well as small fish and amphibians, where selenium levels are elevated in macroinvertebrate and salamander populations, Waterthrush will be exposed in a majority of their prey (Patnode et al. 2005) .

As the scientific literature demonstrates, Louisiana Waterthrush populations are vulnerable to impairments in water quality downstream of mining operations. EPA believes that there will be unacceptable adverse impacts to Louisiana Waterthrush populations downstream of the Spruce No. 1 project area as the result of indirect water quality impacts from the filling of Pigeonroost Branch and Oldhouse Branch and their tributaries.

V.D.6. Summary

Construction of valley fills, sediment ponds, and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) in Pigeonroost Branch and Oldhouse Branch will eliminate headwater stream systems that support some of the last remaining least-disturbed conditions within the Coal River sub-basin and will therefore result in a significant loss of wildlife habitat. The burial of these streams will lead to discharges of TDS and selenium, which will result in unacceptable adverse effects on wildlife in downstream waters. Increased salinity levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. Through the loss of stream macroinvertebrate and salamander communities, there will be, in turn, substantial effects to both aquatic and terrestrial vertebrate populations that rely on these communities as a food source.

It is well recognized that the loss of a certain number of individuals of a species in a local ecological community can be tolerated, provided that the species continues to reproduce to replace lost individuals. However, when species are impacted by both acute stressors (e.g., food web changes, algal blooms) and exposure to reproductive toxicants, there is an increased risk of the loss of an entire species within an area. The loss of macroinvertebrate prey populations, increased risk of harmful golden algal blooms, and additional exposure to selenium will have an unacceptable adverse effect on the 26 fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on downstream waters for food or habitat.

Based on this information, EPA has concluded that the discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) will have unacceptable adverse effects on wildlife downstream of the Spruce No. 1 Mine.

V.E Compliance with Relevant Portions of the § 404(b)(1) Guidelines

EPA has broad discretion under § 404(c) in evaluating and determining whether a discharge will result in "unacceptable adverse effects." EPA has concluded, in this case, that burying 6.6 miles of rare and important high quality streams will have an unacceptable adverse impact on the wildlife that rely on those streams for all or part of their life cycles, and that the discharges of TDS and selenium, loss of freshwater dilution from these buried streams, and significant alteration of aquatic macroinvertebrate communities will have an unacceptable adverse effect to aquatic wildlife downstream of the mining operation. Each of these determinations on its own is a sufficient basis to withdraw the specification of these streams as disposal sites and to prohibit the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine

In addition, EPA's § 404(c) regulations at 40 CFR 231.2(e) provide that in evaluating the "unacceptability" of impacts, consideration should be given to the "relevant portions of the § 404(b)(1) Guidelines." As discussed further below, EPA has identified numerous inconsistencies with the requirements of the § 404(b)(1) Guidelines. In Sections V.C. and V.D., EPA determined that there are unacceptable adverse impacts to wildlife, and the Agency's evaluation of compliance with relevant portions of the Guidelines in this section provides support and confirmation of the conclusion that the impacts are unacceptable.

For purposes of the Spruce No. 1 Mine, the relevant portions of the § 404(b)(1) Guidelines that are particularly important for assessing the unacceptability of environmental impacts include:

- Less environmentally damaging practicable alternatives (40 CFR 230.10(a))
- Significant degradation of waters of the United States (40 CFR 230.10(c))
    - Cumulative effects (40 CFR 230.11(g))
    - Secondary effects (40 CFR 230.11(h))
- Minimization of adverse impacts to aquatic ecosystems (40 CFR 230.10(d))

V.E.1. Less Environmentally Damaging Alternatives/Failure to Minimize Impacts

The § 404(b)(1) Guidelines state at 40 CFR 230.10(a) that no permit may be issued if there is a practicable alternative that would result in less damage to aquatic resources while still meeting the basic project purpose, provided it would not result in other significant adverse environmental impacts. Similarly, 40 CFR 230.10(d) states that steps should be taken to minimize all remaining unavoidable impacts. These two required elements of the Guidelines are typically fulfilled with a thorough analysis of alternatives, including evaluation of alternative project sitings, changes to project design, implementation of best management practices, and adaptive management plans to

minimize the risk of adverse impacts. EPA's determination that the Spruce No. 1 Mine will result in unacceptable adverse impacts to wildlife does not depend on the presence or absence of alternatives that would result in less severe environmental impacts to waters of the United States, or on whether there are or are not further opportunities to minimize the impacts from the project. Nonetheless, EPA's evaluation of these portions of the § 404(b)(1) Guidelines serves to strengthen EPA's determination about the unacceptability of the significant impacts that would occur from Spruce No. 1 Mine.

In discussions with the permittee before and during the § 404(c) process, EPA has repeatedly stated its belief that there are alternative mine design and construction practices that would further reduce aquatic resource impacts, while allowing the majority of coal present on site to be mined in a cost effective and technically feasible manner. As referenced in Section III.C., the permittee has presented only limited alterations to the permitted project that it believes would likely result in environmental improvements. These proposals included additional compensatory mitigation projects, new mine construction practices, and increased water quality monitoring.

EPA maintains, however, that there appear to be additional practicable alternative project configurations and practices that would significantly reduce and/or avoid anticipated environmental and water quality impacts to Pigeonroost Branch and Oldhouse Branch. Moreover, § 230.10(a) establishes rebuttable presumptions that, in the case of non-water dependent projects (such as this), practicable, less environmentally damaging alternatives exist. EPA does not believe the permittee has carried its burden to clearly demonstrate that such alternatives do not exist.

EPA is working effectively with mining companies to identify alternative mining configurations and practices to reduce the nature and extent of anticipated adverse environmental and water quality impacts. EPA and mining companies have, for example, coordinated to reduce the volume of excess spoil being placed in valley fills, minimize rainwater and groundwater contact with pollutant-bearing strata, divert stormwater away from streams and other surface waters, phase mining construction to assess the effectiveness of best management practices designed to protect water quality, eliminate and consolidate valley fills, remove treatment ponds from stream beds, compact excess spoil and cant fills to reduce rainwater infiltration, and other cost effective actions for reducing or avoiding environmental and water quality impacts without significantly affecting coal recovery. Mingo Logan Company has expressed a willingness to take some additional steps focusing on best management practices to reduce impacts, but has been consistently unwilling to consider needed actions to further reduce the 35,000 feet of direct impacts of valley fills on headwater streams or to phase valley fill construction in a manner that would allow for effective assessment of, and an adaptive management response to, adverse impacts to wildlife habitat and anticipated water quality problems.

Because the scope of this Final Determination is limited to withdrawal of specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged or fill material in connection with the Spruce No. 1 Mine, as well as future discharges, within the defined area constituting Pigeonroost Branch, Oldhouse Branch

and their tributaries, associated with surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine, EPA takes no position as to whether other, less damaging alternatives would be likely to result in acceptable effects on wildlife or satisfy the § 404(b)(1) Guidelines. However, the facts that such alternatives appear to exist based on extensive experience with other mining operations in Appalachia, and that the permittee has not clearly demonstrated to the contrary, further enhance EPA's assessment of the unacceptability of the impacts that were previously described.

V.E.2. Significant Degradation

The § 404(b)(1) Guidelines direct that no discharge of dredged or fill material shall be permitted if the discharge will cause or contribute to significant degradation of waters of the United States (40 CFR 230.10(c)). Of particular relevance in this instance, the Guidelines state that effects contributing to significant degradation considered individually or collectively, include:

> (1) Significantly adverse effects of the discharge of pollutants on human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites.
>
> (2) Significantly adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, including the transfer, concentration, and spread of pollutants or their byproducts outside of the disposal site through biological, physical, and chemical processes; and
>
> (3) Significantly adverse effects of the discharge of pollutants on aquatic ecosystem diversity, productivity, and stability. Such effects may include, but are not limited to, loss of fish and wildlife habitat or loss of the capacity of a wetland to assimilate nutrients, purify water, or reduce wave energy

As discussed in Section IV.A. above, Pigeonroost Branch and Oldhouse Branch and their tributaries are some of the last remaining streams within the Headwaters Spruce Fork sub-watershed and the larger Coal River sub-basin that represent "least-disturbed" conditions. As such, they perform important hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role with regard to providing necessary habitat for wildlife within the context of the overall Headwaters Spruce Fork sub-watershed and Coal River sub-basin.

The Spruce No. 1 Mine as authorized will bury virtually all of Oldhouse Branch and its tributaries and much of Pigeonroost Branch and its tributaries under excess spoil generated by surface coal mining operations. These discharges will result in the burial of approximately 6.6 miles of high quality Appalachian headwater streams in a watershed

that has already experienced substantial impairment. The loss of these portions of Pigeonroost Branch and Oldhouse Branch will result in a significant loss of wildlife habitat and would therefore adversely impact wildlife that depend on those headwater streams for all or part of their life cycles. As detailed in Sections V.C. and V.D., these direct impacts will result in significantly adverse effects on over 84 taxa of macroinvertebrates, as well as up to 46 species of reptiles and amphibians, 4 species of crayfish, 5 species of fish and at least one water-dependent bird species

Beyond the direct burial of wildlife species and loss of habitat, EPA has also determined that the project will result in significantly adverse effects on downstream wildlife. If constructed as permitted, the Spruce No. 1 Mine will result in increased pollutant loadings in Spruce Fork and the Little Coal River. Increased salinity levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. Further, loss of macroinvertebrate prey populations, increased risk of harmful golden algal blooms, and additional exposure to selenium will result in significantly adverse effects on the 26 fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on downstream waters for food or habitat.

The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by the streams of Pigeonroost Branch and Oldhouse Branch including maintenance of biologically diverse wildlife habitat and will critically degrade the chemical and biological integrity of downstream waters. Impacts to these functions at the scale associated with this project will result in significant degradation (40 CFR 230.10(c)) of the Nation's waters, particularly in light of the extensive cumulative stream losses in the Spruce Fork and Coal River watersheds discussed in more detail below.

V.E.2.a Cumulative Effects

Fundamental to the § 404(b)(1) Guidelines "is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." 40 CFR 230.1(c).

The § 404(b)(1) Guidelines (at 40 CFR 230.11(g)) also direct that factual findings be made regarding cumulative effects on the aquatic ecosystem and that those findings be considered in determining whether the discharge complies with the foregoing restriction. To that end, the § 404(b)(1) Guidelines describe the factual finding that must be made with respect to cumulative effects as follows:

> Cumulative impacts are the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can

> result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems.
>
> Cumulative effects attributable to the discharge of dredged or fill material in waters of the United States should be predicted to the extent reasonable and practical. The permitting authority shall collect information and solicit information from other sources about the cumulative impacts on the aquatic ecosystem. This information shall be documented and considered during the decision-making process concerning the evaluation of individual permit applications, the issuance of a general permit, and monitoring and enforcement of existing permits.

As has been described in Section IV.A., the Coal River sub-basin and the Headwaters Spruce Fork sub-watershed are already impacted by mining activity. Based upon the National Land Cover Database (NLCD) change product for 1992-2001 and the WVDEP's GIS mine permit data, more than 257 past and present surface mining permits have been issued in the Coal River sub-basin, and the corresponding mines collectively occupy more than 13% of the land area. In the Spruce Fork watershed, more than 34 past and present surface mine permits have been issued, and the corresponding mines collectively occupy more than 33% of the land area. The project will affect an additional 2,278 acres (3.56 mi^2), which is equivalent to approximately 2.8% of the Spruce Fork watershed. This percentage of land cover affected by surface mines will continue to increase in the Coal River sub-basin, as additional projects are proposed and authorized.

A 1997 WVDEP ecological assessment of the Coal River sub-basin indicated that because the sub-basin is becoming increasingly impaired due to stressors such as mining, there is a need to protect the remaining quality resources, highlighting the need to "[l]ocate and protect the few remaining high quality streams in the Coal River watershed.…" (WVDEP 1997a). Pigeonroost Branch and Oldhouse Branch, two of the streams directly affected by the Spruce No. 1 Mine, are high quality resources that support an exceptionally high number of mayfly taxa, both within the Central Appalachian Region and statewide (see Appendix 2). By directly impacting these streams, which serve as refugia for aquatic life and potential sources for recolonizing nearby waters, the action will have a significant adverse effect on the aquatic ecosystem integrity in the sub-basin.

For purposes of this analysis, EPA considered cumulative effects to the Coal River sub-basin (891 square miles) and the Headwaters Spruce Fork sub-watershed (126.4 square miles) if the Spruce No. 1 Mine is constructed as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) and other reasonably foreseeable (proposed and/or authorized but not constructed) surface mining projects within the Coal River sub-basin are constructed. This cumulative effects analysis also takes into consideration the past and present mining projects within the sub-basin and sub-watershed, and the extent to which they have affected the current baseline conditions within the sub-basin and sub-watershed (Figure 15).

EPA is aware of at least 11 additional mining operations either proposed or authorized but not constructed in addition to Spruce No.1 in the Coal River sub-basin. Construction of valley fills and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) along with these additional projects in the Coal River sub-basin, if constructed, would directly impact approximately 29.4 miles of stream channels, and will have significant secondary and cumulative effects on downstream waters in the Coal River sub-basin. Downstream impacts from these projects can be expected to include reduced freshwater dilution, reduced headwater stream functional inputs, increased discharges of pollutants, including TDS and selenium, and the potential to contribute to existing water quality impairments within the Spruce Fork watershed and the Coal River sub-basin.

The Coal River sub-basin contains 743 miles of impaired streams, 33% of the total stream length in the sub-basin (WVDEP 2010b). The WVDEP has listed certain of these stream segments for selenium and biological impairment, among other pollutants. The additional fills associated with the Spruce No. 1 Mine, in combination with past and present mining by the applicant and other mining in the sub-basin, will cause or contribute to significant cumulative adverse impacts to the stream resources in the Coal River sub-basin, and will contribute to current water quality impairments within the sub-basin, and result in unacceptable adverse effects on wildlife and their habitat.

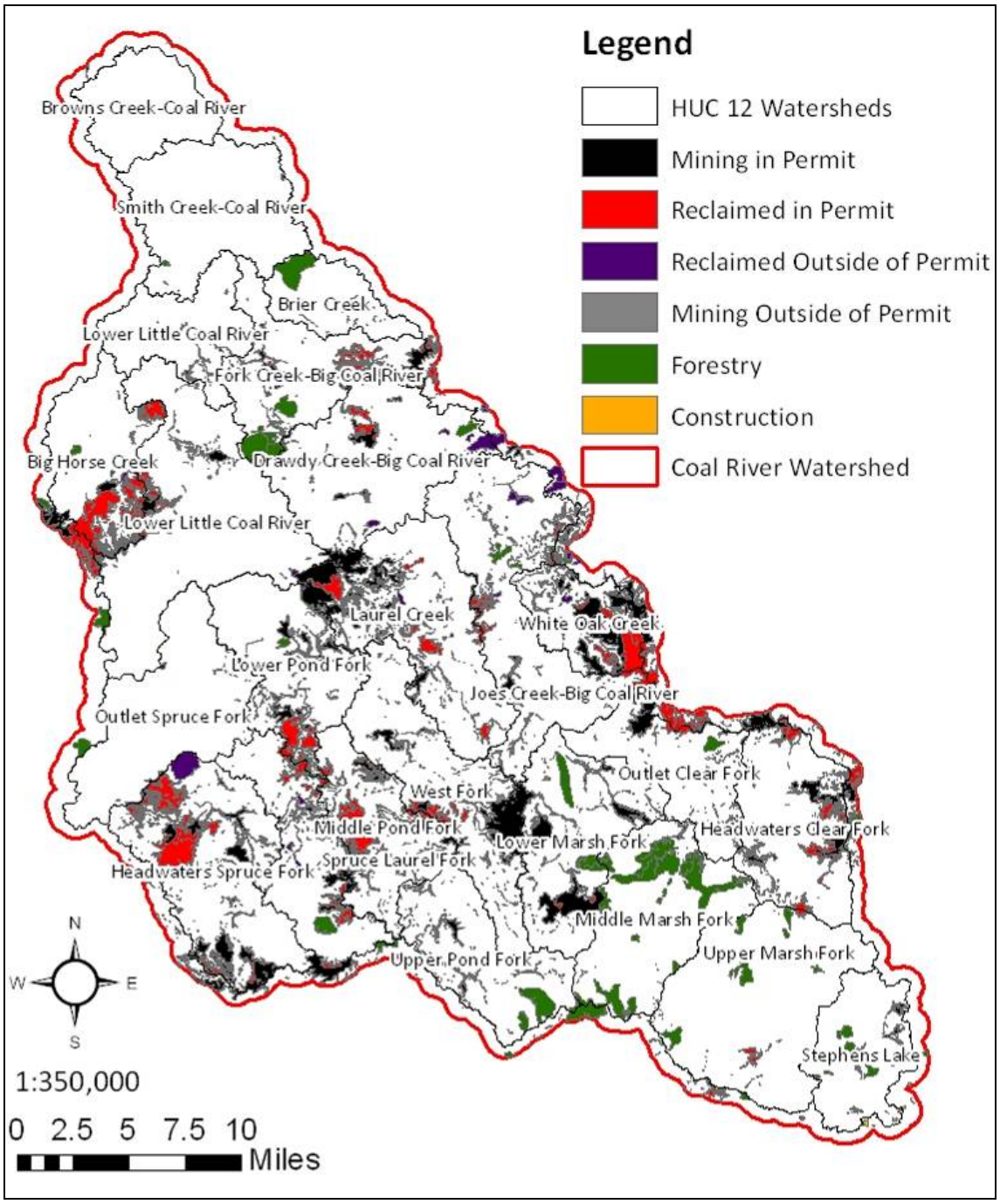

Figure 15. Illustration of the types of disturbance currently found in the Coal River sub-basin

In order to predict cumulative effects from the Spruce No. 1 Mine in conjunction with historic activities, as well as these foreseeable surface mining projects, EPA used mapped landscape data generated from remote sensing techniques and site-specific stream data generated from field sampling techniques to determine the relationship between mining activity and downstream conductivity. This analysis was then used to develop levels of mining activity, measured as percent mining in a watershed, associated with increasing

levels of conductivity that reflect increasing extirpation of aquatic life communities (see Appendix 5 for detailed methods and results).

Results of this analysis indicate that there are significant and strong quantitative relationships between mining activities in a watershed and downstream conductivity condition (See also USEPA 2010a, Appendix A and F). The majority of development-only sites had stream conductivity less than 500 µS/cm, with no development-only sites measuring higher than 800 µS/cm (Figure 16). The two regression curves based on the combined mining/development and mining-only sites were similar to each other. The mining-only regression was used to identify percent mining levels related to increasing conductivity conditions.

Using these calculations, a watershed network modeling system was constructed to estimate downstream chemical response to mining activities upstream within the Coal River sub-basin. The calculated percent mining levels were embedded in an alternative futures analysis and used to quantify changes in stream conductivity conditions under three development scenarios; current condition, full construction of the Spruce No. 1 Mine, and full construction of the Spruce No. 1 Mine plus full construction of currently WVDEP-permitted surface mines.[18] For each scenario, the number of stream segments and length of stream were calculated and classified into conductivity ranges.

Based on the results of this model, EPA estimates that summer conductivity is currently below 300 µS/cm in 5.3% (4.6 miles) of the 86.7 miles of stream segments within or downstream of the Spruce No. 1 Mine site to the mouth of the Coal River. If the Spruce No. 1 Mine is constructed as permitted, this analysis shows that there will be no stream segments with conductivity less than 300 µS/cm downstream of the mine site in the Coal River sub-basin. Currently, 2.2% (1.9 mi) of the stream segments within or downstream of the Spruce No. 1 Mine site are calculated to have conductivity greater than 1000 µS/cm. Following full construction of the permitted area, 21.7% (18.8 mi) are projected to have conductivity greater than 1000 µS/cm. As this demonstrates, conductivity is predicted to significantly increase in Spruce Fork as the Spruce No. 1 Mine is constructed.

If other permitted mine areas, in addition to Spruce No. 1, are included in the analyses, the cumulative effects are predicted to result in higher conductivities in both the Little Coal and Coal Rivers. Within the Headwaters Spruce Fork sub-watershed, percent mining is predicted to increase by 15.8% over current conditions under this scenario, which will elevate conductivity from less than 750 µS/cm to greater than 1000 µS/cm at the mouth of Spruce Fork. Similarly, within the Little Coal River watershed, the calculation of full construction of all permitted mines results in percent mining increasing by 11.2% over current conditions, which results in predicted conductivity elevating from less than 750 µS/cm to as much as 1000 µS/cm within the Little Coal River. At the broadest scale analyzed, percent mining is predicted to increase by 9.3% in the Coal

[18] EPA makes no determination at this time regarding whether these other mines comply with the § 404(b)(1) Guidelines or may result in unacceptable adverse impact under § 404(c).

River sub-basin with full construction of all permitted mines. This also resulted in conductivity increasing from less than 750 µS/cm to as much as 1000 µS/cm within the Coal River.

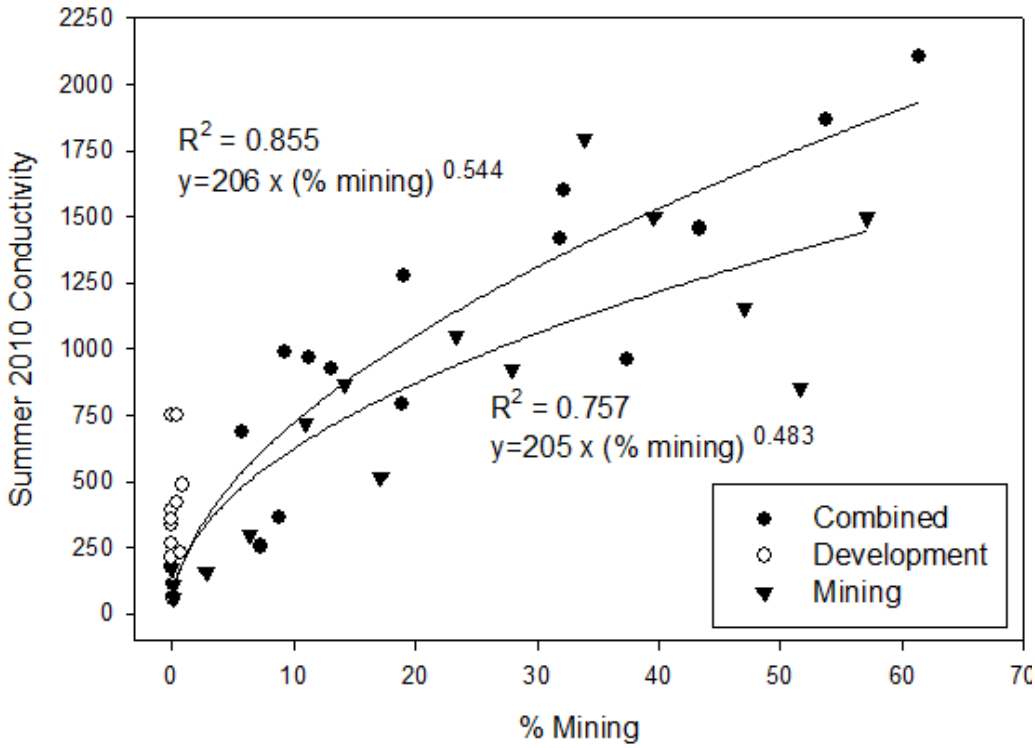

Figure 16. Model of the relationship between percent mining within a watershed and conductivity. The lower regression line is for mining-only sites, and the upper line is for combined mining/development sites.

As detailed in Section V.D.2.a., these conductivity levels have been associated with the impairment and extirpation of macroinvertebrate aquatic life. At this watershed scale, shifts in macroinvertebrate communities, and the loss of the primary food sources that these communities represent for higher trophic levels, will result in cascading ecosystem changes downstream.[19] Combined with increased levels of selenium and other mining-related pollutants, EPA believes these adverse effects will cause or contribute to significant degradation within the Coal River sub-basin. The severity of the cumulative impacts further strengthens EPA's conclusion that this project will result in unacceptable adverse impacts to wildlife and its habitat.

V.E.2.b. Secondary Effects

The § 404(b)(1) Guidelines (at 40 CFR 230.11(h)) also direct that factual findings be made regarding secondary effects on the aquatic ecosystem and that those findings be

[19] In the 2008 West Virginia Integrated Water Quality Monitoring And Assessment Report, WVDEP stated "A "shift" in the benthic macroinvertebrate community of a stream can constitute biological impairment pursuant to 47CSR2 – 3.2.i, and the WVSCI (recognized as a "best science method" in the PEIS) provides a sound scientific basis for assessment."

considered in determining whether the discharge will cause or contribute to significant degradation of the Nation's waters. To that end, the § 404(b)(1) Guidelines describe the factual finding that must be made with respect to secondary effects as follows:

> Secondary effects are effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material. Information about secondary effects on aquatic ecosystems shall be considered prior to the time final section 404 action is taken by permitting authorities.
>
> Some examples of secondary effects on an aquatic ecosystem are fluctuating water levels in an impoundment and downstream associated with the operation of a dam, septic tank leaching and surface runoff from residential or commercial developments on fill, and leachate and runoff from a sanitary landfill located in waters of the U.S.

Section V.D. includes a discussion and analysis of the secondary effects of the Spruce No. 1 Mine including the degradation of downstream water quality by 1) removing streams that currently provide sources of freshwater dilution and 2) transforming those stream areas into sources of contaminants (particularly TDS and selenium). The downstream water quality changes associated with the authorized project would significantly reduce the functional diversity, as well as the overall abundance and productivity of macroinvertebrate communities, thus, through cascading food web effects, adversely impact an extensive list of vertebrate species which depend upon the macroinvertebrate community within these streams for nourishment.

The adverse secondary effects discussed in Section V.D. include substantial changes in aquatic communities, such as loss of fish and salamander diversity and sensitive mayfly and stonefly taxa, as well as shifts to more pollution-tolerant taxa. Through the loss of stream macroinvertebrate and salamander communities, there will be, in turn, substantial effects to both aquatic and terrestrial vertebrate populations that rely on these communities as a food source. In addition, the discharges will increase loading of pollutants to downstream receiving waters, increasing the risk of harmful golden algal blooms and causing or contributing to fish and bird impairments due to selenium exposure.

V.E.3. Mitigation Will Not Adequately Offset Anticipated Impacts

If constructed as authorized the Spruce No. 1 Mine will result in direct impacts through discharge of dredged or fill material to approximately 6.6 miles of stream in Pigeonroost Branch and Oldhouse Branch. The impacts from these discharges are discussed in Sections V.C. While recognizing that the project includes mitigation efforts (including stream creation and enhancement of existing streams) to compensate for unavoidable adverse impacts, EPA believes that known compensatory mitigation techniques will not replace the high quality resources of Pigeonroost Branch and Oldhouse Branch that will be impacted by the project. Additionally, EPA believes that the current mitigation plan

does not adequately account for the quality and function of the impacted resources.

Under § 404(c), EPA has discretionary authority to prohibit or withdraw the specification of a defined area as a disposal site whenever the Administrator determines that the discharge will have an unacceptable adverse effect on a number of identified categories. Therefore, as a legal matter, EPA can make a determination that a discharge of dredged or fill material will cause unacceptable adverse effects without consideration of compensatory mitigation. The statutory standard does not mention mitigation directly and authorizes EPA to determine what constitutes an unacceptable adverse effect. In other words, EPA does not need to determine that mitigation is somehow flawed or insufficient in order to conclude that a proposed or authorized discharge would have unacceptable adverse effects. EPA's conclusion that there is noncompliance with the Guidelines with respect to mitigation confirms the unacceptability of the adverse impacts on wildlife within the project area and downstream.

The Compensatory Mitigation Plan (CMP) submitted by Mingo Logan describes on-site and off-site, in-kind mitigation. On-site compensation would include the restoration of 7,132 linear feet of stream segments temporarily impacted by the sediment ponds, and the creation of 43,565 linear feet of on-bench stream channel within the project area. On-bench sedimentation ditches are SMCRA-required Best Management Practices (BMPs) to control runoff. Off-site compensation includes stream enhancements to Spruce Fork and Rockhouse Creek through a combination of physical, aquatic habitat, and stream stabilization improvements. The CMP also proposes to direct surface water flow from the project area in existing drainage ways to promote the development of more defined channels, thus creating 26,625 linear feet of streams.

Both EPA and the USFWS have repeatedly identified problems with the mitigation techniques that are part of the CMP for the Spruce No. 1 Mine. EPA Region III's comments on the 2006 draft and final EISs for the Spruce No. 1 Mine expressed concerns that the compensatory mitigation plan did not adequately mitigate all adverse impacts and was inadequate in terms of its lack of functional assessment, as well as whether proposed headwater stream creation would in fact replace the functions of impacted resources. EPA Region III emphasized the importance of headwater stream functions that would be lost and likely not replaced, particularly by the conversion of existing drainage channels to streams as described in the CMP. In its December 4, 2001, letter the USFWS expressed similar concerns that the proposed mitigation was unlikely “to provide sufficient mitigation for permanent stream and riparian habitat loss and for the losses of the functions and values of the stream to aquatic species in the fill footprint and to the downstream ecosystem.” These concerns were reiterated by the USFWS in its June 2, 2010, and December 16, 2010, letters commenting on the EPA Region III Proposed Determination and Recommended Determinations, respectively.

As discussed below and in Appendix 3, the project fails to include all appropriate and practicable steps to minimize and compensate for the project’s adverse impacts on the aquatic ecosystem as required by 40 CFR 230.10(d). Further, EPA believes that the anticipated level of adverse impacts associated with the Spruce No. 1 Mine will not be

offset by the required compensatory mitigation to the extent necessary to prevent significant and unacceptable effects on wildlife and their habitat.

V.E.3.a. Proposed Mitigation Will Not Replace High Quality Resources in Pigeonroost Branch and Oldhouse Branch

There is no evidence in the peer-reviewed literature that the type of stream creation included in the CMP will successfully replace lost biological function and comparable stream chemistry to high quality stream resources, such as Pigeonroost Branch and Oldhouse Branch. Scientific research has demonstrated that replacement of streams is among the most difficult and frequently unsuccessful forms of mitigation (Bernhardt et al.2007). Even if stream structure and hydrology can be replaced, it is not clear that replacing structure and hydrology will result in true replacement of functions, especially the native aquatic community and headwater functions. Based upon this research, the Corps and EPA stated in the response to comments on the 2008 Compensatory Mitigation for Losses of Aquatic Resources Final Rule:

> We recognize that the scientific literature regarding the issue of stream establishment and re-establishment is limited and that some past projects have had limited success (Bernhardt et al.2007). Accordingly, we have added a new paragraph at 33 CFR 332.3(e)(3) [40 CFR 230.93(e)(3)] that specifically notes that there are some aquatic resources types that are difficult to replace and streams are included among these. It emphasizes the need to avoid and minimize impacts to these 'difficult-to-replace' resources and requires that any compensation be provided by in-kind preservation, rehabilitation, or enhancement to the extent practicable. This language is intended to discourage stream establishment and re-establishment projects while still requiring compensation for unavoidable stream impacts in the form of stream corridor restoration (via rehabilitation), enhancement, and preservation projects, where practicable.[20]

An additional 26,625 feet of high gradient stream credit is sought for connectivity channels. Connectivity channels are areas where surface water flows from the on-bench ditches, passes through NPDES outfalls, and runs downhill to eventually "form a hydrological connection to a surface tributary of a navigable water" (USACE 2007). The premise is that, if properly placed, connectivity channels will enable mine runoff water to travel down natural, steep hill slopes and ephemeral channels and into naturally non-flowing receiving segments. However, based on the changes to water quality discussed in Section V.D.1., they will receive selenium and dissolved solids from the mined area, resulting in degraded water quality and an inability of these channels to provide meaningful ecological functions and values to replace the affected streams. In addition,

[20] EPA recognizes that the effective date of the regulations governing compensatory mitigation that were promulgated at 73 Fed. Reg. 19594 (April 10, 2008) is June 9, 2008, and therefore were not in effect when the Corps of Engineers issued DA Permit No. 199800436-3 (Section 10: Coal River). Nevertheless, the above-quoted statement, taken from the preamble to those regulations, represents the most recent regulatory statement by the agencies regarding types and effectiveness of mitigation and summarizes scientific research and literature that is applicable to consideration of the likely efficacy of the compensatory mitigation proposed for the Spruce No. 1 Mine.

these channels will function as sources of pollutants, delivering additional selenium and total dissolved solids to downstream headwater streams.

As discussed in this document, the streams of Pigeonroost Branch and Oldhouse Branch have been shown to exhibit high water quality and high functional capacity. Given the difficulty of stream re-establishment to mitigate for impacts to streams in general, EPA believes it is extremely unlikely that high-value streams such as these can be replaced by on-site stream creation techniques involving conversion of sedimentation ditches fed by mine spoil runoff and seepage. As explained further in Appendix 3, EPA believes that the mitigation for the Spruce No. 1 Mine will not offset the anticipated impacts to an acceptable level.

V.E.3.b. The Compensatory Mitigation Plan is Based upon a Misclassification of the Impacted Resources

The starting point for an adequate compensatory mitigation plan is accurate characterization of the impacted resources. EPA believes that the Spruce No. 1 Mine CMP is based upon a misclassification of impacts to perennial and intermittent streams, thereby resulting in an insufficient baseline from which to design adequate stream compensation.

The USGS documented the flow origin, drainage areas and hydrologic characteristics of perennial and intermittent streams in this region in 2000 and 2001 (Paybins 2003). A field reconnaissance by EPA during dry conditions in September 1998 (Green and Passmore 1999) found distinct perennial benthic communities (i.e., long-lived taxa representative of perennial conditions) in the upper reaches of Pigeonroost Branch and Oldhouse Branch. Through these onsite visits and biological data collection, combined with USGS drainage estimates, EPA estimates that, within the mine footprints of Pigeonroost Branch, and Oldhouse Branch, approximately four miles of stream (~20,000 feet) are perennial. In this case, "perennial" refers to streams that have either 1) perennial flow and indicator biota requiring at least a 6 month life cycle, or 2) non-contiguous surface flow during drought conditions but indicator biota requiring at least a 6 month life cycle.

This is in contrast to the DA Permit estimation of 165 feet of perennial waters within the entire project area. This misclassification has a critical impact upon the type of mitigation that would be required to offset these impacts. The resource type plays an important role in the types of expected aquatic communities, the degree in which each resource provides structure and function, and the amount of organic matter and nutrients (and contaminants) ultimately retained or loaded to receiving streams. This misclassification means that the compensatory mitigation plan does not properly account for, and therefore will not offset, the full range of adverse impacts related to the project. A more detailed description of EPA's analysis of stream type is described in Appendix 3.

V.E.3.c. The Compensatory Mitigation Plan Lacks an Adequate Functional Assessment

In addition to being based on a misclassification of resource type, the CMP also is based upon an inadequate functional assessment of the impacted resources. The goal of compensatory mitigation is to replace the aquatic resource function lost or adversely affected by authorized activities. Therefore, to ensure that the functions are being replaced, the compensatory mitigation must create or restore streams that sustain comparable biological communities and chemical and physical characteristics and provide comparable physical, chemical and biological functions to the streams that have been eliminated. The § 404(b)(1) Guidelines require the permitting authority to make certain factual determinations addressing the potential short-term or long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment. See, 40 CFR 230.11. Among the factual determinations required of the permitting authority is the following:

> *(e) Aquatic ecosystem and organism determinations*. Determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystem and organisms.

This provision of the Guidelines requires the permitting authority to determine the nature and degree of effect that the proposed discharge will have on both the structure and function of the aquatic ecosystem and organisms. This principal from the Guidelines was reiterated and clarified in a joint Department of the Army/EPA guidance memo, focused specifically on the review of permit applications for Appalachian surface coal mining.[21]

In order to ensure adequate replacement of both structure and function, the impacted streams must be accurately assessed and the proposed compensation must be evaluated using comparable standards for assessment. As discussed above, the baseline assessment of the existing and impacted streams on the site missed and misclassified well over twenty thousand linear feet of headwater streams, which prevented the USACE from identifying the appropriate compensation needs of this project.

In addition, the assessment method used by the permittee was inadequate and led to an improper valuation of compensation needs and proposals. The CMP utilized an assessment method referred to as the Stream Habitat Unit (SHU) method to calculate mitigation debits and credits. This assessment entails a combination of linear lengths of impact, habitat assessment scores, and stream hydrological status.[22] The limitations of the

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[21] EPA recognizes that the effective date of this memorandum is July 30, 2010, and therefore was not in effect at the time the Corps issued DA Permit No. 199800436-3 (Section 10: Coal River). Nevertheless, the requirement in the Guidelines regarding the factual determination of the impact to the structure and function of the aquatic ecosystem is applicable and relevant to EPA's evaluation of the Spruce No. 1 compensatory mitigation plan, and the July 30, 2010 memorandum reflects the agencies most recent statement about the meaning of that requirement.

[22] Even though the Corps did not finally rely solely on the SHU for mitigation requirements, the Corps did not categorically prevent the permittee from using this approach as a basis for its mitigation plan, and thereby allowed Mingo Logan to use this approach to help justify their mitigation performance and success criteria.

SHU and need for an adequate functional assessment are further explained in Appendix 3. The SHU as presented in the CMP only accounts for the physical aspects of stream condition and fails to account for the interrelationship of water chemistry and biological resources in stream functioning.

As a result of this EPA believes the current CMP does not adequately account for or replace the structure and function of the lost streams. EPA does not believe that increased ratios of intermittent or ephemeral streams offset this inadequacy. While DA Permit No. 199800436-3 (Section 10: Coal River) refers to biological success criteria and the use of a yet-to-be developed functional assessment method for mitigation monitoring, the permit conditions do not clearly require the replacement of lost biological function and comparable stream chemistry or adequate compensatory mitigation success criteria.

V.E.3.d. Conversion of Erosion Control Channels Will Not Successfully Replace the Impacted Resources

Based on observations of other on-bench SMCRA drainage or erosion control ditches (Kirk 1999a, Green et al. 2000, and Gingerich 2009), EPA believes the CMP's proposed conversion of these ditches will not successfully replace the impacted resources, alone or in concert with other mitigation contained in the CMP. Over 50% of the linear stream length in the Spruce mitigation plan relies on conversion of on-bench SMCRA drainage or control ditches. Data show that water quality in these types of sedimentation ditches in the Appalachian region is typically highly degraded, as a result of the water in these ditches percolating through mine spoil (Gingerich 2009). Even when the sedimentation ditches are enhanced for benthic substrata and riparian vegetation, such as by adding boulder clusters, the resulting water quality will be so degraded that the ditches will not meet pre-mining water chemistry baselines, especially in the case of high quality streams such as Pigeonroost Branch and Oldhouse Branch.

As described previously, degraded water chemistry caused by the addition of TDS and selenium typically leads to degraded biological communities. The proposed constructed stream channels will not meaningfully reduce the concentrations of these ions in the water flowing through them. Because of this degraded water chemistry, any created waterbodies would not support the healthy and diverse biological communities that they are intended to replace. Moreover, the water quality (e.g., salinity) would be so degraded that it will foster conditions favorable to the establishment of toxic Golden Algae.

A comparison of family-level macroinvertebrate data between sediment ditches and Pigeonroost Branch and Oldhouse Branch reveals marked differences in species richness and very little taxonomic overlap. Based upon Kirk (1999a) and EPA data, total familial richness in sediment ditches ranged between 4 to 11 taxa, with 0 to 3 families of Ephemeroptera, Plecoptera or Trichoptera (EPT) taxa present. In contrast, total familial richness at Oldhouse Branch and Pigeonroost Branch was 40, with 26 families of EPT taxa present.

Of the taxa collected in the sediment ditches, only seven were also present in Oldhouse Branch and Pigeonroost Branch. With regards to the taxa present in the sediment ditches that were not found in Oldhouse Branch and Pigeonroost Branch, Pond et al. (2008) found that these taxa do not generally occur at sites unaffected by mining. These data demonstrate that taxonomic assemblages in sediment ditches are not only less diverse than streams unaffected by mining, but include a suite of organisms not found in high quality headwater streams unaffected by mining, such as Oldhouse Branch and Pigeonroost Branch.

EPA believes these created streams converted from erosion control channels would be considered degraded and will not successfully replace Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution with healthy biological communities and water quality, either alone or in concert with other mitigation contained in the CMP.

A more detailed discussion of the limitations of on-bench sedimentation ditches for mitigation is provided in Appendix 3.

V.E.3.e. The Compensatory Mitigation Plan Does Not Account for the Loss of Ecological Services Provided by Headwater Streams

EPA is also concerned with the separation of the ecological elements into single, separate aspects of the ecology in the Spruce No. 1 Mine CMP, with limited consideration for the interconnectedness of the entire ecosystem. The forested slopes and coves located within the Spruce No. 1 Mine area are drained by a dendritic mosaic of ephemeral, intermittent and perennial headwater streams and watercourses. The watershed is inextricably linked with the stream system that drains it. The overwhelming bulk of the organic matter that sustains the stream biota in Spruce Fork is a function of the upstream environment. While compensatory mitigation is required for the impacts to waters of the United States under the § 404 program, EPA believes that a well-designed compensatory mitigation plan should take into account this terrestrial-aquatic linkage and ensure that restored or created channels provide greater functions than simply service as water conveyance structures.

In a pre-mined condition, these headwater streams are recipients of allochthonous material (i.e., material originating from outside of the stream system) and water inputs (i.e., surface, subsurface, and groundwater) from the surrounding forested communities. The post-mined environment, however, creates severely altered conditions in stream courses that are not destroyed by valley fills. Those alterations include:

a. Elimination of water and processed organic material from former upstream tributaries that will be under valley fills.

b. Altered contributions of water and allochthonous material from the surrounding upland watershed, due to the altered character of the soil and vegetation communities in a post-mine environment.

c. Altered hydrograph with new flow regimes that markedly depart from that under which the streams have evolved.

d. Altered timing, temperature and chemical composition of post-mine discharges of water to receiving streams.

The permittee proposes to restore or create 71 acres of riparian forest as part of its reclamation and stream creation and restoration activities. While EPA agrees that planting trees along any newly created stream channels better recreates pre-mining riparian conditions than no riparian vegetation, EPA has not seen evidence that such practices can effectively replace lost natural riparian ecosystems. The current riparian zone consists largely of basswood, beech, tulip poplar, buckeye, sugar maple, white oak and red oak, yet out of the 11 tree species listed in the Compensatory Mitigation Plan, only two are found within or near the project area. Riparian systems created through this plan are likely to function differently from buried streams because their vegetation communities will differ from those present on the project site.

The Spruce No. 1 Mine will profoundly alter the contributing watershed. Effectively the new landscape widely departs from that within which the stream network has evolved. The subsequent ecosystem is an entirely new system. Based on available information, the mitigation will not replace the structure and function of the pre-mined conditions including those elements that are dependent on contributions from the surrounding watershed. These concerns regarding the mitigation are shared by the USFWS whose comment letter to EPA regarding the Recommended Determination states "…the currently-proposed mitigation for these impacts is unlikely to adequately compensate for the loss and degradation of these streams, their biological productivity and diversity, or their ecological integrity."

V.E.4. Summary

The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by the streams of Pigeonroost Branch and Oldhouse Branch including maintenance of biologically diverse wildlife habitat and profoundly alter the contributing watershed. EPA maintains that impacts to these functions at the scale associated with this project will result in significant degradation (40 CFR 230.10(c)) of the Nation's waters, particularly in light of the extensive cumulative stream losses in the Spruce Fork and Coal River watersheds, and that such degradation will result in unacceptable adverse impacts on wildlife and wildlife habitat. EPA does not believe these impacts can be adequately mitigated to reduce the impacts to an acceptable level by the compensatory mitigation described in the CMP. Finally, the possibility that additional practicable alternative project configurations and practices exist that would significantly reduce and/or avoid much of the discharges to Pigeonroost Branch and Oldhouse Branch further enhances EPA's assessment of the unacceptability of the impacts that were previously described.

VI. Other Considerations

As set forth above, EPA has determined that the impacts from the discharges to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) described in Section V. will have an unacceptable adverse effect on wildlife both within the project area and downstream of the project area, and that the project does not comply with the requirements of the § 404(b)(1) Guidelines. This section identifies other, additional considerations that are of concern to EPA but are not part of the basis for EPA's conclusion that the impacts will have an unacceptable adverse effect on wildlife.

EPA includes this discussion to recognize additional significant environmental, public health, and environmental justice impacts associated with the Spruce No. 1 Mine that are relevant to EPA's and the Corps' broader responsibilities in reaching permit decisions under the Clean Water Act and other statutes and policies, including the National Environmental Policy Act and the Environmental Justice Executive Order (E.O. 12898). EPA understands that the impacts identified in Section VI are not directly relevant to the Agency's determination under § 404(c). However, EPA includes this section to emphasize for the public the broader impacts of the project as they relate to EPA's legal responsibilities. EPA takes seriously each of its responsibilities to assure effective protection for coalfield communities from environmental, human health, and water quality impacts associated with surface coal mining activities.

VI.A. Impacts from Activities Dependent upon Specification of Pigeonroost Branch and Oldhouse Branch as Disposal Sites for the Discharge of Dredged or Fill Material for the Spruce No. 1 Mine

The following sections discuss impacts that depend upon specification of Pigeonroost Branch and Oldhouse Branch for construction of valley fills and sediment ponds for the Spruce No. 1 Mine, but occur as a result of discharges of excess spoil to areas outside of jurisdictional waters, or occur as a result of other mining-related activities, such as deforestation.

VI.A.1. Migratory Birds

The Spruce No. 1 Mine will destroy approximately 2,278 acres of deciduous forests. Among the many migratory birds likely to breed in the project area, there are six species that the USFWS has designated as Birds of Conservation Concern within the Appalachian Mountains Bird Conservation Region that may be impacted. These include the Cerulean, Kentucky, Swainson's and Worm-eating Warblers, the Wood Thrush, and the Louisiana Waterthrush. The water-dependent Louisiana Waterthrush was discussed in Sections V.C.4. and V.D.5. above. The other five avian species are also designated as BCC species within the USFWS's Northeast Region as a whole and nationally (U.S. Fish and Wildlife Service 2008). The first four are also considered to be among the 100 most at-risk bird species in North America (Wells 2007).

Cerulean and Worm-eating Warblers are also both area-sensitive species that rely on large blocks of intact, mature, interior forest habitats to support productive breeding populations. The Cerulean Warbler breeding population is thought to have declined by about 75% over the past 45 years – the most dramatic decline of any North American warbler monitored by the Breeding Bird Survey (Sauer et al. 2005). Both species are threatened by the loss and fragmentation of these habitats (U.S. Fish and Wildlife Service 2007, Wells 2007). Deforestation associated with the Spruce No. 1 Mine can be expected to adversely impact their breeding populations (Weakland and Wood 2005, Wells 2007).

The project also will impact other bird species that rely on mature forest habitats. Bird species that rely on mature forest habitats that are abundant in the Appalachian region are Kentucky warblers in the understory; and Wood Thrush, Swainson's Warbler, Acadian Flycatcher, and Ovenbirds in mesic hardwoods. These and many other avian species are all impacted by forest fragmentation and habitat loss, such as that which would occur in connection with the Spruce No. 1 Mine. Spatial analyses of the effect of Appalachian mountaintop mining on interior forest indicate that interior forest is lost at a rate 1.75-5.0 times greater than the direct rate of loss of overall forest cover due to mountaintop mining (Wickham et al. 2007).

The Spruce No. 1 Mine will impact mature forested habitat, over a substantial timeframe, replacing the impacted areas with reclaimed areas dominated by grasses and herbaceous species. Many reclaimed areas such as those expected at Spruce No. 1 Mine show little or no regrowth of woody vegetation even after 15 years. The PEIS found significant differences in bird populations between forested and reclaimed sites, namely the loss of the above-mentioned species, and subsequent replacement by more opportunistic grassland species. Also, the loss of the healthy headwater areas of Spruce Fork will reduce the feeding and foraging areas available to specialist bird species in this ecoregion. This reduction in available habitat could potentially impact their long-term viability in the Spruce Fork watershed and the larger ecoregion.

The USFWS evaluated the terrestrial habitats of the project area and concluded that construction of the mine was likely to impact migratory birds via the loss and fragmentation of forest habitat, decreasing habitat heterogeneity, increasing isolation of populations, and increasing exposure to nest predators and parasites (USFWS 1998). The USFWS also expressed concerns specific to bird populations within the Coal River sub-basin related to adverse impacts of the Spruce No. 1 Mine. These concerns included the direct loss of habitat and direct and indirect loss of food resources, for forest interior and riparian-obligate species of migratory birds, including six species the Service considers Birds of Conservation Concern (i.e., Cerulean, Kentucky, Swainson's, and Worm-eating Warblers; Louisiana Waterthrush; Wood Thrush) (USFWS, 2008).

The USFWS continues to believe that construction of the Spruce No. 1 Mine will adversely impact these and other forest-breeding migratory birds. The valley fills will result in the permanent loss of headwater streams that may be used by Louisiana Waterthrushes. The USFWS indicates they are unaware of peer-reviewed research that suggests that these birds will simply relocate to an adjacent, unimpacted watershed and

have comparable survival and reproductive success. The downstream increases in conductivity, selenium and perhaps other contaminants are also likely to adversely affect those waterthrushes not excluded by the direct impacts of the fill via impacts to their food base. In some freshwater food webs, selenium has bioaccumulated to four times the level considered toxic, which can expose birds to reproductive failure when they eat fish or insects with high selenium levels.

While the work of the Appalachian Regional Reforestation Initiative (ARRI) shows substantial promise for better reclamation of mined lands, it has not been demonstrated that these reclaimed areas will generate and sustain forests that provide habitat characteristics and qualities comparable to those of native forest. For these reasons, the construction of the Spruce No. 1 Mine will result in permanent and/or long-term loss of breeding habitats important to several migratory bird species of conservation concern.

VI.A.2. Bats & Other Mammals

Large-scale mountaintop mining has been identified among the threats to bat species in the region according to the USFWS. Loss of the bat's habitat, foraging areas, and food sources, in conjunction with recently identified concerns related to white-nose syndrome, may result in adverse impacts to these wildlife resources. Similarly, habitat loss from land clearing will also affect numerous other mammal species within the project area that rely on forested landscapes for shelter and foraging.

As set forth in Section IV.B.5., the habitat in the project area is quite suitable for federally endangered Indiana Bats, which have been documented in adjacent counties. It is therefore quite possible that Indiana Bats occur within the project area, and that they could be impacted by the loss of forest habitat associated with the Spruce No. 1 Mine and by the loss of headwater streams, riparian areas and associated aquatic and terrestrial insects, as well as by the downstream degradation of these resources likely to be caused by the project.

In addition to Indiana Bats, the USFWS was recently petitioned to list two other bat species, the Eastern Small-footed Bat and Northern Long-eared Bat, under the Endangered Species Act (Center for Biological Diversity 2010). Both species occur in the vicinity of the Spruce No. 1 Mine, and both were captured during mist net surveys at the project site. Like Indiana Bats, these two species are susceptible to population-level impacts from White Nose Syndrome (WNS), which has devastated some populations of eastern bats. If WNS affects West Virginia bats as it has bats in other states, and if large die-offs occur, it will further complicate the already complex challenge of conserving bat species. Previous mining and logging activities and forest loss have also been identified as having adverse affects on bat populations. Traditionally used reclamation techniques, many of which are designed to minimize erosion and provide backfill stability, are incompatible with re-establishment of trees necessary for successful roosting by bats. Such reclamation techniques have the potential to further stress bat populations.

In addition to bats, forest habitat loss associated with the project could have substantial effects on other mammals that depend upon forest resources. While some mammal species are habitat generalists and will not be greatly affected by conversion to a grassland environment, others require forest habitats for protection from predation, foraging and specific habitat needs. These species will likely be adversely affected by the project. Additionally, healthy forested riparian areas can be important habitat for small mammals that feed on insects and small amphibians, as they are proximate to aquatic food sources. As such, insectivorous small mammals that feed on larval aquatic insects, emergent adult aquatic insects, and salamanders will likely be adversely affected by reduced aquatic macroinvertebrate abundances and increased levels of selenium in their prey.

VI.B. Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EPA has this goal for all communities and persons across this Nation. Executive Order 12898 directs: "To the greatest extent practicable…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations…"

According to the 2000 United States Census, Spruce No. 1 Mine is located in a census block group that contains 335 people. A census block group is a geographical unit used by the U.S. Census Bureau (Bureau) that is between a census tract and a census block in size and scale. It is the smallest geographical unit for which the Bureau publishes data. Census block groups generally contain between 600 and 3,000 people, with a target size of 1,500 people.

Spruce No. 1 Mine is located in a census block group where the average per capita income is $15,411. This is more than $6,000 less than the national average of $21,587 and more than $1,000 less than the West Virginia state average of $16,477. The average median family income is also almost $13,000 less than the national average of $52,029. Moreover, 24% of the residents of Logan County live below the poverty line, which also exceeds state and national averages. Studies have highlighted that, despite the economic benefits provided by coal extraction, coal-producing counties in Central Appalachia continue to have some of the highest poverty and unemployment rates in the region (McIlmoil and Hansen 2010).

The Corps included a discussion of environmental justice in the Spruce No. 1 EIS. However, as noted in comment letters in June and October 2006, EPA's environmental justice analysis indicates that there may be a disproportionately high and adverse impact on the low-income population affected by the mining activity. Additionally, EPA remains concerned that the local community did not have the necessary information, or

the opportunity, to meaningfully participate in the EIS process. Specifically, EPA is concerned the community was not informed when changes were made to different aspects of the mine project during the permitting and EIS process and therefore was not able to meaningfully comment on the final aspects of the mine.

The mountains affected by Spruce No. 1 Mine are an important cultural resource for many residents. In many cases the mountains have helped define their culture, and they are an integral part of their daily lives. For example, the mountain ridges of southern West Virginia have for over two centuries been viewed largely as a "commons", where local residents have gathered wild medicinal herbs such as American Ginseng (*Panax quinquefolius*) and Goldenseal (*Hydrastis canadensis*) (Hufford 2003). In many cases, collection of these wild herbs provides much needed extra income to local communities during times of unemployment or economic hardship (Bailey 1999). Removing these mountains may have profound cultural changes on the residents in the area, and so it is important that cultural impacts be considered as well.

EPA considers action pursuant to § 404(c) to be within the scope of the policy directive of Executive Order 12898. A § 404(c) action has the potential to affect human health or the environment of low-income or minority populations. Accordingly, EPA evaluates environmental justice concerns when undertaking an action pursuant to § 404(c). In this case, EPA Region III conducted a public hearing on May 18, 2010 and received comments both orally and in writing. EPA has considered that members of the community expressed concern about loss of jobs and tax revenue (supporting local communities and schools) in the event that EPA's § 404(c) action would preclude any activities authorized at the Spruce No. 1 Mine. At the same time, EPA also has considered that members of the community have expressed concern regarding the adverse environmental and cultural aspects of the project described above. EPA also has received a petition from a variety of stakeholders raising concerns related to environmental justice issues associated with mountaintop mining.

In order to satisfy Executive Order 12898, EPA has considered whether there would be "…disproportionately high and adverse human health or environmental effects…" from its regulatory action. The scope of the inquiry for purposes of EPA's environmental justice analysis is directly tied to the scope of the regulatory action that EPA is taking. In the context of a Clean Water Act § 404(c) action, EPA is authorized to prohibit, restrict, or deny specification (or withdraw specification) of the discharge of dredged or fill material at defined sites in waters of the United States whenever it determines that use of such sites for disposal would have an unacceptable adverse impact on "municipal water supplies, shellfish beds, fishery areas (including spawning and breeding areas), wildlife, or recreational areas."

Accordingly, EPA has considered the potential effects on municipal water supplies, shellfish beds, fishery areas, wildlife and recreational areas (all § 404(c) resources) of the project site in its environmental justice analysis within the context of this Final Determination under § 404(c). EPA has also considered whether the effects, if any, of EPA's § 404(c) action on the § 404(c) resources will have a "disproportionately high and

adverse human health or environmental [effect]" on "minority populations and low-income populations" of the project area.

EPA concludes, after performing the EJ analysis contemplated in Executive Order 12898 to the greatest extent practicable, and incorporating public comment, that this Final Determination under § 404(c) will not have a disproportionately high and adverse human health or environmental effect on the low-income and minority populations of the project area. EPA notes that the scope of this Final Determination is limited to withdrawal of specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for the discharge of dredged or fill material for the construction of valley fills and sediment ponds associated with the Spruce No. 1 Mine as authorized, as well as the prohibition of future discharges, within the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries, associated with surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine. This action neither prohibits nor authorizes coal mining.

VI.C. Public Health

Interest in the overall environmental and human health effects from mountain top mining has been increasing during recent years. A growing body of research suggests that health disparities are not uniformly distributed across the Appalachian region, but instead are concentrated in areas where surface coal mining activity takes place (Hendryx et al. 2007, 2008, Hendryx 2008, Hitt and Hendryx 2010, Hendryx and Zullig 2009). This body of research examined study areas that include the Spruce No. 1 Mine project area. EPA has reviewed these studies, which sought to evaluate whether associations between surface coal mining and health exist. These studies do not provide direct assessments of environmental air and water quality in mining areas in relation to individual exposures and health outcomes. More comprehensive research to develop these direct assessments, including environmental chemical analyses and biological monitoring, would require significantly greater study than is appropriate for this Final Determination.

However, the authors of these studies identify significant associations between surface coal mining activity and a variety of health disparities. They indicate that mortality rates in Appalachian coal mining regions for chronic respiratory, cardiovascular, and kidney disease, and for some forms of cancer including lung cancer are disproportionately elevated when compared to other regions (Hendryx 2008, Hendryx et al. 2007, 2008, Hendryx and Zullig 2009). One study also demonstrates that higher cancer mortality rates are strongly associated with lower WVSCI scores even after accounting for smoking, poverty, and urbanization (Hitt and Hendryx 2010). Another study spatially autocorrolates cancer mortality with surface mining intensity as measured by West Virginia permit boundaries after accounting for the same factors (Hendryx et al. 2010). These studies by their nature could not and do not establish any causal linkage between surface coal mining and these elevated rates of adverse health effects, but because they point to significant associations between surface coal mining and elevated rates of adverse health impacts, the results warrant more research using rigorous epidemiological methods. The existing body of literature suggests that various negative health outcomes

are not the result of a single exposure, but may reflect chronic exposures to multiple environmental contaminants, both air and/or water, which will vary for each individual.

VII. Conclusions and Final Determination

Based on the foregoing analyses, EPA Region III's Recommended Determination, and upon consideration of the public comments received in response to EPA Region III's Proposed and Recommended Determinations, EPA has determined that discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch and their tributaries for the purposes of construction, operation, and reclamation of the Spruce No. 1 Mine as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) will have unacceptable adverse effects on wildlife. DA Permit No. 199800436-3 (Section 10: Coal River) authorizes construction of valley fills and sediment ponds and other discharges into Pigeonroost Branch and Oldhouse Branch and their tributaries that will bury approximately 6.6 miles of high quality headwater streams. Pigeonroost Branch and Oldhouse Branch support diverse and healthy biological communities comparable to nearby White Oak Branch, recognized by the WVDEP as supporting least-disturbed, reference quality conditions. Pigeonroost Branch and Oldhouse Branch represent streams within the larger Headwaters Spruce Fork sub-watershed and Coal River sub-basin that remain relatively free of water quality degradation. As such, Pigeonroost Branch and Oldhouse Branch are valuable in and of themselves and provide essential habitat for wildlife species within the Headwaters Spruce Fork sub-watershed and Coal River sub-basin.

As authorized by the DA Permit, discharges to Pigeonroost Branch and Oldhouse Branch will bury wildlife that live in those streams or within the footprint of the valley fills. Other wildlife will lose important headwater stream habitat on which they depend for all or part of their life cycles. EPA has determined that those impacts alone are unacceptable adverse impacts because of the miles of stream destroyed, the rarity of those streams, and the importance of those streams and their wildlife to the watershed. Unacceptable adverse effects on wildlife from the activities authorized by the permit will not be limited to direct burial of wildlife and significant loss of wildlife habitat. Burial of Pigeonroost Branch and Oldhouse Branch would also result in unacceptable adverse effects on wildlife downstream caused by the removal of functions performed by the buried resources and by transformation of the buried areas into sources that contribute contaminants to downstream waters. In addition, authorized discharges to Pigeonroost Branch and Oldhouse Branch would contribute to conditions that would support blooms of golden algae that release toxins that kill fish and other aquatic life. Thus, EPA has also determined that these adverse impacts on downstream wildlife by themselves are unacceptable.

In addition, these adverse impacts are not in compliance with the requirements of the Clean Water Act (CWA) and EPA's implementing regulations under § 404(b)(1). EPA has determined that the impacts described above may be avoidable and the permittee has failed to demonstrate that there are no less environmentally damaging alternatives; the discharges associated with the Spruce No. 1 Mine will cause or contribute to significant degradation of waters of the United States (especially when considered in the context of the significant cumulative losses and impairment of streams across the Central Appalachian ecoregion); and the compensatory mitigation will not adequately offset the

impacts to Pigeonroost Branch and Oldhouse Branch. These failures to comply with the Guidelines serve to strengthen EPA's judgment about the unacceptability of the significant adverse impacts that will occur.

EPA also notes that USFWS, in its comments on both the Proposed and Recommended Determinations, concurred with EPA Region III's conclusion that the project, as authorized, would result in unacceptable adverse effects on wildlife and that this conclusion is supported by the available scientific information. USFWS also notes that it has consistently expressed concerns regarding the loss of headwater streams and adjacent riparian and terrestrial habitats associated with the Spruce No. 1 Mine, as well as its likely impacts on downstream water quality, aquatic organisms, and terrestrial and aquatic wildlife that depend on those resources.

Finally, EPA notes that this Final Determination is a case-specific determination based on the facts and circumstances presented here. EPA's § 404(c) authority does not require a finding that the particular circumstances are unique, rather it requires a finding of unacceptable adverse impacts to protected resources. EPA's authority is discretionary, and the agency evaluates unacceptability based on the context of the adverse impacts, including their relative size and whether or not it is an impact the aquatic resource can incur without significant adverse environmental effects. Similarly, EPA's decision to undertake a § 404(c) action after a permit had been issued is also a case-specific one and does not threaten the tens of thousands of permits and authorizations that are issued by the U.S. Corps of Engineers every year. This determination was initiated based on the substantial number of project-specific considerations focusing on important headwater stream miles impacted in a stressed watershed where a vast majority of the impacts authorized by the permit had not occurred because of third-party litigation. This is a rare circumstance and the fact that this is only the second final determination following permit issuance in the past 40 years demonstrates that EPA does not undertake such an action lightly.

Accordingly, pursuant to § 404(c) of the Clean Water Act and its implementing regulations at 40 CFR Part 231 and for the reasons set forth herein, it is my determination that the specification embodied in DA Permit No. 199800436-3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch, and their tributaries, as disposal sites for discharges of dredged or fill material for construction, operation, and reclamation of the Spruce No. 1 Mine be withdrawn. This Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine.

Date: 1/13/11

Peter Silva
Assistant Administrator
Office of Water

Matthew Klasen/DC/USEPA/US
01/13/2011 10:31 AM

To Christopher Hunter
cc Gregory Peck
bcc
Subject Here it is (fact sheet)

Greg: Should Chris go live or wait?

mk

Mining Spruce Final Fact Sheet JAN 13 11.pdf

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EPA Action Halts Disposal of Mining Waste in Streams at Spruce No. 1 Mine to Protect Environment, Water Quality, and Appalachian Communities

EPA's Decision: Using authority provided under the Clean Water Act (CWA), the U.S. Environmental Protection Agency (EPA) completed its 15-month comprehensive review of impacts on water quality and wildlife from the Spruce No. 1 mountaintop coal mine in Logan County, West Virginia. EPA concluded, based on a substantial body of new scientific work completed since 2007, that the mine would result in significant environmental impacts from burying over 6.6 miles of ecologically valuable streams under mining waste and would also cause unacceptable adverse environmental effects to wildlife in downstream waters. As a result, EPA is acting under the CWA to protect wildlife, water quality, and Appalachian communities, who rely upon healthy streams, by prohibiting the Mingo Logan Coal Company from disposing of 110 million cubic yards of mining waste into waterways as part of proposed mountaintop coal mining at the Spruce No. 1 mine. The Spruce No. 1 Mine, among the largest mountaintop coal mines ever proposed in Appalachia, would disturb approximately 2,278 acres (about 3.5 square miles) of forestlands in southern West Virginia and bury over six miles of streams under waste rock and mining debris. Two of these streams, Pigeonroost Branch and Oldhouse Branch, are two of the last-remaining high-quality streams in the watershed and are protected by EPA's action.

Summary of EPA Findings: EPA's decision to stop mining waste discharges to high-quality streams at the Spruce No. 1 mine is based on several major environmental, water quality, and wildlife concerns:

- Burying more than 35,000 feet (more than 6 miles) of high-quality streams under mining waste, which will eliminate all fish, invertebrates, salamanders, and other wildlife that live in them;
- Polluting downstream waters as a result of burying these streams, which will lead to unhealthy levels of salinity and toxic levels of selenium;
- Causing downstream watershed degradation that will kill aquatic wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms;
- Inadequately mitigating for the mine's environmental impacts to high-quality streams , by using mining ditches, for example, to offset the functions provided by these natural streams; and
- Failure to consider cumulative watershed degradation resulting from past, present, and future mining in the area.

In addition, EPA is concerned that the Spruce mine will expose Appalachian communities to additional mining related sources of pollution in a watershed already highly impacted by mining activity.

Key Background: Under CWA section 404(c), Congress authorized EPA to prohibit or restrict activities involving the placement of pollutants in the nation's waterways where the Agency determines that these pollutants will cause unacceptable adverse effects to municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. EPA has used its Section 404(c) authority sparingly, prohibiting just 13 projects, including the Spruce mine, since 1972. In this case, EPA is taking this action because a substantial body of new scientific studies and work completed since the mine was permitted in 2007 demonstrate that the burial of Pigeonroost Branch, Oldhouse Branch and their tributaries will have direct, unacceptable adverse effects on wildlife, including fish, salamanders, and waterfowl; and will contribute to downstream water quality degradation and associated adverse impacts to wildlife.

Mountain streams within the Central Appalachian ecoregion have some of the richest aquatic animal diversity of any area in North America, including one of the highest concentrations of salamanders in the world, as well as many rare species of mayflies, stoneflies and caddisflies, which are ecologically important aquatic insects that form the foundation of stream food webs. The project will bury 6.6 miles of some of the last remaining high quality streams and riverbank areas within the Coal River watershed. These streams contain important wildlife communities and habitat and they rank extremely high in comparison to other streams in West Virginia and in Central Appalachia. Including their riverbanks

areas, the streams within the Spruce No. 1 Mine area provide important habitat for over 40 species of amphibians and reptiles, 4 species of crayfish, and 5 species of fish, as well as numerous birds, bats, and other mammals. The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by these streams and will result in the loss of salamander, fish, and other wildlife populations that depend on that habitat for survival.

Burial of Pigeonroost Branch and Oldhouse Branch will also result in unacceptable adverse effects on wildlife by increasing levels of pollution to downstream waters, where over 25 different species of fish are found. Full construction of the Spruce No. 1 Mine will bury streams on site beneath tons of broken mining waste rock that will leach pollutants, particularly total dissolved solids and selenium, into downstream waters and adversely impact the wildlife communities that live in or utilize these streams. The loss of food sources caused by these increased pollution levels, as well as additional exposure to selenium will cause adverse effects to fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on downstream waters for food or habitat.

Section 404(c) Review Process: Key steps in EPA's CWA review of the Spruce No. 1 mine:

- October 2009: EPA begins coordinating with Mingo Logan Coal Company and Corps of Engineers to identify potential corrective actions that reduce mining impacts and would eliminate need for further CWA review. Company does not agree to alternative mine configuration to avoid impacts.
- March 26, 2010: EPA Region III publishes comprehensive Proposed Determination outlining the project's environmental effects and requests public comments.
- May 18, 2010: EPA conducts Public Hearing in Charleston, West Virginia to discuss anticipated mine impacts and provide opportunity for public input. EPA receives over 50,000 public comments – most in support of EPA's review of the Spruce No. 1 mine.
- September 24, 2010: EPA Region III prepares Recommended Determination for EPA Headquarters concluding that discharges associated with the Spruce No. 1 Mine would be likely to lead to significant adverse environmental effects. Region III developed its Recommended Determination in consideration of the Corps permit record, 50,000 public comments, and extensive scientific information relevant to the Spruce No. 1 project.
- October 2010: EPA Office of Water initiates second consultation process with Corps, Mingo Logan Company, State, and landowner to identify potential corrective actions that might eliminate need for EPA action. Company expresses unwillingness to improve its mining operation.
- January 11, 2011: EPA Office of Water completes Section 404(c) review of the Spruce Mine and publishes Final Determination concluding that the project, as currently designed, would cause unacceptable environmental impacts, including water quality impacts, to waterways at the Spruce site and prohibits disposal of mining waste in streams.

A copy of the Final Determination is available at
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/ 404c_index.cfm

Matthew Klasen/DC/USEPA/US
01/13/2011 10:36 AM

To Christopher Hunter
cc
bcc
Subject Take 3

Mining Spruce Fact Sheet JAN 13 11.pdf

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

EPA Action Halts Disposal of Mining Waste in Streams at Spruce No. 1 Mine to Protect Environment, Water Quality, and Appalachian Communities

EPA's Decision: Using authority provided under the Clean Water Act (CWA), the U.S. Environmental Protection Agency (EPA) completed its 15-month comprehensive review of impacts on water quality and wildlife from the Spruce No. 1 mountaintop coal mine in Logan County, West Virginia. EPA concluded, based on a substantial body of new scientific work completed since 2007, that the mine would result in significant environmental impacts from burying over 6.6 miles of ecologically valuable streams under mining waste and would also cause unacceptable adverse environmental effects to wildlife in downstream waters. As a result, EPA is acting under the CWA to protect wildlife, water quality, and Appalachian communities, who rely upon healthy streams, by prohibiting the Mingo Logan Coal Company from disposing of 110 million cubic yards of mining waste into waterways as part of proposed mountaintop coal mining at the Spruce No. 1 mine. The Spruce No. 1 Mine, among the largest mountaintop coal mines ever proposed in Appalachia, would disturb approximately 2,278 acres (about 3.5 square miles) of forestlands in southern West Virginia and bury over six miles of streams under waste rock and mining debris. Two of these streams, Pigeonroost Branch and Oldhouse Branch, are two of the last-remaining high-quality streams in the watershed and are protected by EPA's action.

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A copy of the Final Determination is available at
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/404c_index.cfm

Gregory Peck/DC/USEPA/US
01/13/2011 10:38 AM

To "Duncan, Deidre", taltmeyer, rshanks
cc
bcc
Subject EPA Decision on Spruce

Tom - as we discussed - here is EPA's press release issued at 10:30am this morning. Please call me if you have any questions.

Regards,
Greg

FINAL Spruce Press Release.docx

EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

Agency Cites Irreversible Damage to Clean Water, Environment in the Region

WASHINGTON – After extensive scientific study, a major public hearing in West Virginia and review of more than 50,000 public comments, the U.S. Environmental Protection Agency (EPA) today announced that it will use its authority under the Clean Water Act to halt the proposed disposal of mining waste in streams at the Mingo-Logan Coal Company's Spruce No. 1 coal mine. EPA is acting under the law and using the best science to protect water quality, wildlife and Appalachian communities, who rely on clean waters for drinking, fishing and swimming. EPA has used this Clean Water Act authority in just 12 circumstances since 1972 and reserves this authority for only unacceptable cases.

"The proposed Spruce No. 1 Mine would use destructive and unsustainable mining practices that jeopardize the health of Appalachian communities and clean water on which they depend," said EPA Assistant Administrator for Water, Peter S. Silva. "Coal and coal mining are part of our nation's energy future, and EPA has worked with companies to design mining operations that adequately protect our nation's waters. We have a responsibility under the law to protect water quality and safeguard the people who rely on clean water."

EPA's final determination on the Spruce Mine comes after discussions with the company spanning more than a year failed to produce an agreement that would lead to a significant decrease in impacts to the environment and Appalachian communities. The action prevents the mine from disposing the waste into streams unless the company identifies an alternative mining design that would avoid irreversible damage to water quality and meets the requirements of the law. Despite EPA's willingness to consider alternatives, Mingo Logan did not offer any new proposed mining configurations in response to EPA's Recommended Determination.

EPA believes that companies can design their operations to make them more sustainable and compliant with the law. Last year, EPA worked closely with a mining company in West Virginia to eliminate nearly 50 percent of their water impacts and reduce contamination while at the same time increasing their coal production. These are the kinds of success stories that can be achieved through collaboration and willingness to reduce the impact on mining pollution on our waters. Those changes helped permanently protect local waters, maximize coal recovery and reduce costs for the operators.

EPA's decision to stop mining waste discharges to high quality streams at the Spruce No. 1 mine was based on several major environmental and water quality concerns. The proposed mine project would have:

- Disposed of 110 million cubic yards of coal mine waste into streams.
- Buried more than six miles of high-quality streams in Logan County, West Virginia with millions of tons of mining waste from the dynamiting of over 2,200 acres of mountains and forestlands.

- Buried more than 35,000 feet of high-quality streams under mining waste, which will eliminate all fish, small invertebrates, salamanders, and other wildlife that live in them.
- Polluted downstream waters as a result of burying these streams, which will lead to unhealthy levels of salinity and toxic levels of selenium that turn fresh water into salty water. The resulting waste that then fills valleys and streams can significantly compromise water quality, often causing permanent damage to ecosystems and streams.
- Caused downstream watershed degradation that will kill wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms.
- Inadequately mitigated for the mine's environmental impacts by not replacing streams being buried, and attempting to use stormwater ditches as compensation for natural stream losses.

Additionally, during the permitting process there was a failure to consider cumulative watershed degradation resulting from past, present, and future mining in the area.

Finally, EPA's decision prohibits five proposed valley fills in two streams, Pigeonroost Branch, and Oldhouse Branch, and their tributaries. Mining activities at the Spruce site are underway in Seng Camp Creek as a result of a prior agreement reached in the active litigation with the Mingo Logan Coal Company. EPA's Final Determination does not affect current mining in Seng Camp Creek.

Background on Clean Water Act Section 404(c)

Clean Water Act Section 404(c) authorizes EPA to restrict or prohibit placing dredged or fill material in streams, lakes, rivers, wetlands and other waters if the agency determines that the activities would result in "unacceptable adverse effects" to the environment, water quality, or water supplies. This authority applies to proposed projects as well as projects previously permitted under the Clean Water Act although EPA is not considering such action for other previously permitted projects.

With today's action, EPA has exercised its Section 404(c) authority only 13 times in its history of the CWA. EPA recognizes the importance of ensuring that its Section 404(c) actions are taken only where environmental impacts are truly unacceptable and will use this authority only where warranted by science and the law.

A copy of the Final Determination is available at
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/ 404c_index.cfm

John Forren/R3/USEPA/US
01/13/2011 10:42 AM

To: Amy Bergdale, Charles Rhodes, David Rider, Frank Borsuk, Greg Pond, Jennifer Fulton, Jim Gouvas, Joy Gillespie, Kelly Krock, Louis Reynolds, Margaret Passmore, Regina Poeske, Renee Searfoss, Sherilyn Morgan, William Hoffman, Jennifermary77
cc
bcc
Subject: Fw: Spruce 404(c) is signed

For those you haven't received this already.

----- Forwarded by John Forren/R3/USEPA/US on 01/13/2011 10:41 AM -----

From: Stefania Shamet/R3/USEPA/US
To: Regina Poeske/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA, Greg Pond/R3/USEPA/US@EPA, Frank Borsuk/R3/USEPA/US@EPA, Louis Reynolds/R3/USEPA/US@EPA, Joy Gillespie/R3/USEPA/US@EPA, Alaina DeGeorgio/R3/USEPA/US@EPA, Carrie Traver/R3/USEPA/US@EPA, David Rider/R3/USEPA/US@EPA, David Kargbo/R3/USEPA/US@EPA, Mazzarella.Christine@epamail.epa.gov, Michael Dunn/R3/USEPA/US@EPA, Rhodes.Charles@epamail.epa.gov
Cc: John Forren/R3/USEPA/US@EPA, Jeffrey Lapp/R3/USEPA/US@EPA, John Pomponio/R3/USEPA/US@EPA, Marcia Mulkey/R3/USEPA/US@EPA, Stephen Field/R3/USEPA/US@EPA, Linda Boornazian/R3/USEPA/US@EPA, Jon Capacasa/R3/USEPA/US@EPA, Evelyn MacKnight/R3/USEPA/US@EPA, Newsom.Jim@epamail.epa.gov, Douglas Frankenthaler/R3/USEPA/US@EPA
Date: 01/13/2011 10:36 AM
Subject: Spruce is signed

For those who don't already know, Spruce was signed shortly before 9:30 this morning. The congressional notifications are going on now, and the press release should go out shortly. So, expect something on the Coal Tatoo soon.

I wanted to take a moment to thank all of you who have worked so hard on this. We've been at this for over a year now.

First -- your tremendous work on the proposed and recommended determinations laid a terrific foundation for the final determination. While we had to answer a lot of comments and make some adjustments to address comments and legal issues, the core science and thinking that went into the proposed and recommended determinations is what carried the day and remains the fundamental underpinnings of the final determination. Additional kudos to those of you who worked on the response to comments on the Proposed Determination -- the responses remained largely in tact throughout the process, which is a tribute to your excellent work.

For those of you who were not aware, as part of the regulatory "consultation" process, Mingo Logan and WVDEP submitted an additional set of comments that wound up being around 220 individual "new" comments on the recommended determination. This happened the week before Christmas, and while a bunch of people worked to respond to those -- Greg and Maggie really saved the entire endeavor and did an amazing job. I've run out of superlatives to describe the quality and speed at which they worked. I wish that you guys could hear some of the senior management briefings that I heard. The level of confidence expressed in the foundational science on conductivity and macroinvertebrates was amazing. Senior management basically was told unequivocally that nobody has any doubt that the science on the conductivity and macroinvertebrates was absolutely solid.

I also just want to thank all of you who were suddenly pulled in to pitch in at the last moment, tracking references, locating documents, running down various loose ends. Your help was invaluable and really

appreciated.

In the press of reviewing references, checking numbers, scrubbing as the "legal and policy police," we sometimes forget about the resource we're actually protecting. Here's a photo (thanks, Mike) of Pigeonroost Branch -- one of the two streams that the 404(c) action protects from destruction.

Gregory Peck/DC/USEPA/US	To	Betsaida Alcantara
01/13/2011 10:55 AM	cc	Jalil Isa, Kevin Minoli
	bcc	
	Subject	Re: greenwire question on spruce

This is the 13th 404(c) final decision in 39 years of the CWA. Only one other 404(c) decision (a landfill in Miami - 1978) did EPA's action affect an issued permit.

Betsaida Alcantara	see question below, is this the answer: by "this c...	01/13/2011 10:50:09 AM

From:	Betsaida Alcantara/DC/USEPA/US
To:	Gregory Peck/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA
Cc:	Jalil Isa/DC/USEPA/US@EPA
Date:	01/13/2011 10:50 AM
Subject:	greenwire question on spruce

see question below, is this the answer:

by "this cwa authority" we mean the 404c authority. we've never used it retroactively, this is the first time

"Paul Quinlan"	Can you clarify: press release says EPA has "us...	01/13/2011 10:39:40 AM

From:	"Paul Quinlan" <pquinlan@eenews.net>
To:	Betsaida Alcantara/DC/USEPA/US@EPA
Date:	01/13/2011 10:39 AM
Subject:	RE: Spruce mountaintop removal mine permit

Can you clarify: press release says EPA has "used this Clean Water Act authority just 12 times." Does that mean it has *retroactively* vetoed 12 CWA permits or does is that just the number of vetoes, retroactive or no? if theres a difference what is the # of retroactive vetoes?

-----Original Message-----
From: Alcantara.Betsaida@epamail.epa.gov [mailto:Alcantara.Betsaida@epamail.epa.gov]
Sent: Thu 1/13/2011 10:29 AM
To: Paul Quinlan
Subject: Re: Spruce mountaintop removal mine permit

here you, its going shortly:

FOR IMMEDIATE RELEASE
January 13, 2011

EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

Agency cites irreversible damage to clean water, environment in the region

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its authority under the Clean Water Act to halt the proposed disposal of mining waste in streams at the Mingo-Logan Coal Company's Spruce No. 1 coal mine. EPA is acting under the law and using the best science to protect water quality, wildlife and Appalachian communities, who rely on clean waters for drinking, fishing and swimming. EPA has used this Clean Water Act authority in just 12 circumstances since 1972 and reserves this authority for only unacceptable cases. This permit was first proposed in the 1990s and has been held up in the courts ever since.

"The proposed Spruce No. 1 Mine would use destructive and unsustainable mining practices that jeopardize the health of Appalachian communities and clean water on which they depend," said EPA Assistant Administrator for Water Peter S. Silva. "Coal and coal mining are part of our nation's energy future and EPA has worked with companies to design mining operations that adequately protect our nation's waters. We have a responsibility under the law to protect water quality and safeguard the people who rely on clean water."

EPA's final determination on the Spruce Mine comes after discussions with the company spanning more than a year failed to produce an agreement that would lead to a significant decrease in impacts to the environment and Appalachian communities. The action prevents the mine from disposing of the waste into streams unless the company identifies an alternative mining design that would avoid irreversible damage to water quality and meets the requirements of the law. Despite EPA's willingness to consider alternatives, Mingo Logan did not offer any new proposed mining configurations in response to EPA's Recommended Determination.

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From: "Paul Quinlan" <pquinlan@eenews net>

To: Betsaida Alcantara/DC/USEPA/US@EPA

Date: 01/13/2011 10:28 AM

Subject: Spruce mountaintop removal mine permit

Betsaida,
Belated happy new year, holidays, etc. Hope you're well.

If EPA's decision on the Spruce No. 1 mountaintop mine is set to be finalized today, please send me whatever you can as early as you can. Happy to hold the story as long as necessary under embargo.

Thanks,
Paul
(b) (6) [redacted]

Matthew Klasen/DC/USEPA/US
01/13/2011 10:55 AM

To Gregory Peck
cc Christopher Hunter
bcc
Subject Fw: Water News Release (HQ): EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

Hey Greg,

Just FYI: There's an extra space in the link below, which makes it unworkable (before the last slash). We might want to let OPA know in case (when) they get questions.

mk

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]
----- Forwarded by Matthew Klasen/DC/USEPA/US on 01/13/2011 10:54 AM -----

From: "U.S. EPA" <usaepa@govdelivery.com>
To: Matthew Klasen/DC/USEPA/US@EPA
Date: 01/13/2011 10:50 AM
Subject: Water News Release (HQ): EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

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CONTACT:
Jalil Isa (News Media Only)
isa.jalil@epa.gov
202-564-3226
202-564-4355

FOR IMMEDIATE RELEASE
January 13, 2011

EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

Agency cites irreversible damage to clean water, environment in the region

WASHINGTON – After extensive scientific study, a major public hearing in West Virginia and review of more than 50,000 public comments, the U.S. Environmental Protection Agency (EPA) today announced that it will use its authority under the Clean Water Act to halt the proposed disposal of mining waste in streams at the Mingo-Logan Coal Company's Spruce No. 1 coal mine. EPA is acting under the law and using the best science to protect water quality, wildlife and Appalachian communities, who rely on clean

waters for drinking, fishing and swimming. EPA has used this Clean Water Act authority in just 12 circumstances since 1972 and reserves this authority for only unacceptable cases. This permit was first proposed in the 1990s and has been held up in the courts ever since.

“The proposed Spruce No. 1 Mine would use destructive and unsustainable mining practices that jeopardize the health of Appalachian communities and clean water on which they depend,” said EPA Assistant Administrator for Water Peter S. Silva. “Coal and coal mining are part of our nation’s energy future and EPA has worked with companies to design mining operations that adequately protect our nation’s waters. We have a responsibility under the law to protect water quality and safeguard the people who rely on clean water.”

EPA’s final determination on the Spruce Mine comes after discussions with the company spanning more than a year failed to produce an agreement that would lead to a significant decrease in impacts to the environment and Appalachian communities. The action prevents the mine from disposing of the waste into streams unless the company identifies an alternative mining design that would avoid irreversible damage to water quality and meets the requirements of the law. Despite EPA’s willingness to consider alternatives, Mingo Logan did not offer any new proposed mining configurations in response to EPA’s Recommended Determination.

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EPA’s decision to stop mining waste discharges to high quality streams at the Spruce No. 1 mine was based on several major environmental and water quality concerns. The proposed mine project would have:

- Disposed of 110 million cubic yards of coal mine waste into streams.
- Buried more than six miles of high-quality streams in Logan County, West Virginia with millions of tons of mining waste from the dynamiting of more than 2,200 acres of mountains and forestlands.
- Buried more than 35,000 feet of high-quality streams under mining waste, which will eliminate all fish, small invertebrates, salamanders, and other wildlife that live in them.
- Polluted downstream waters as a result of burying these streams, which will lead to unhealthy levels of salinity and toxic levels of selenium that turn fresh water into salty water. The resulting waste that then fills valleys and streams can significantly compromise water quality, often causing permanent damage to ecosystems and streams.

- Caused downstream watershed degradation that will kill wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms.

- Inadequately mitigated for the mine’s environmental impacts by not replacing streams being buried, and attempting to use stormwater ditches as compensation for natural stream losses.

Additionally, during the permitting process there was a failure to consider cumulative watershed degradation resulting from past, present, and future mining in the area.

Finally, EPA’s decision prohibits five proposed valley fills in two streams, Pigeonroost Branch, and Oldhouse Branch, and their tributaries. Mining activities at the Spruce site are underway in Seng Camp Creek as a result of a prior agreement reached in the active litigation with the Mingo Logan Coal Company. EPA’s Final Determination does not affect current mining in Seng Camp Creek.

Background on Clean Water Act Section 404(c)

Clean Water Act Section 404(c) authorizes EPA to restrict or prohibit placing dredged or fill material in streams, lakes, rivers, wetlands and other waters if the agency determines that the activities would result in “unacceptable adverse effects” to the environment, water quality, or water supplies. This authority applies to proposed projects as well as projects previously permitted under the Clean Water Act although EPA is not considering such action for other previously permitted projects.

With today’s action, EPA has exercised its Section 404(c) authority only 13 times in its history of the CWA. EPA recognizes the importance of ensuring that its Section 404(c) actions are taken only where environmental impacts are truly unacceptable and will use this authority only where warranted by science and the law.

For a copy of the Final Determination:
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/ 404c_index.cfm

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01/13/2011 11:05 AM	cc	Arvin Ganesan, Brendan Gilfillan, Jack Bowles, Kevin Minoli
	bcc	
	Subject	Re: Fw: Water News Release (HQ): EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

An extra space was added to the link? the PR is being reissued now - but here's the correct link

http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/404c_index.cfm

Anthony Raia	Maybe it's just happening for me at my PC....but...	01/13/2011 11:03:16 AM

From:	Anthony Raia/DC/USEPA/US
To:	Brendan Gilfillan/DC/USEPA/US@EPA, Arvin Ganesan/DC/USEPA/US@EPA, Gregory Peck/DC/USEPA/US@EPA
Cc:	Jack Bowles/DC/USEPA/US
Date:	01/13/2011 11:03 AM
Subject:	Fw: Water News Release (HQ): EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

Maybe it's just happening for me at my PC....but the web link to the final determination in this PR is not working fyi.

Anthony Raia
U.S. Environmental Protection Agency
Office of the Administrator, Intergovernmental Relations (OCIR)
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----- Forwarded by Anthony Raia/DC/USEPA/US on 01/13/2011 11:00 AM -----

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Subject:	Water News Release (HQ): EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

CONTACT:
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202-564-3226
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FOR IMMEDIATE RELEASE
January 13, 2011

EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

Agency cites irreversible damage to clean water, environment in the region

WASHINGTON – After extensive scientific study, a major public hearing in West Virginia and review of more than 50,000 public comments, the U.S. Environmental Protection Agency (EPA) today announced that it will use its authority under the Clean Water Act to halt the proposed disposal of mining waste in streams at the Mingo-Logan Coal Company's Spruce No. 1 coal mine. EPA is acting under the law and using the best science to protect water quality, wildlife and Appalachian communities, who rely on clean waters for drinking, fishing and swimming. EPA has used this Clean Water Act authority in just 12 circumstances since 1972 and reserves this authority for only unacceptable cases. This permit was first proposed in the 1990s and has been held up in the courts ever since.

"The proposed Spruce No. 1 Mine would use destructive and unsustainable mining practices that jeopardize the health of Appalachian communities and clean water on which they depend," said EPA Assistant Administrator for Water Peter S. Silva. "Coal and coal mining are part of our nation's energy future and EPA has worked with companies to design mining operations that adequately protect our nation's waters. We have a responsibility under the law to protect water quality and safeguard the people who rely on clean water."

EPA's final determination on the Spruce Mine comes after discussions with the company spanning more than a year failed to produce an agreement that would lead to a significant decrease in impacts to the environment and Appalachian communities. The action prevents the mine from disposing of the waste into streams unless the company identifies an alternative mining design that would avoid irreversible damage to water quality and meets the requirements of the law. Despite EPA's willingness to consider alternatives, Mingo Logan did not offer any new proposed mining configurations in response to EPA's Recommended Determination.

EPA believes that companies can design their operations to make them more sustainable and compliant with the law. Last year, EPA worked closely with a mining company in West Virginia to eliminate nearly 50 percent of their water impacts and reduce contamination while at the same time increasing their coal production. These are the kinds of success stories that can be achieved through collaboration and willingness to reduce the impact on mining pollution on our waters. Those changes helped permanently protect local waters, maximize coal recovery and reduce costs for the operators.

EPA's decision to stop mining waste discharges to high quality streams at the Spruce No. 1 mine was based on several major environmental and water quality concerns. The proposed mine project would have:

- Disposed of 110 million cubic yards of coal mine waste into streams.
- Buried more than six miles of high-quality streams in Logan County, West Virginia with millions of tons of mining waste from the dynamiting of more than 2,200 acres of mountains and forestlands.
- Buried more than 35,000 feet of high-quality streams under mining waste, which will eliminate all fish, small invertebrates, salamanders, and other wildlife that live in them.
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- Caused downstream watershed degradation that will kill wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms.

- Inadequately mitigated for the mine's environmental impacts by not replacing streams being buried,

and attempting to use stormwater ditches as compensation for natural stream losses.

Additionally, during the permitting process there was a failure to consider cumulative watershed degradation resulting from past, present, and future mining in the area.

Finally, EPA's decision prohibits five proposed valley fills in two streams, Pigeonroost Branch, and Oldhouse Branch, and their tributaries. Mining activities at the Spruce site are underway in Seng Camp Creek as a result of a prior agreement reached in the active litigation with the Mingo Logan Coal Company. EPA's Final Determination does not affect current mining in Seng Camp Creek.

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With today's action, EPA has exercised its Section 404(c) authority only 13 times in its history of the CWA. EPA recognizes the importance of ensuring that its Section 404(c) actions are taken only where environmental impacts are truly unacceptable and will use this authority only where warranted by science and the law.

For a copy of the Final Determination:
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/ 404c_index.cfm

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Jennifer Fulton/R3/USEPA/US	To	Paul Ziemkiewicz, Michael Strager, Todd Petty
01/13/2011 11:57 AM	cc	
	bcc	
	Subject	Fw: Coal Tattoo: Breaking news: EPA vetoes Spruce Mine permit

Hi guys,
FYI, the Final Determination for the Spruce Mine went out today. Your cumulative impact work was an appendix to the FD. You might want to consider a press release?
Jen

Jennifer B. Fulton
Aquatic Biologist
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U.S. EPA Region III
1060 Chapline St., Suite 303
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304-234-0248 Phone
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Learn more about the Office of Monitoring & Assessment at:
http://epa.gov/reg3esd1/3ea50.htm

----- Forwarded by Jennifer Fulton/R3/USEPA/US on 01/13/2011 11:29 AM -----

From:	John Forren/R3/USEPA/US
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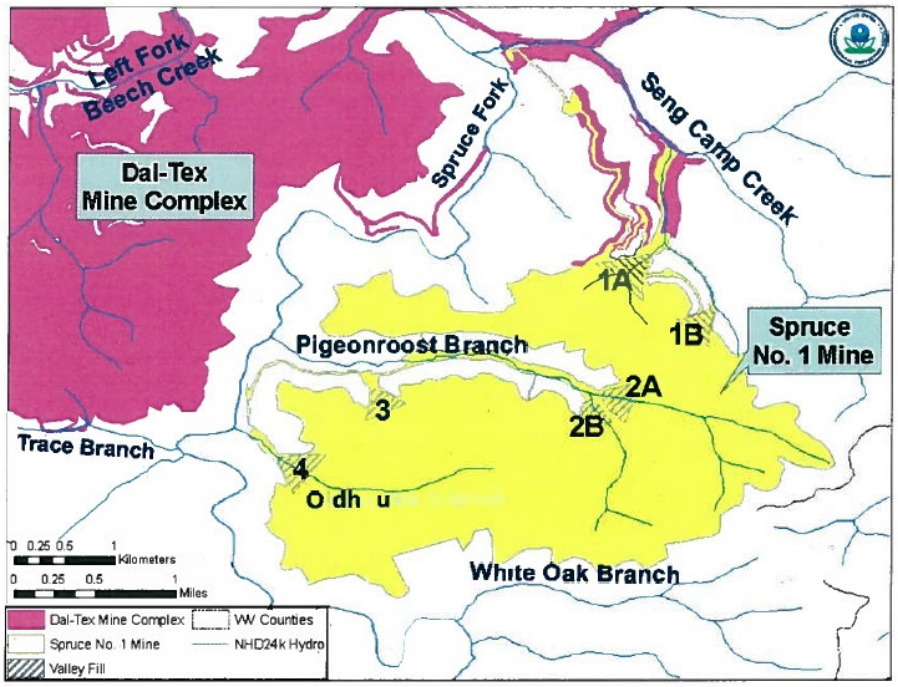
Date:	01/13/2011 10:50 AM
Subject:	Coal Tattoo: Breaking news: EPA vetoes Spruce Mine permit

Charleston Gazette's Coal Tattoo

Breaking news: EPA vetoes Spruce Mine permit

January 13, 2011 by Ken Ward Jr.



Word is just coming down that the U.S. Environmental Protection Agency
mountaintop removal permit in West Virginia history.

The move is part of an Obama administration crackdown aimed at reducin
removal coal-mining on the environment and on coalfield communities in
scientists are increasingly finding to be pervasive and irreversible.

The final EPA decision document is available here.

EPA officials this morning were alerting West Virginia's congressional del
undoubtedly preparing for a huge backlash from the mining industry and
political leaders.

In making its decision to veto the U.S. Army Corps of Engineers' appro
proposed for the Blair area of Logan County, EPA noted that it reviewe
comments and held a major public hearing in West Virginia. EPA officials
under the law and using the best science available to protect water qualit

communities who rely on clean waters for drinking, fishing and swimming."

Peter S. Silva, EPA's assistant administrator for water, said:

The proposed Spruce No. 1 Mine would use destructive and unsustainc jeopardize the health of Appalachian communities and clean water on wh coal mining are part of our nation's energy future, and EPA has worked mining operations that adequately protect our nation's water. We have resp protect water quality and safeguard the people who rely on clean water.

The agency also said:

EPA's final determination on the Spruce Mine comes after discussions w more than a year failed to produce an agreement that would lead to a sig to the environment and Appalachian communities. The action prevents th waste into streams unless the company identifies an alternative minin irreversible damage to water quality and meets the requirements of the law to consider alternatives, Mingo Logan did not offer any new proposed response to EPA's Recommended Determination.

In addition, EPA argued:

EPA believes that companies can design their operations to make them mor with the law. Last year, EPA worked closely with a mining company in nearly 50 percent of their water impacts and reduce contamination while c their coal production. These are the kinds of success stories that can be achi and willingness to reduce the impact on mining pollution on our wate permanently protect local waters, maximize coal recovery and reduce costs

Readers will recall that the Obama EPA began looking more closely at the 2009. But debate over the proposed operation dates back to the late 199 Judge Charles H. Haden II issued an injunction that blocked the mine, w more than 3,000 acres. After the Haden ruling, the company reduced the operation underwent much more intense scrutiny, in the form of a full-bl Statement by the Corps of Engineers, which approved the new mining config

SHARE

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site.

Stefania Shamet	For those who don't already know, Spruce was s...	01/13/2011 10:36:23 AM

From: Stefania Shamet/R3/USEPA/US
To: Regina Poeske/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA, Greg Pond/R3/USEPA/US@EPA, Frank Borsuk/R3/USEPA/US@EPA, Louis Reynolds/R3/USEPA/US@EPA, Joy Gillespie/R3/USEPA/US@EPA, Alaina DeGeorgio/R3/USEPA/US@EPA, Carrie Traver/R3/USEPA/US@EPA, David Rider/R3/USEPA/US@EPA, David Kargbo/R3/USEPA/US@EPA, Mazzarella.Christine@epamail.epa.gov, Michael Dunn/R3/USEPA/US@EPA, Rhodes.Charles@epamail.epa.gov
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Date: 01/13/2011 10:36 AM
Subject: Spruce is signed

For those who don't already know, Spruce was signed shortly before 9:30 this morning. The congressional notifications are going on now, and the press release should go out shortly. So, expect something on the Coal Tatoo soon.

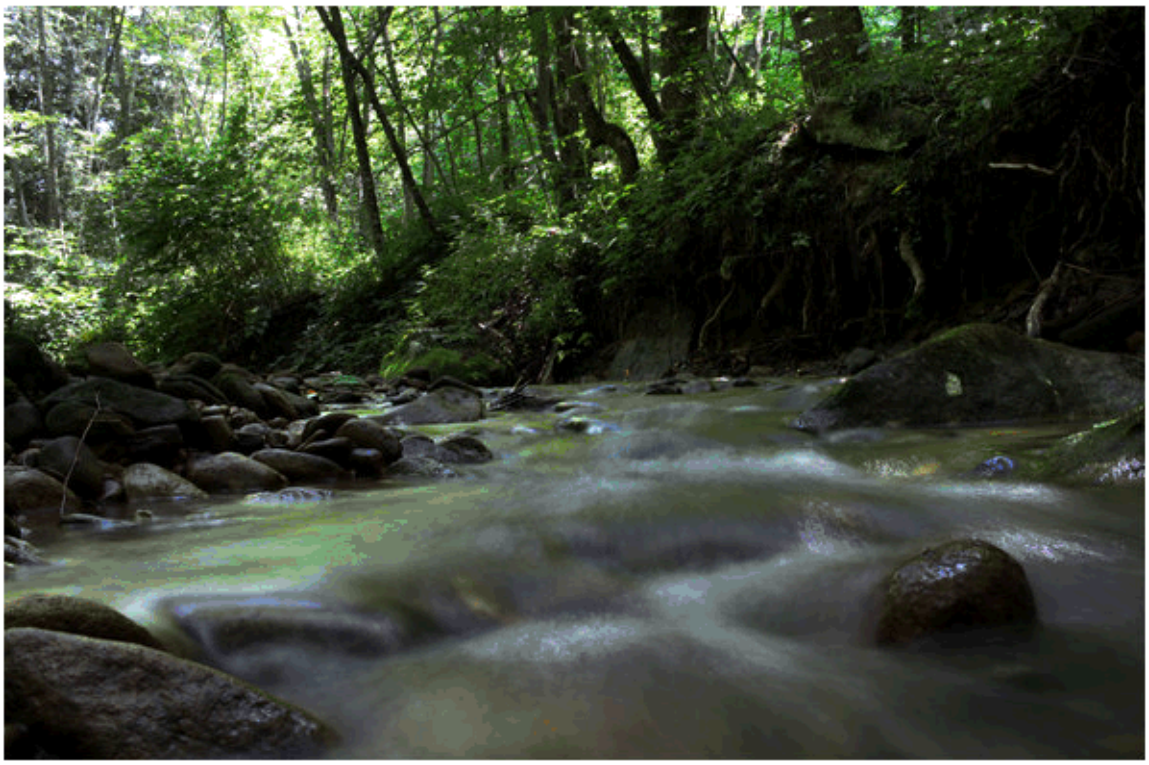
I wanted to take a moment to thank all of you who have worked so hard on this. We've been at this for over a year now.

First -- your tremendous work on the proposed and recommended determinations laid a terrific foundation for the final determination. While we had to answer a lot of comments and make some adjustments to address comments and legal issues, the core science and thinking that went into the proposed and recommended determinations is what carried the day and remains the fundamental underpinnings of the final determination. Additional kudos to those of you who worked on the response to comments on the Proposed Determination -- the responses remained largely in tact throughout the process, which is a tribute to your excellent work.

For those of you who were not aware, as part of the regulatory "consultation" process, Mingo Logan and WVDEP submitted an additional set of comments that wound up being around 220 individual "new" comments on the recommended determination. This happened the week before Christmas, and while a bunch of people worked to respond to those -- Greg and Maggie really saved the entire endeavor and did an amazing job. I've run out of superlatives to describe the quality and speed at which they worked. I wish that you guys could hear some of the senior management briefings that I heard. The level of confidence expressed in the foundational science on conductivity and macroinvertebrates was amazing. Senior management basically was told unequivocally that nobody has any doubt that the science on the conductivity and macroinvertebrates was absolutely solid.

I also just want to thank all of you who were suddenly pulled in to pitch in at the last moment, tracking references, locating documents, running down various loose ends. Your help was invaluable and really appreciated.

In the press of reviewing references, checking numbers, scrubbing as the "legal and policy police," we sometimes forget about the resource we're actually protecting. Here's a photo (thanks, Mike) of Pigeonroost Branch -- one of the two streams that the 404(c) action protects from destruction.



Gregory Peck/DC/USEPA/US
01/13/2011 12:11 PM

To Avi Garbow
cc
bcc
Subject Re: Spruce Final Determination

Thanks Avi - here's the FD.

Spruce No. 1 Mine Final Determination 011311.pdf

Avi Garbow	Greg, Thanks very much for those sentiments. ...	01/13/2011 12:04:50 PM

From: Avi Garbow/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA
Date: 01/13/2011 12:04 PM
Subject: Re: Spruce Final Determination

Greg,

Thanks very much for those sentiments. A lot of hard work by a lot of dedicated EPA folks.

Can you forward to me a copy (minus appendices/record docs) of the final FD? Thx.

Avi

Avi Garbow
Deputy General Counsel
U.S. Environmental Protection Agency
(202) 564-1917

Gregory Peck	Pete signed the Final Determination for the Spru...	01/13/2011 10:19:39 AM

From: Gregory Peck/DC/USEPA/US
To: Scott Fulton/DC/USEPA/US@EPA, Avi Garbow/DC/USEPA/US@EPA, Brenda Mallory/DC/USEPA/US@EPA, Steven Neugeboren/DC/USEPA/US@EPA
Date: 01/13/2011 10:19 AM
Subject: Spruce Final Determination

Pete signed the Final Determination for the Spruce Mine this morning. The FD itself is 100 pages plus additional hundreds of pages of appendices and record documents. This is the most comprehensive 404(c) review of a project ever undertaken by the Agency - lucky number 13! The Office of Water simply could not have completed this action without the considerable efforts of the Office of General Counsel. Kevin Minoli and Karyn Wendelowski have been amazing throughout this entire 15 month process. OW would like to acknowledge, once again, that we could not do our jobs without the remarkable contributions of Kevin and Karyn.

I'm sure Pete will be sending you a message of appreciation too - but I wanted you to let you know this morning how much we sincerely appreciate your help.

Best,
Greg

Gregory E. Peck
Chief of Staff
Office of Water
U.S. Environmental Protection Agency

Final Determination of the U.S. Environmental Protection Agency
Pursuant to § 404(c) of the Clean Water Act
Concerning the Spruce No. 1 Mine, Logan County, West Virginia

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I. Executive Summary

This document explains the basis for the US Environmental Protection Agency (EPA) Clean Water Act § 404(c) Final Determination to withdraw the specification of Pigeonroost Branch, Oldhouse Branch and their tributaries, all of which are waters of the United States within Logan County, West Virginia, as a disposal site for dredged or fill material in connection with construction of the Spruce No. 1 Surface Mine, as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) (DA Permit).[1] This Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine. The DA Permit was issued by the US Army Corps of Engineers, Huntington District (Corps) in January 2007, authorizing the Mingo Logan Coal Company to construct six valley fills, associated sediment structures, and other discharges of fill material to the Right Fork of Seng Camp Creek, Pigeonroost Branch, Oldhouse Branch, and their tributaries. If fully constructed, the project will disturb approximately 2,278 acres (about 3.5 square miles) and bury approximately 7.48 miles of streams beneath 110 million cubic yards of excess spoil. This is among the largest individual surface mines ever authorized in West Virginia.

Under § 404(c) of the Clean Water Act, EPA is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site whenever EPA determines that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. EPA is taking this action under § 404(c) of the Clean Water Act because the discharges associated with the DA Permit in Pigeonroost Branch, Oldhouse Branch and their tributaries will have unacceptable adverse effects on wildlife. In addition, the impacts downstream due to the destruction of those streams will result in unacceptable adverse impacts to wildlife and also warrant EPA's action under § 404(c).

The project, as permitted, will bury 6.6 miles of Pigeonroost Branch, Oldhouse Branch, and their tributaries under excess spoil generated by surface coal mining operations.[2] These streams represent some of the last remaining least-disturbed, high quality stream and riparian resources within the Headwaters Spruce Fork sub-watershed and the Coal

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[1] While the permit also authorizes construction of valley fills and other discharges to the Right Fork of Seng Camp Creek and its tributaries, EPA is not withdrawing specification of those waters, in part because some of those discharges have already occurred and because the stream resources in Right Fork of Seng Camp Creek were subject to a higher level of historic and ongoing human disturbance than those found in Pigeonroost Branch or Oldhouse Branch. Due to litigation and an agreement with environmental groups, represented by Ohio Valley Environmental Coalition, operations following the issuance of this DA Permit have been limited to the Seng Camp Creek watershed, and as part of that agreement one valley fill is partially constructed.

[2] As noted above, the permit authorizes the filling of approximately 7.48 total miles of stream. For the reasons in footnote 1, EPA's Final Determination only addresses the approximately 6.6 miles of Pigeonroost Branch, Oldhouse Branch and their tributaries subject to the DA Permit.

River sub-basin and contain important wildlife resources and habitat. The quality of these streams is comparable to a West Virginia-designated reference site, and the macroinvertebrate communities found in these streams, which are used as an indicator of quality, rank extremely high in comparison to other streams throughout the Central Appalachia ecoregion and the state of West Virginia. These streams perform critical hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role within the context of the overall Headwaters Spruce Fork sub-watershed and Coal River sub-basin.

Unacceptable adverse impacts to Pigeonroost Branch, Oldhouse Branch, and their tributaries include the direct burial of 6.6 miles of high quality stream habitat, including all wildlife in this watershed that utilize these streams for all or part of their life cycles (e.g., macroinvertebrate, amphibian, fish, and water-dependent bird populations). Streams within the Central Appalachian ecoregion have some of the greatest aquatic animal diversity of any area in North America, including one of the richest concentrations of salamander fauna in the world, as well as many endemic and rare species of mayflies, stoneflies and caddisflies. In fact, Pigeonroost Branch and Oldhouse Branch contain extremely high mayfly and stonefly diversity, both within the Central Appalachian ecoregion and within the state of West Virginia. With their adjacent riparian areas, these streams provide important habitat for 84 taxa of macroinvertebrates, up to 46 species of amphibians and reptiles, 4 species of crayfish, and 5 species of fish, as well as birds, bats, and other mammals. As some of the last remaining high quality, least-disturbed headwater stream habitat within the sub-basin, these streams not only support resident wildlife, but also provide ecosystem functions for downstream waters, serve as refugia for aquatic life and potential sources for recolonizing nearby waters, and ultimately serve to maintain the aquatic ecosystem integrity in the sub-basin and the rich animal diversity in the ecoregion.

Burial of Pigeonroost Branch and Oldhouse Branch and their tributaries will also result in unacceptable adverse effects on wildlife downstream through the transformation of the buried areas into sources of pollution that will contribute contaminants to downstream waters and the removal of functions performed by the buried streams. Based on recent peer-reviewed literature, as well as available data from adjacent mine sites and from the active portion of the Spruce No. 1 Surface Mine, EPA has concluded that the full construction of the Spruce No. 1 Surface Mine will transform these headwater streams from high quality habitat into sources of pollutants (particularly total dissolved solids and selenium) that will travel downstream and adversely impact the wildlife communities that utilize these downstream waters. Increased pollutant levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. Through the loss of stream macroinvertebrate communities, there will be, in turn, substantial effects on fish, amphibian, and bird populations that rely on these communities as a food source.

Furthermore, the increased loading of pollutants to downstream receiving waters increases the potential for harmful golden algal blooms, while increased selenium

exposure will result in impaired salamander populations and adverse effects to the reproduction of fish and bird species, thus harming the ability of these local populations to rebound. It is well recognized that the loss of a certain number of individuals of a species in a local ecological community can be tolerated, provided that the species continues to reproduce to replace lost individuals. However, when species are impacted by both acute stressors (e.g., food web changes, algal blooms) and exposure to reproductive toxicants, there is an increased risk of the loss of an entire species within an area. The loss of macroinvertebrate prey populations, increased risk of harmful golden algal blooms, and additional exposure to selenium will have an unacceptable adverse effect on the 26 fish species found in Spruce Fork as well as amphibians, crayfish, and bird species that depend on downstream waters for food or habitat.

The watersheds the project is located in, the Headwaters Spruce Fork sub-watershed and the larger Coal River sub-basin, have been heavily impacted by mining and the streams within this watershed have experienced substantial impairment. Currently, there have been more than 257 past and present surface mining permits issued in the Coal River sub-basin, and the corresponding mines collectively occupy more than 13% of the land area. In the Headwaters Spruce Fork sub-watershed, more than 34 past and present surface mine permits have been issued, and the corresponding mines collectively occupy more than 33% of the land area. If constructed as permitted, the project will occupy an additional 2.8% of the Headwaters Spruce Fork sub-watershed land area, and burial of Pigeonroost Branch, Oldhouse Branch and their tributaries will destroy 5.6% of the streams within the sub-watershed.

As least-disturbed streams in a watershed largely affected by mining, Pigeonroost Branch, Oldhouse Branch and their tributaries represent a high-value resource for the wildlife within the watershed. The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by these streams, including maintenance of biologically diverse wildlife habitat, and will critically degrade the chemical and biological integrity of downstream waters. Because the project will have unacceptable adverse effects on these high quality wildlife resources, EPA believes it is appropriate to withdraw specification to ensure the protection of these resources from discharges of dredged or fill material authorized under this DA permit.

Throughout the history of the Spruce No. 1 Surface Mine DA permit, EPA has raised concerns regarding adverse impacts to the environment. Additional data and information, including peer-reviewed scientific studies of the ecoregion, have become available since permit issuance. The peer-reviewed literature now reflect a growing consensus of the importance of headwater streams; a growing concern about the adverse ecological effects of mountaintop removal mining, specifically with regard to the effects of elevated levels of total dissolved solids discharged by mining operations on downstream aquatic ecosystems; and concerns that impacted streams cannot be easily recreated or replaced. These advances in understanding support EPA's long-standing concerns about this project regarding the potential for unacceptable adverse effects on wildlife, adverse water quality impacts, significant cumulative effects, as well as the shortcomings in avoidance,

minimization, and compensatory mitigation measures designed to reduce environmental impacts from the project.

On April 2, 2010, EPA Region III published in the Federal Register a Proposed Determination to prohibit, restrict or deny the specification or the use for specification (including withdrawal of specification) of certain waters at the project site as disposal sites for the discharge of dredged or fill material for the construction of the Spruce No. 1 Surface Mine. EPA Region III took this step because it believed that discharges authorized by the DA Permit would result in a significant loss of wildlife habitat and also cause significant degradation of downstream aquatic ecosystems and therefore could have unacceptable adverse effects on wildlife. A public hearing regarding the Proposed Determination was conducted on May 18, 2010. EPA Region III received more than 100 oral comments and more than 50,000 written comments both supporting and opposing its Proposed Determination.

On September 24, 2010, U.S. Environmental Protection Agency (EPA) Region III submitted to EPA Headquarters its Recommended Determination that the specification embodied in DA Permit No. 199800436-3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged or fill material for construction of the Spruce No. 1 Surface Mine be withdrawn. EPA Region III based this recommendation upon a conclusion that the discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch for the purpose of constructing the Spruce No. 1 Surface Mine as authorized would likely have unacceptable adverse effects on wildlife.

The U.S. Fish and Wildlife Service (USFWS), in its comments on both the Proposed and Recommended Determinations, concurred with EPA Region III's conclusion that the project, as authorized, would result in unacceptable adverse effects on wildlife and that this conclusion is supported by the available scientific information. USFWS also notes that it has consistently expressed concerns regarding the loss of headwater streams and adjacent riparian and terrestrial habitats associated with the Spruce No. 1 Surface Mine, as well as its likely impacts on downstream water quality, aquatic organisms, and terrestrial and aquatic wildlife that depend on those resources.

Following review of the public comments received, the past and new scientific data, and EPA Region III's Recommended Determination, EPA Headquarters has concluded that the discharge of dredged or fill material to Pigeonroost Branch, Oldhouse Branch, and their tributaries, in connection with the construction of valley fills and sediment ponds, as authorized by DA Permit No. 199800436-3 (Section 10: Coal River), will result in unacceptable adverse effects on wildlife. The administrative record developed in this case fully supports the conclusion that the Spruce No. 1 Surface Mine will have unacceptable adverse effects to wildlife, due to the filling of Pigeonroost and Oldhouse Branch, and their tributaries. In addition, the administrative record demonstrates that the Spruce No. 1 Surface Mine will have unacceptable adverse effects on wildlife downstream of the project site.

Furthermore, these adverse impacts do not comply with the requirements of the Clean Water Act (CWA) and EPA's implementing regulations under § 404(b)(1). EPA has determined that the Spruce No. 1 Surface Mine fails to adequately evaluate less environmentally damaging alternatives, will cause or contribute to significant degradation of waters of the United States (especially when considered in the context of the significant cumulative losses and impairment of streams across the Central Appalachian ecoregion), and lacks compensatory mitigation to adequately offset the impacts to Pigeonroost Branch and Oldhouse Branch. These failures to comply with the Guidelines serve to strengthen EPA's judgment about the unacceptability of the significant adverse impacts that will occur.

Based on these findings and pursuant to § 404(c) of the CWA, this Final Determination withdraws the specification of Pigeonroost Branch, Oldhouse Branch, and their tributaries, as described in DA Permit No. 199800436-3 (Section 10: Coal River), as a disposal site for the discharge of dredged or fill material for the purpose of construction of the Spruce No. 1 Surface Mine. This Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine.

II. Introduction

The purpose of the Clean Water Act is to “restore and maintain the physical, chemical, and biological integrity of the Nation’s waters” (33 U.S.C. 1251(a)). The Act also defines "pollution" as "the man made or man induced alteration of the chemical, physical, biological, and radiological integrity of water" (33 U.S.C. § 1362(19)). The Supreme Court has recognized "[t]his broad conception of pollution--one which expressly evinces Congress' concern with the physical and biological integrity of water" (*PUD No. 1 of Jefferson County v. Washington Dep't of Ecology*, 511 U.S. 700, 719 (1994)). Over the years, various definitions have been given to the term "biological integrity." The working definition that has been in place since 1981 is: "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region." (http://www.epa.gov/bioindicators/html/biointeg.html). This definition includes protection of macroinvertebrate communities, as well as fish populations. This goes beyond protecting the function performed by various members of the aquatic community and extends to protection of the quality of the aquatic community itself.

The CWA, 33 U.S.C. §§ 1251 et seq., prohibits the discharge of pollutants, including dredged or fill material, into waters of the United States (including wetlands) except in compliance with, among other provisions, § 404 of the CWA, 33 U.S.C. § 1344. Section 404 authorizes the Secretary of the Army (Secretary), acting through the Chief of Engineers, to authorize the discharge of dredged or fill material at specified disposal sites. This authorization is conducted, in part, through the application of environmental guidelines developed by EPA, in conjunction with the Secretary, under § 404(b) of the CWA, 33 U.S.C. § 1344(b) (§ 404(b)(1) Guidelines). Section 404(c) of the CWA, 33 U.S.C. § 1344(c), authorizes the EPA to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site. EPA is authorized to restrict or deny the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever it determines, after notice and opportunity for public hearing, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas.

The procedures for implementation of § 404(c) are set forth in 40 CFR Part 231. Under those procedures, if the Regional Administrator has reason to believe that use of a site for the discharge of dredged or fill material may have an unacceptable adverse effect on one or more of the aforementioned resources, he may initiate the § 404(c) process by notifying the U.S. Army Corps of Engineers and the applicant (and/or project proponent) that he intends to issue a Proposed Determination. Each of those parties then has fifteen days to demonstrate to the satisfaction of the Regional Administrator that no unacceptable adverse effects will occur, or that corrective action to prevent an unacceptable adverse effect will be taken. If no such information is provided to the Regional Administrator, or if the Regional Administrator is not satisfied that no unacceptable adverse effect will occur, the Regional Administrator will publish a notice

in the Federal Register of his Proposed Determination, soliciting public comment and offering an opportunity for a public hearing.

The procedures provide that the Regional Administrator will decide whether to withdraw the Proposed Determination or prepare a Recommended Determination following the public hearing and the close of the comment period. A decision to withdraw may be reviewed at the discretion of the Assistant Administrator for Water at EPA Headquarters. If the Regional Administrator prepares a Recommended Determination, the recommendation and the administrative record compiled in the Regional Office is forwarded to the Assistant Administrator for Water at EPA Headquarters. The Assistant Administrator for Water makes the Final Determination affirming, modifying, or rescinding the Recommended Determination.[3]

This document explains the basis for the EPA Final Determination to withdraw the specification of Pigeonroost Branch, Oldhouse Branch and their tributaries, all of which are waters of the United States within Logan County, West Virginia, as a disposal site for dredged or fill material in connection with construction of the Spruce No. 1 Surface Mine (hereafter "Spruce No. 1 Mine" or "the project") as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) (hereafter "DA permit").[4] While the permit also authorizes construction of valley fills and other discharges to the Right Fork of Seng Camp Creek and its tributaries, EPA is not withdrawing specification of those waters, in part because some of those discharges have already occurred and because the stream resources in Right Fork of Seng Camp Creek were subject to a higher level of historic and ongoing human disturbance than those found in Pigeonroost Branch or Oldhouse Branch.

EPA is taking this action under § 404(c) of the Clean Water Act because the discharges to Pigeonroost Branch and Oldhouse Branch and their tributaries for the purpose of constructing Spruce No. 1 Mine as authorized by the permit will have unacceptable adverse effects on wildlife. Pigeonroost Branch and Oldhouse Branch and their tributaries are some of the last remaining streams within the Headwaters Spruce Fork sub-watershed and the larger Coal River sub-basin that represent "least-disturbed" conditions.[5] As such, they perform important hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role within the context of the overall Headwaters Spruce Fork sub-watershed and Coal River sub-basin. Within the streams and riparian areas of the project area, over 84 taxa of macroinvertebrates are

[3] In 1984, the EPA Administrator delegated the authority to make final decisions under § 404(c) to EPA's national Clean Water Act § 404 program manager, who is the Assistant Administrator for Water. That delegation remains in effect.

[4] As stated in the Section VII, this Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 Mine.

[5] Least-disturbed conditions reflect a type of reference condition, where these sites have less human disturbance than others and represent the best existing condition within a watershed (Stoddard et al. 2006).

documented to exist, as well as up to 46 species of reptiles and amphibians, 4 species of crayfish, 5 species of fish and at least one water-dependent bird species.

The construction of Spruce No. 1 Mine as authorized will bury virtually all of Oldhouse Branch and its tributaries and much of Pigeonroost Branch and its tributaries under excess spoil generated by surface coal mining operations. These discharges will result in the burial of approximately 6.6 miles of high quality Appalachian headwater streams in a watershed that has already experienced substantial impairment. The loss of the 6.6 miles of high quality Appalachian headwater streams in this watershed will result in a significant loss (over 5.6% of the total stream miles in Headwaters Spruce Fork sub-watershed) of valuable wildlife habitat for many species in this watershed. These direct impacts will result in unacceptable adverse impacts to wildlife in this watershed, within the project boundaries.

Beyond the direct burial of wildlife species and loss of high quality habitat in this watershed, EPA has also determined that the project will result in unacceptable adverse impacts on downstream wildlife. If constructed as permitted, the Spruce No. 1 Mine will result in increased pollutant loadings in Spruce Fork and the Little Coal River. Increased salinity levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. In addition to these unacceptable adverse impacts, loss of macroinvertebrate prey populations, combined with increased potential for harmful golden algal blooms and additional exposure to selenium will have an unacceptable adverse effect on the 26 fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on aquatic organisms and downstream waters for food or habitat.

In addition, EPA has given consideration to the project's compliance with the § 404(b)(1) Guidelines. As stated in the Preamble to the § 404(c) regulations, "one of the basic functions of 404(c) is to police the application of the 404(b)(1) Guidelines" (44 FR 58076, 58078 (Oct. 9, 1979)). Accordingly, EPA has determined that the Spruce No. 1 Mine, as permitted,

- fails to adequately evaluate less environmentally damaging alternatives (for a non-water dependent project such as this one, a failure to adequately evaluate alternatives means that the applicant has failed to rebut the presumption that there are less environmentally damaging practicable alternatives available);
- will cause or contribute to significant degradation of waters of the United States (especially when considered in the context of the significant cumulative losses and impairment of streams across the Central Appalachian ecoregion); and
- lacks compensatory mitigation to offset the impacts to Pigeonroost Branch and Oldhouse Branch to below the level of significance.

These inconsistencies with the Guidelines provide additional support for EPA's conclusion that the adverse impacts are unacceptable.

This document is divided into seven sections. The next section, Section III., describes the Spruce No. 1 Mine as authorized and summarizes the history of the project. Section IV.

describes the environmental characteristics of the project area, specifically Pigeonroost Branch and Oldhouse Branch, and the overall Coal River sub-basin. Section V. examines the anticipated impacts from the Spruce No. 1 Mine, as authorized. Consistent with § 404(c), this discussion focuses on unacceptable adverse impacts to wildlife. Section VI. discusses other considerations, including impacts from activities associated with the Spruce No. 1 Mine that do not include direct discharges of dredged or fill material to jurisdictional waters but which may depend upon authorization of such discharges, and that are likely to cause direct, indirect, and cumulative effects to the environment and to local communities. Section VII. contains EPA's Final Determination.

III. Background

III.A. Project Description

According to the Environmental Impact Statement (EIS) prepared by the Corps in 2006 (Spruce No. 1 EIS) for the project, the Spruce No. 1 Mine is a mountaintop mining project targeting bituminous coal seams overlying and including the Middle Coalburg coal seam in the western portion of the project area. In the eastern portion of the project area, mountaintop mining would be limited to those seams including and overlying the Upper Stockton seam, with contour mining in conjunction with auger and/or highwall/thin-seam mining utilized to recover the Middle Coalburg seam.

The project is located in the East District of Logan County, West Virginia at Latitude 38°52'39" and Longitude 81°47'52" depicted on the United States Geological Survey 7.5-minute Clothier and Amherstdale Quadrangles (Figure 1). The mine site is located approximately two miles northeast of the town of Blair in Logan County, West Virginia.

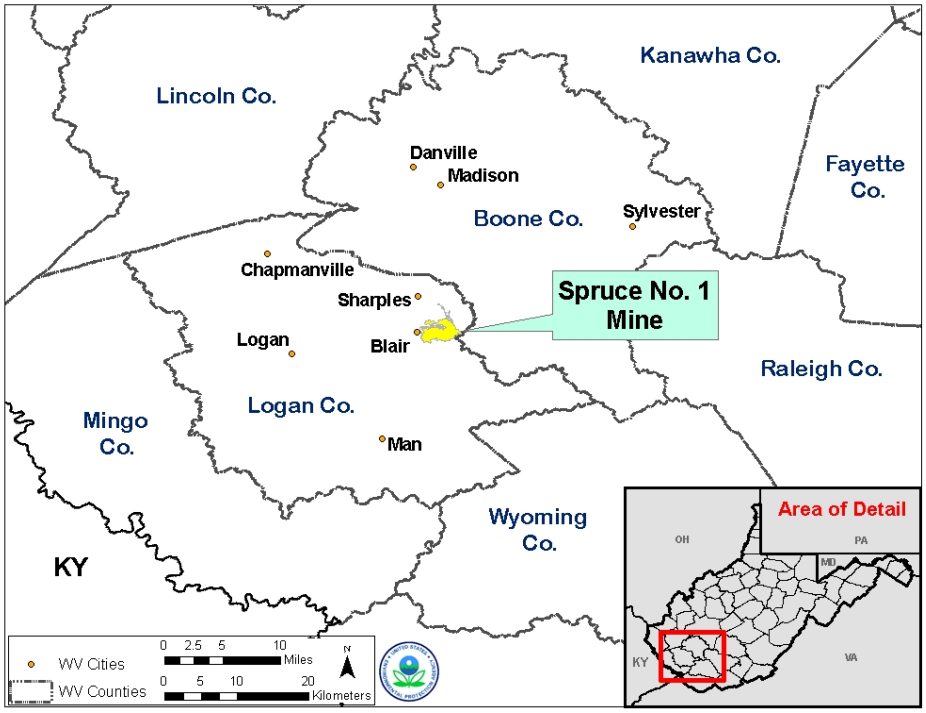

Figure 1. Spruce No. 1 Mine location

The Spruce No. 1 Mine as authorized by DA Permit No. 199800436-3 (Section 10: Coal River), is one of the largest mountaintop mining projects ever authorized in West Virginia. As authorized, it will disturb approximately 2,278 acres (about 3.5 square miles) and bury approximately 7.48 miles of streams. By way of comparison, the project area would take up a sizeable portion of the downtown area of Pittsburgh, PA (Figure 2).

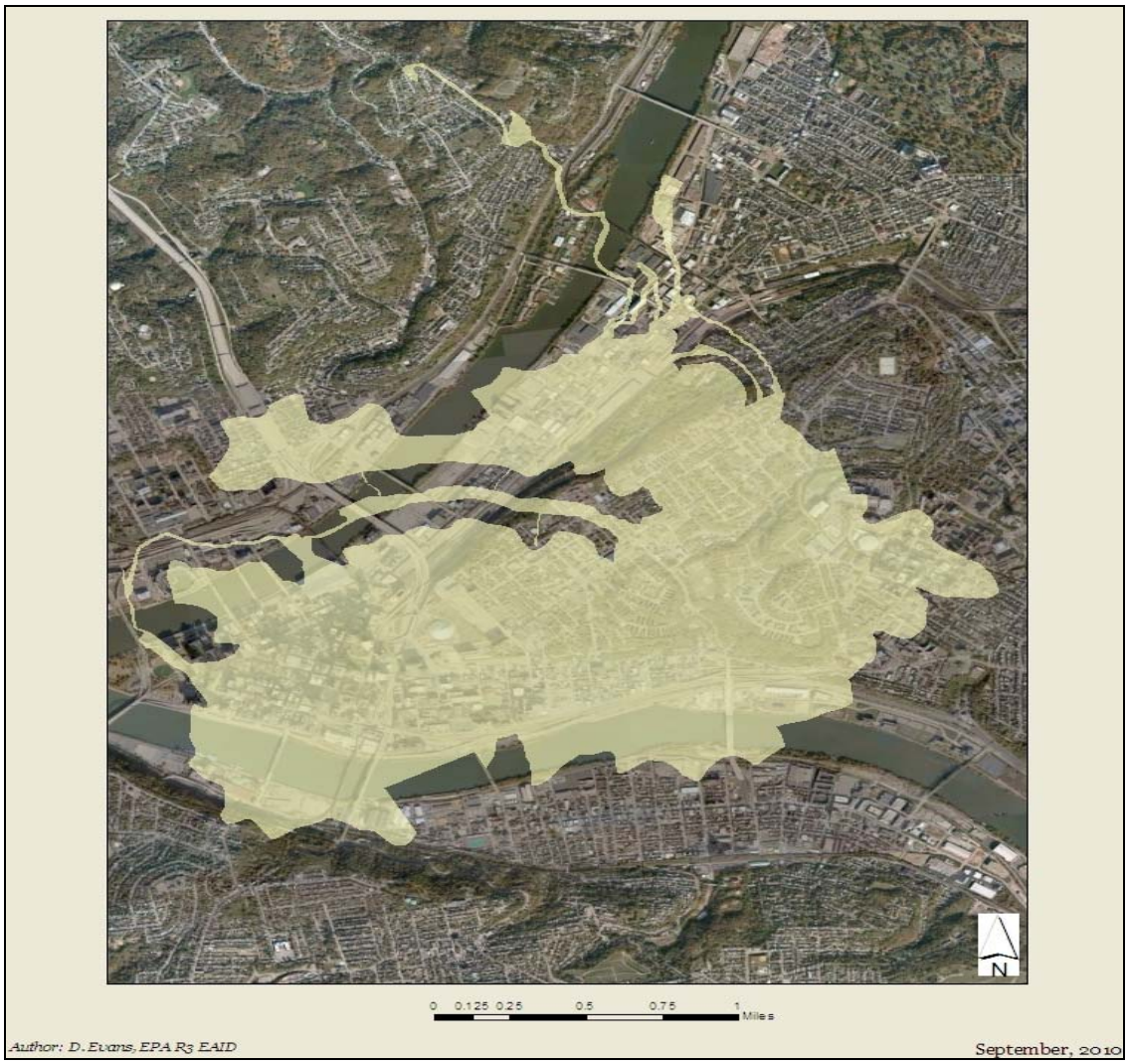

Figure 2. Spruce No. 1 Mine compared to downtown Pittsburgh, PA

Mountaintop mining involves removing the top of a mountain to recover coal seams contained within the mountain. Explosives are used to break apart the mountain's bedrock and earth-moving equipment is used to remove the excess rock, topsoil and debris, called “spoil”, which formerly had composed the portions of the mountain above and immediately below the coal seam. The fractured material is larger in volume than when it was consolidated bedrock within the mountain. The amount of spoil that may be placed back on the mined area is limited by this “swell” in volume, as well as by stability concerns. As a result, mountaintop mining generates large quantities of "excess spoil" that cannot be placed back in the mined area. The “spoil” is then typically deposited in adjacent valleys, thereby burying streams that flow through those valleys.

The Spruce No. 1 Mine EIS describes the project impacts as a disturbance of a total of 2,278 acres to recover seventy-five percent (75%) of the coal reserve targeted for extraction within the project area during fifteen (15) phases. The mining process would remove 400 to 450 vertical feet from the height of the mountain, or approximately 501 million cubic yards of overburden material. Nearly 391 million cubic yards of spoil

would be placed within the mined area (i.e., back onto the mountains) and the remaining 110 million cubic yards of excess spoil would be placed in six valley fills, burying all or portions of the Right Fork of Seng Camp Creek, Pigeonroost Branch, and Oldhouse Branch and their tributaries (hereafter, references to Seng Camp Creek, Pigeonroost Branch, and Oldhouse Branch also include all tributaries to those waters that will be impacted by the project as authorized). Specifically, the permit authorizes construction of Valley Fills 1A and 1B in Seng Camp Creek; Valley Fills 2A, 2B, and 3 in Pigeonroost Branch; and Valley Fill 4 in Oldhouse Branch, and numerous sediment ponds, mined-through areas and other fills in waters of the U.S. (Figure 3). A detailed discussion of Spruce No. 1 Mine can be found in the Spruce No. 1 EIS on pages 2-35 through 2-61.

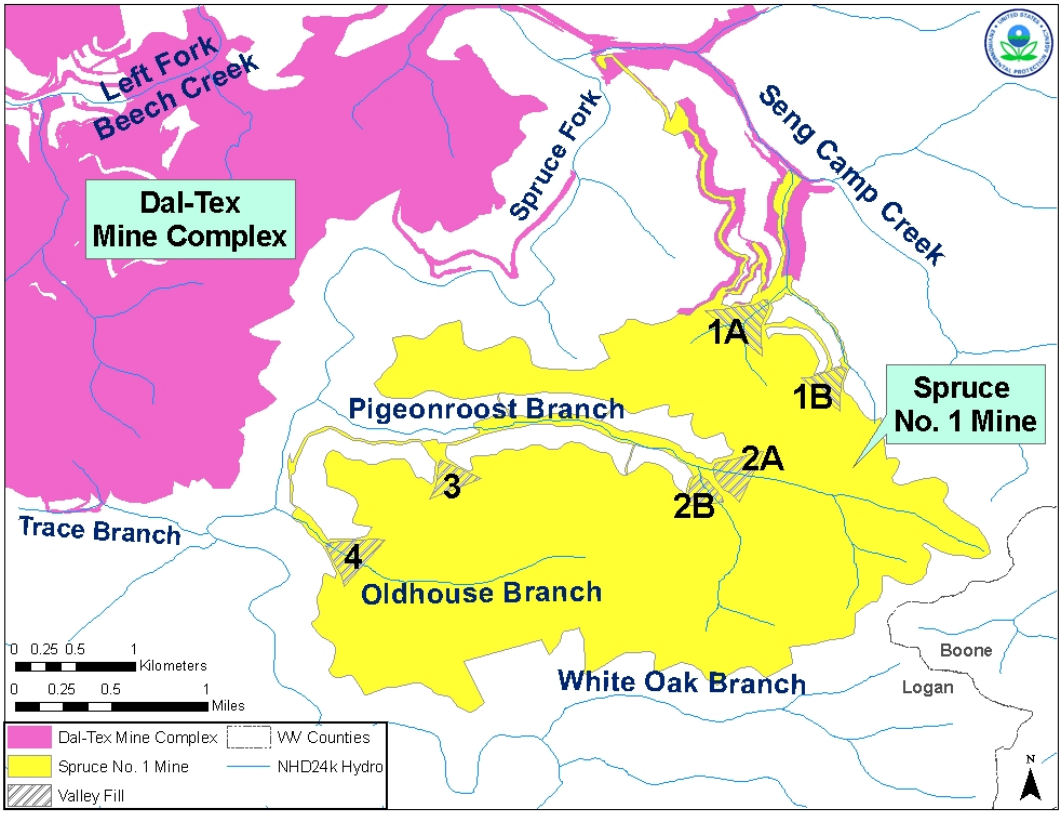

Figure 3. Spruce No. 1 Mine and associated valley fills

The Spruce No.1 Mine Surface Mining Control and Reclamation Act (SMCRA) Permit S-5013-97, Incidental Boundary Revision (IBR4, Modification 11) describes impacts from the project as including placement of dredged and fill material into approximately:

- 0.12 acre of emergent wetlands
- 10,630 linear feet (2.01 miles) of ephemeral stream channels
- 28,698 linear feet (5.44 miles) of intermittent stream channels
- 165 linear feet (0.03 miles) of perennial stream channel

While EPA is providing the foregoing summary from the SMCRA Permit S-5013-97 IBR for descriptive purposes, EPA believes that the description provided in the Spruce No. 1 Mine SMCRA Permit and in the Spruce No. 1 EIS incorrectly characterizes over 5 miles of stream resources that will be impacted, as set forth in more detail in Section V.E.3.b. and in Appendix 3.

III.B. Project History

The Spruce No. 1 Mine has a lengthy and complex regulatory history. The project was originally proposed by Hobet Mining Inc., a subsidiary of Arch Coal, Inc. The project as originally proposed in 1998 was larger than the authorized project and would have directly impacted a total surface area of 3,113 acres and 57,755 linear feet (more than ten miles) of streams. At that time, the Corps tendered and ultimately withdrew a nationwide permit for the project, and Hobet Mining, Inc. advised the Corps it would submit an individual permit application. An EIS was prepared for the Spruce No. 1 Mine by the Army Corps of Engineers Huntington District pursuant to the National Environmental Policy Act, 42 U.S.C. 4332(C). The original project application was also a primary impetus for the Interagency Mountaintop Mining/Valley Fills in Appalachia Programmatic Environmental Impact Statement (PEIS), which was finalized in October 2005. The PEIS is available at www.epa.gov/Region3/mtntop/eis2005.htm.

An initial 2002 Spruce No. 1 Mine Draft EIS considered a proposed project that was similar in scope and size to the original project described above. EPA's review of the 2002 Draft Environmental Impact Statement found gaps in the analyses of the mine and related adverse environmental impacts. EPA was particularly concerned by the lack of information regarding the nature and extent of impacts to the high quality streams that would be buried under valley fills, and recommended additional evaluation to support the analysis of less environmentally damaging alternatives. In a letter dated August 12, 2002, EPA Region III indicated the EIS contained inadequate information for public review and for decision-makers.

Following the transfer of the Spruce No. 1 Mine holdings and responsibilities by Arch Coal, Inc. to its Mingo Logan Coal Company (hereafter Mingo Logan or "permittee") in late 2005, a revised Spruce No. 1 Mine Draft EIS was prepared in 2006. At that time, the project was reconfigured to reduce impacts. The mine plan was revised to eliminate construction of a valley fill in White Oak Branch, a State-designated reference stream (see Section IV.A.) and the project area was reduced from 3,113 to 2,278 acres with direct stream impacts reduced to 7.48 miles.

In EPA's June 16, 2006, comment letter on the 2006 Draft EIS, EPA recognized that impacts from the mine had been reduced and the quality of EIS information had improved. However, the letter also noted that EPA had remaining environmental concerns associated with the Spruce No. 1 Mine. These concerns included potential adverse impacts to water quality (specifically, the potential to discharge selenium and the known association of similar mining operations with degradation of downstream aquatic communities); uncertainties regarding the proposed mitigation; the need for additional

analysis of potential environmental justice issues; and the lack of a study related to the cumulative effects of multiple mining operations within the Little Coal River watershed. EPA continued to stress its belief that corrective measures should be required to reduce environmental impacts and that other identified information, data, and analyses should be included in the final EIS.

Concerns regarding the Spruce No. 1 Mine were also raised by the USFWS, Ecological Services West Virginia Field Office in a letter dated May 30, 2006 from the Department of Interior, Philadelphia to the Huntington District Army Corps of Engineers. In that letter, the USFWS expressed concerns over the permittee's compensatory mitigation plan. The USFWS stated there was inadequate compensatory mitigation for the project because the assessment methodology used by the permittee to evaluate stream impacts considered only the physical characteristics of the impacted streams, without considering the equally important biological or chemical characteristics. The USFWS expressed concern the project would impact healthy, biologically functional streams and the mitigation included erosion control structures that were designed to convey water but would not replace the streams' lost ecological services.

The Corps issued the Spruce No. 1 Mine Final EIS on September 22, 2006. On October 23, 2006, EPA commented on the Final EIS, noting that many of EPA's comments had not been adequately addressed. On January 22, 2007, the Corps issued Clean Water Act § 404 Permit, DA Permit No. 199800436-3 (Section 10: Coal River), to Mingo Logan for the Spruce No. 1 Mine. That permit specified the Right Fork of Seng Camp Creek, Pigeonroost Branch and its tributaries, and Oldhouse Branch and its tributaries as disposal sites for the discharge of dredged or fill material from the Spruce No. 1 Mine. In addition to its DA Permit No. 199800436-3 (Section 10: Coal River), the project has received the following authorizations from the West Virginia Department of Environmental Protection (WVDEP): authorization pursuant to the State's surface mining program approved under SMCRA, 30 U.S.C. 1201-1328 (SMCRA permit); a National Pollutant Discharge Elimination System (NPDES) permit for discharges of pollutants pursuant to § 402 of the Clean Water Act (33 U.S.C. 1342); and a Clean Water Act § 401 water quality certification (33 U.S.C. 1341).

On January 30, 2007, a number of environmental groups, represented by Ohio Valley Environmental Coalition, filed a complaint against the Corps in federal district court challenging its decision to issue the permit. In early 2007, Mingo Logan commenced limited operations at Spruce No. 1 Mine pursuant to DA Permit No. 199800436-3 (Section 10: Coal River), subject to an agreement with the environmental groups who are plaintiffs in the litigation. Pursuant to that agreement, Mingo Logan has been operating in a portion of the project site in the Seng Camp Creek drainage area, and has been constructing one valley fill in that area (valley fill 1A). Under the agreement, Mingo Logan must give plaintiffs 20 days' notice before expanding operations beyond the area subject to the agreement, and has done so once without objection from the plaintiffs. Mingo Logan's operations in the Seng Camp Creek watershed have generated data related to impacts from the project as constructed, including discharge monitoring reports submitted to WVDEP. The litigation filed by the environmental groups was stayed for a

period of time pending the U.S. Court of Appeals for the Fourth Circuit's decision in *Ohio Valley Environmental Coalition v. Aracoma Coal Co.*, 556 F. 3d 177 (4th Cir. 2009).

During this period, the scientific literature reflected a growing consensus of the importance of headwater streams; a growing concern about the adverse ecological effects of mountaintop removal mining; and concern that impacted streams cannot easily be recreated or replaced. This Final Determination cites to nearly 100 articles and studies developed since the time the Spruce No. 1 Mine DA permit was issued. Many studies now point to the role headwater streams play in the transport of water, sediments, organic matter, nutrients, and organisms to downstream environments; their use by organisms for spawning or refugia; and their contribution to regional biodiversity (Meyer et al. 2007). Additionally, destruction or modification of headwater streams has been shown to affect the integrity of downstream waters, in part through changes in hydrology, chemistry and stream biota (Freeman et al. 2007, Wipfli et al. 2007).

The literature specifically documenting the effects of mountaintop removal mining has also grown, and additional studies have increased EPA's understanding of the effects of elevated levels of total dissolved solids (TDS) discharged through mining operations on downstream aquatic ecosystems (Pond et al. 2008, Simmons et al. 2008, Palmer et al. 2010, Fritz et al. 2010). EPA's understanding of adverse effects from selenium associated with surface coal mining likewise has expanded since issuance of the permit. In February 2009, WVDEP issued out a report entitled: 'Selenium bioaccumulation among select stream and lake fishes in West Virginia.' The WVDEP report confirmed that significant environmental harm due to selenium was a problem in West Virginia. A January 2010 WVDEP report to the West Virginia legislature outlined the issues with selenium in West Virginia watersheds. Other studies that have contributed to a greater understanding of the adverse effects of selenium include additional investigations and discussions have continued increased selenium concerns including: (Chapman et al. 2009, Diehl et al. 2005, Ferreri et al. 2004, Lemly 2009, Palmer et al. 2010, Neuzil et al. 2005, Vesper et al. 2008).

In addition to the growing body of literature documenting the importance of headwater streams and the effects of mountaintop removal mining, additional information on the efficacy of mitigation has also been published. For example, recent research has shown that stream restoration projects based upon channel design can be problematic (Slate et al. 2007, Simon et al. 2007) and are not effective in restoring ecological function and biodiversity (Tullos et al. 2009, Palmer et al. 2009, Fritz et al. 2010). In a study on streams impacted by mountaintop mining and valley fills, Fritz et al. (2010) found that habitat features and aquatic assemblages were very different in constructed channels than natural channels, and suggested that constructed channels should not be used for mitigation on-site. In the 2008 Mitigation Rule, EPA and the Corps acknowledged that headwater streams are a difficult to replace resource and stream creation is among the more difficult and least successful forms of mitigation.

In light of this growing body of scientific data documenting the environmental impacts associated with surface coal mining, EPA and other federal agencies discussed opportunities to reduce those impacts under existing statutory and regulatory authorities. On June 11, 2009, EPA, the Department of the Army, and the Department of the Interior entered into a *Memorandum of Understanding Implementing the Interagency Action Plan on Appalachian Surface Coal Mining,* in which the agencies agreed to take steps to reduce the harmful environmental consequences of Appalachian surface coal mining.

On September 3, 2009, EPA Region III requested that the Corps suspend, modify or revoke DA Permit No. 199800436-3 (Section 10: Coal River) for discharges associated with the Spruce No. 1 Mine. On September 30, 2009, the Corps stated that it would not reconsider the permit authorization. As a result, EPA Region III initiated the Clean Water Act § 404(c) process on October 16, 2009. EPA Region III communicated with representatives of Mingo Logan and the Corps in person, by telephone, and by electronic mail on several occasions to determine whether corrective action would be taken to address EPA Region III's concerns. Earlier in 2009, litigation by the environmental groups had reactivated following the decision in *Ohio Valley Environmental Coalition v. Aracoma Coal Co.,* 556 F. 3d 177 (4th Cir. 2009). The litigation was then stayed until November 3, 2009, a deadline that would be further extended by the Court as EPA's CWA § 404(c) process proceeded.

On April 2, 2010, EPA Region III published in the Federal Register a Proposed Determination to withdraw specification of Pigeonroost Branch and Oldhouse Branch pursuant to CWA § 404(c). EPA Region III solicited public comments on the Proposed Determination and held a public hearing in Charleston, West Virginia on May 18, 2010 that was attended by 520 people, during which 121 oral comments were communicated to EPA. EPA Region III received over 50,000 comments on the Proposed Determination. Of these, approximately 70% of comment letters submitted on the Proposed Determination generally supported EPA's Proposed Determination while 65% of public hearing participants generally opposed EPA's Proposed Determination.

USFWS, in its comments on EPA Region III's Proposed and Recommended Determinations, supported the withdrawal of specification for discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch. Its June 2, 2009 comment letter on the Proposed Determination expressed concerns about potential impacts of the project on fish and wildlife resources, including macroinvertebrate genera. In addition, the letter stated

> "[T]he preponderance of available scientific information strongly suggests that construction of the project as authorized would cause or contribute to significant degradation of waters of the United States, both on-site and in receiving waters downstream of the proposed mine."
>
> "Some adverse impacts of the proposed project include:

- the likely loss of macroinvertebrate genera (diversity and abundance) and the cascading biological consequences of that loss on other aquatic and terrestrial wildlife;
- the direct loss of a significant number of salamanders, indirect effects to perhaps as many more, and the effects of these losses on other aquatic and terrestrial wildlife;
- degraded fish communities, including reduced diversity and abundance;
- direct loss of habitat, and direct and indirect loss of food resources for forest interior and riparian-obligate species of migratory birds, including six species the Service considers Birds of Conservation Concern (cerulean, Kentucky, Swainson's, and worm-eating warblers; Louisiana Waterthrush; wood thrush); and
- direct loss of habitat, and direct and indirect loss of food resources, for a variety of bat species, many of which are already threatened by the spread of white-nose syndrome in West Virginia and which may require additional protection in the near future."

EPA's regulations require that the Regional Administrator either withdraw the Proposed Determination or prepare a Recommended Determination within 30 days after the conclusion of the public hearing, in this case by June 16, 2010 (40 CFR 231.5(a)). However, in order to allow full consideration of the extensive record, including the over 50,000 public comments received, EPA Region III extended the time period provided in 40 CFR 231.5(a) for the preparation of the Recommended Determination until no later than September 24, 2010 (75 FR 39691). This time extension was made under authority of 40 CFR 231.8, which allows for such extensions upon a showing of good cause. EPA Region III reviewed the information provided during the public comment period, and completed its review within the extended time period.

The Recommended Determination was signed by the Regional Administrator and submitted to EPA Headquarters along with the complete administrative record on September 24, 2010, concluding EPA Region III's § 404(c) review of the Spruce No. 1 Mine. This action initiated the period for review and final action by EPA's Assistant Administrator for Water.

III.C. EPA Headquarters' Actions

Recognizing the role for EPA Headquarters in taking any final action to withdraw or restrict specification from the project, EPA Headquarters has been engaged in the § 404(c) review since it was initiated on October 16, 2009. Staff from EPA Headquarters attended the public hearing in Charleston, West Virginia, and heard first-hand the testimony provided by those who live and work in the region.

Following receipt of the Recommended Determination, § 404(c) regulations require EPA Headquarters to provide an opportunity for the project's proponents to propose corrective actions intended to prevent the unacceptable adverse environmental impacts presented in the Recommended Determination. EPA Headquarters provided the Region III

Recommended Determination to Arch Coal Inc., the United States Department of the Army, the Corps, WVDEP and four land and mineral rights owners and notified these stakeholders that they would have 15 days to present any corrective actions to EPA Headquarters, consistent with EPA's § 404(c) regulations.

EPA received a response from Hunton & Williams, LLP, on behalf of Arch Coal (i.e., Mingo Logan), Inc. requesting a 30-day extension of this period, to November 29, 2010, in order to review the Recommended Determination. Provided in 40 CFR 231.8, EPA may, upon showing of good cause, extend the time requirements in the § 404(c) regulations. EPA believed it was appropriate to grant the permittee's request for a 30-day extension to the consultation process, and an announcement was published in the Federal Register on November 10, 2010, announcing the deadline for proposing corrective actions was extended to November 29, 2010.

EPA's § 404(c) regulations provide that the Assistant Administrator for Water shall issue a Final Determination within 60 days of receiving the Regional Administrator's Recommended Determination. This 60-day period was scheduled to expire on November 23, 2010. As the consultation period with the permittee was extended to November 29, 2010, EPA believed it was necessary to extend the deadline for issuing a Final Determination until February 22, 2011. This extension was published in the same Federal Register announcement as the extension of the consultation period, and was intended to enable EPA to more carefully consider the Region's Recommended Determination, as well as the public comments received, and information on possible corrective actions presented during the consultation process. In addition, this date was consistent with an order issued by the U.S. District Court for the Southern District of West Virginia on November 2, 2010, granting a continued stay in litigation over the Spruce No. 1 permit until February 22, 2011.

EPA also received a response from one of the land and mineral rights owners, the United Company. In his November 9, 2010 letter to EPA, James McGlothlin, President of the United Company, expressed his opposition to the EPA Region III Recommended Determination and his belief that such an action would represent a "regulatory taking." Mr. McGlothlin's letter included a copy of a May 10, 2010, letter he had submitted to EPA Region III and a request that he be included in any consultation meeting organized by EPA Headquarters regarding EPA Region III's Recommended Determination on the Spruce No. 1 Mine.

On November 16, 2010, a consultation meeting was held at EPA Headquarters in Washington, DC to discuss the Region III Recommended Determination and potential corrective actions that could be undertaken to avoid the unacceptable adverse impacts that were of concern to EPA. Participants at the meeting included the EPA Assistant Administrator for Water, the EPA Region III Regional Administrator and Regional management, Office of Water staff, managers, and legal counsel, representatives from Arch Coal, Inc. and their legal counsel, United Company and their legal counsel, WVDEP, and the Corps' Huntington District.

At the beginning of the meeting, EPA Region III gave an overview of the Recommended Determination, stating that discharges of fill material into Pigeonroost Branch and Oldhouse Branch associated with the Spruce No.1 Mine would likely result in unacceptable adverse effects on wildlife. The EPA Assistant Administrator for Water then stated that a major purpose of the consultation process is to explore corrective actions that might avoid the need for a final § 404(c) action. He noted that while the Agency's regulations make clear that the consultation process is an opportunity for the project's proponents to propose corrective actions, EPA was willing and prepared to discuss potential actions that may effectively reduce anticipated environmental and water quality impacts.

In response, the permittee stated that revisions to the mine plan that Arch Coal, Inc. had previously proposed would be effective in reducing these potential water quality and environmental impacts. These actions included improved best management practices, eliminating two small valley fills at Seng Camp Creek and Pigeonroost Branch, and increased monitoring. The permittee also indicated that other approaches previously discussed, such as "sequencing" or "phasing" of valley fills, remained unacceptable to Arch Coal, Inc., due primarily to economic considerations. In the meeting, the permittee did not propose new or additional corrective actions for EPA's consideration.

As part of the follow-up from the consultation meeting, on November 22, 2010, the Assistant Administrator for Water sent a letter to Arch Coal, Inc. indicating that EPA was prepared to continue discussions regarding corrective actions that effectively reduce anticipated environmental and water quality impacts. The letter noted that EPA's focus in evaluating these alternatives would be on whether they would effectively protect the streams at Pigeonroost Branch and Oldhouse Branch. Noting that the consultation period was set to expire on November 29, 2010, the letter requested a response as soon as possible. On November 29, 2010, EPA received notification via email from Hunton & Williams, LLP, on behalf of Arch Coal, Inc. While this response did not request any further opportunity for consultation, it did include extensive comments, a Technical Evaluation Document and supporting information in response to the Recommended Determination.

EPA reviewed the additional comments, evaluation, and supporting documents provided by Hunton & Williams and, where necessary, clarified the relevant information and analysis in the Final Determination. EPA's detailed responses to the issues raised by Hunton & Williams are contained in Appendix 6. After an EPA Region has submitted a Recommended Determination to the Assistant Administrator for Water, EPA's regulations governing the § 404(c) process allow the company to submit information on corrective actions they intend to take to address the unacceptable adverse effects, but those regulations do not explicitly provide an additional opportunity to submit comments on EPA's action. In addition, EPA's Final Determination is an informal adjudication and unlike the Administrative Procedure Act's (APA) requirements for notice and comment rulemaking to respond to all significant comments, the APA contains no such requirement for adjudications. Nonetheless, consistent with the Agency's transparency goals, EPA has voluntarily chosen to draft responses to many of comments received

throughout this process, including those comments received on the Recommended Determination during the consultation process.

In his November 29, 2010 letter to EPA, Colonel Robert Peterson, District Engineer for the Corps' Huntington District, responded on behalf of LTG Robert Van Antwerp, Commanding General for the Corps. Colonel Peterson noted that after reviewing the Recommended Determination, the Corps continued to believe it has no basis to take any corrective actions regarding DA Permit No. 199800436-3 (Section 10: Coal River) and that this position is consistent with the Corps' response to EPA Region III's September 3, 2009 request that Huntington District suspend, modify or revoke this permit.

In a November 29, 2010 letter to EPA, Randy Huffman, the Secretary of WVDEP, provided comments on the Recommended Determination. The letter raised concerns regarding a number of issues in the Recommended Determination including its analysis of the project's potential effects on water chemistry, the project's likely impacts to wildlife and the conclusions drawn regarding the proposed compensatory mitigation. In response to these comments, a number of clarifications have been made to the information and analysis in the Final Determination and detailed responses to Secretary Huffman's comments have been included in Appendix 6.

Finally, on December 16, 2010, the USFWS sent a letter to EPA in support of the Recommended Determination. In the letter, USFWS states that the available scientific information supports the EPA Region III recommendation and that USFWS concurs with EPA Region III's conclusion that construction of the Spruce No. 1 Mine, as authorized, would result in unacceptable adverse effects on wildlife. The letter highlights the fact that the USFWS has consistently expressed concerns regarding the loss of headwater streams and adjacent riparian and terrestrial habitats associated with the Spruce No. 1 Mine, as well as its likely impacts on downstream water quality, aquatic organisms, and terrestrial and aquatic wildlife that depend on those resources.

IV. Site Characteristics and Ecological Functions

The resources that will be impacted by the Spruce No. 1 Mine include Central Appalachian headwater stream ecosystems in Pigeonroost Branch and Oldhouse Branch. These waters connect via surface flow directly to Spruce Fork, which in turn flows to the Little Coal River and eventually to the Coal River. Because of the connectivity between headwater systems and downstream waters, Spruce Fork, the Little Coal River and the Coal River would be adversely impacted by discharges to Pigeonroost Branch and Oldhouse Branch because such discharges would transform these streams into sources that contribute contaminants to these downstream waters. Accordingly, the characteristics and functions of the resources that will be adversely impacted by discharges of dredged or fill material associated with the Spruce No. 1 Mine are best viewed from the perspective of the ecological functions performed by Appalachian headwater stream ecosystems and within the context of the larger Headwaters Spruce Fork sub-watershed and Coal River sub-basin.

Information on the aquatic and terrestrial ecosystem and the predicted impacts of the project comes from several sources. The Final (October 2005) Interagency Mountaintop Mining/Valley Fills in Appalachia PEIS represents important inter-agency efforts designed to inform more environmentally sound decision-making for future permitting of mountaintop mining and associated valley fills. The PEIS had a geographic focus of 12 million acres encompassing most of eastern Kentucky, southern West Virginia, western Virginia, and scattered areas of eastern Tennessee; and included the Spruce No. 1 Mine project area and the Coal River sub-basin. EPA also incorporated information gathered by the WVDEP, including an assessment of the Coal River sub-basin conducted in 1997, data collected to support the 2006 Coal River sub-basin total maximum daily load (TMDL), and WVDEP and nationally available GIS data. EPA also reviewed the 2006 Spruce No.1 EIS, and other sources of site-specific data including studies conducted by EPA scientists and discharge monitoring reports generated by Mingo Logan. In addition, EPA consulted a wide range of peer reviewed studies and literature. EPA Region III also communicated with the US Fish and Wildlife Service Elkins Field Office on impacts to fish and wildlife resources in the project area.

Headwater streams play an important role in the ecosystem far beyond the mere transport of water from one point to another. In many ways, headwater streams are similar to capillaries, the smallest blood vessels within the human circulatory system. In the same way capillaries are critical to the movement of carbon dioxide, oxygen, water and other essential compounds between the blood and surrounding tissues, small headwater streams, which make up over two-thirds of the total stream length in a stream network (Leopold et al. 1964), are critically important to the movement of water, sediments, organic matter, and nutrients from within their watersheds to downstream environments (Ensign and Doyle 2006). And just as a loss of blood flow through capillaries can lead to organ failure, alteration of headwater streams has the potential to affect the ecological integrity of aquatic ecosystems at broad spatial scales (Freeman et al. 2007). Thus, headwater streams, as the early stages of the river continuum, provide the most basic and fundamental building blocks to the remainder of the aquatic environment.

Appalachian headwaters provide habitat for wildlife including a wide variety of macroinvertebrates, amphibians, reptiles, birds, fish and mammals. They also are a significant interface between the river system and the terrestrial environment. Appalachian headwater streams and their wildlife inhabitants, such as macroinvertebrates, convert organic matter (e.g., leaf litter) from the surrounding landscape and transform it into nutrients and energy that can be transported and consumed by downstream ecological communities. They also play an important role in storing, retaining and transporting nutrients, organic matter and sediment. In addition they perform hydrologic functions related to downstream flow regimes, moderating flow rate and temperature (USEPA 2003, Fischenich 2006).

As authorized, the Spruce No. 1 Mine will bury under valley fills or impact through construction of sediment ponds nearly all of Oldhouse Branch and its tributaries and a substantial portion of Pigeonroost Branch and its tributaries. Oldhouse Branch and Pigeonroost Branch support healthy ecosystems consistent with least-disturbed conditions in the Coal River sub-basin. As such, they are valuable in and of themselves and for the functions they perform within the context of the Headwaters Spruce Fork sub-watershed and the Coal River sub-basin.

IV.A. Watershed and Stream Conditions

The Spruce No. 1 Mine is located within the Headwaters Spruce Fork sub-watershed (12-digit hydrologic unit code (HUC)) and the Coal River sub-basin (8-digit HUC) (Figure 4). Pigeonroost Branch and Oldhouse Branch flow to Spruce Fork, which in turn flows into the Little Coal River and then into the Coal River. The Coal River sub-basin encompasses nearly 891 square miles within West Virginia. Major tributaries within the Coal River sub-basin include Marsh Fork, Clear Fork, Pond Fork, Spruce Fork, and Little Coal River. Marsh Fork and Clear Fork join at Whitesville, WV to form the Big Coal River. Pond Fork and Spruce Fork join at Madison, WV to form the Little Coal River. The Little Coal and Big Coal Rivers join to form the Coal River at Forks of the Coal, WV.

The Coal River sub-basin has been impacted by past and present surface mining. Based upon the National Land Cover Database (NLCD) Retrofit Land Cover Change Product for 1992-2001 and the WVDEP's Geographic Information System (GIS) mine permit data, more than 257 past and present surface mining permits have been issued in the Coal River sub-basin, and the corresponding mines collectively occupy more than 13% of the land area. Some sub-watersheds in the Coal River sub-basin have more than 55% of the land occupied by historic, ongoing or permitted surface mines.

Spruce Fork is a fourth order tributary that combines with Pond Fork to form the Little Coal River, which in turn flows into the Coal River. Spruce Fork is located in the southwestern portion of the Coal River sub-basin and drains approximately 126.4 square miles. The dominant land cover in the Headwaters Spruce Fork sub-watershed is forest. Other significant land cover types include urban/residential and barren/mining land.

According to the WVDEP Division of Mining and Reclamation permit maps, more than 34 surface mine permits have been issued within the Headwaters Spruce Fork sub-watershed, and the resulting mines do or will collectively occupy more than 33% of the land area. Assuming full construction of these projects along with projects associated with known future surface mining permits, more than 40% of the land area of the sub-watershed will be occupied by surface mining permits.

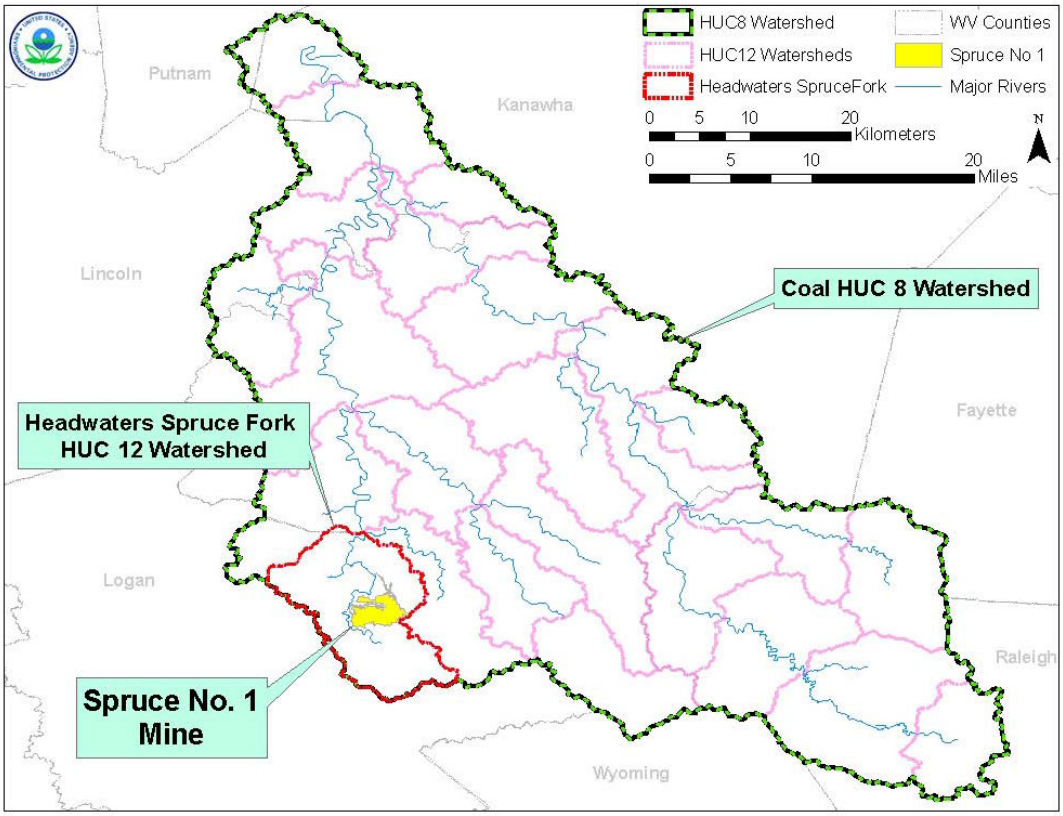

Figure 4. Headwaters Spruce Fork sub-watershed (12-digit hydrologic unit code (HUC)) and the Coal River sub-basin (8-digit HUC)

In 1997, the WVDEP performed its first comprehensive ecological assessment of the Coal River sub-basin.[6] The WVDEP assessed three major aspects of watershed health: water quality, habitat condition, and benthic macroinvertebrate community status. The subsequent report, *An Ecological Assessment of the Coal River Watershed* (1997), indicated that sediments, coal mining and inadequate sewage treatment were the major stressors on streams in this watershed. The WVDEP report also noted the importance and paucity of reference-quality streams in the watershed, stating

> [s]ince reference sites reflect least-disturbed conditions, it is vital that the WVDEP do its part in fulfilling the mission of preserving the high quality of these rare and important streams. It is also important that the agency make a concerted

[6] Report can be found at http://www.dep.wv.gov/WWE/watershed/wqmonitoring/Documents/EcologicalAssessments/EcoAssess_Coal_1997.pdf

> effort to find the apparently few remaining streams within the watershed that have not been significantly impacted by human disturbances.

Further the report indicated that because the sub-basin is becoming increasingly impaired due to stressors such as mining, there is a need to protect the remaining quality resources, highlighting the need to "[l]ocate and protect the few remaining high quality streams in the Coal River watershed…" (WVDEP 1997a).

Out of approximately 250 stations sampled by the WVDEP in the Coal River sub-basin since 1996, only 3 (~1%) are designated as reference sites. One of these three reference sites is White Oak Branch, which flows into Spruce Fork immediately upstream of Oldhouse Branch and Pigeonroost Branch. The WVDEP defines reference conditions as those conditions that "describe the characteristics of waterbody segments least impaired by human activities and are used to define attainable biological and habitat conditions. Final selection of reference sites depends on a determination of minimal disturbance, which is derived from physio-chemical and habitat data collected during the assessment of the stream sites." Reference sites are used to determine the score that represents the threshold between impaired and non-impaired sites. As discussed in detail below, Oldhouse Branch and Pigeonroost Branch are important within the context of the larger Coal River sub-basin and Headwaters Spruce Fork sub-watershed because, like White Oak Branch, they represent some of the few stream systems supporting least-disturbed conditions within those watersheds.

The stream systems that are the subject of this Final Determination, Pigeonroost Branch and Oldhouse Branch, are high quality stream systems supporting diverse aquatic communities, as measured by their benthic macroinvertebrate populations (see Section IV.B.1. and Appendix 2). Macroinvertebrates are used by West Virginia and other states in the Mid-Atlantic region and across the U.S. to assess the quality of their waters and are good indicators of stream health. While Pigeonroost Branch and Oldhouse Branch are not WVDEP-designated reference sites, their quality is comparable to White Oak Branch, a WVDEP-designated reference site, and their macroinvertebrate communities rank highly in comparison to other central Appalachian streams and streams throughout the state of West Virginia (see Section IV.B.1). Accordingly, Oldhouse Branch and Pigeonroost Branch reflect least-disturbed conditions and represent some of the few remaining streams within the Coal River sub-basin that have not been significantly adversely impacted by human disturbances.

Water chemistry data for Pigeonroost Branch and Oldhouse Branch also reflect healthy streams with little human disturbance. Data from the WVDEP indicate that average conductivity values for the unmined streams on the Spruce No. 1 Mine project area are very low.[7] Based on the WVDEP dataset (2002-2003), Oldhouse Branch had an average

[7] Specific conductance, or conductivity, is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salt) in the water, and typically measured as microsiemens per centimeter (µS/cm). Pure water, such as distilled water, will have a very low specific conductance, and seawater will have a high specific conductance. Conductivity is an important water quality measurement because it gives a good idea of the amount of dissolved material in the water.

conductivity level of 90 µS/cm, which is below that of White Oak Branch, a WVDEP-designated reference site, which had an average conductivity level of 118 µS/cm. Conductivity levels described above in Oldhouse Branch and White Oak Branch indicate excellent water quality, comparable to reference-quality streams for this ecoregion. Sulfate concentrations in these streams are also low (28 mg/l in Oldhouse Branch and 24 mg/l in White Oak Branch). Pigeonroost Branch had a conductivity level of 199 µS/cm and sulfate level of 99 mg/l. The slightly elevated average conductivity and sulfate values reflect the relatively small amount of historical mining land use in the Pigeonroost watershed.

During the December 2008 to March 2010 time frame, monitoring reports submitted by the permittee indicate 15 of the 16 selenium measurements at both Pigeonroost Branch and Oldhouse Branch were below the detection limit of 0.6 µg/L. The single detection of selenium on Oldhouse Branch was 0.9 µg/L during July 2009. The single detection of selenium on Pigeonroost Branch was 1.9 µg/L during August 2009. By way of comparison, these readings are far below 5 µg/L, which is the concentration associated with West Virginia's chronic water quality criterion for selenium.[8] These levels are also significantly lower than levels documented immediately downstream of adjacent mining operations (see Section V.D.1.a.).

The relatively high quality of Oldhouse Branch and Pigeonroost Branch also can be demonstrated by comparison to other streams in the Headwaters Spruce Fork sub-watershed that have been impacted by mining operations similar to the Spruce No. 1 Mine, located directly northwest of the Spruce No. 1 Mine, on the west side of Spruce Fork. These streams, in part, are impacted by the Mingo Logan Dal-Tex Mining Operation (Dal-Tex). Section V.D.2.a. compares the health of the relatively unimpacted macroinvertebrate communities in Pigeonroost Branch and Oldhouse Branch with the macroinvertebrate communities in these streams that have been impacted by mining activity. This comparison demonstrates that Oldhouse Branch and Pigeonroost Branch support a much healthier and more diverse assemblage of benthic macroinvertebrates than do the four comparison streams that are impacted by the Dal-Tex operation.

IV.B. Wildlife

The Spruce No. 1 Mine is located in the Central Appalachian ecoregion, which encompasses most of the central Appalachian coalfields (Bryce et al. 1999) (Figure 5). This ecoregion has some of the greatest aquatic animal diversity of any area in North America, especially for species of amphibians, fishes, mollusks, aquatic insects, and crayfishes. Individual watersheds and peaks in the Appalachian chain, isolated for millions of years with benign environmental conditions, provided a perfect setting for the evolution of many unique species of plants and animals. The Nature Conservancy has identified this region as one of North America's prominent biodiversity hotspots of rarity and richness (Figure 6) (Stein et al. 2000). Salamanders, in particular, reach some of the highest levels of North American diversity in the Central Appalachian ecoregion, and are

[8] The West Virginia numeric chronic water quality criterion for selenium defined as a four-day average concentration not to be exceeded more than once every three years

often abundant enough to account for the greatest vertebrate biomass in a given patch of forest (Stein et al. 2000). It has also been documented that other specialized wildlife such as some neotropical migrant birds and forest amphibians rely on the natural headwater stream conditions and adjacent forest types exhibited by Pigeonroost Branch and Oldhouse Branch for maintenance of their populations (Stein et al., 2000).

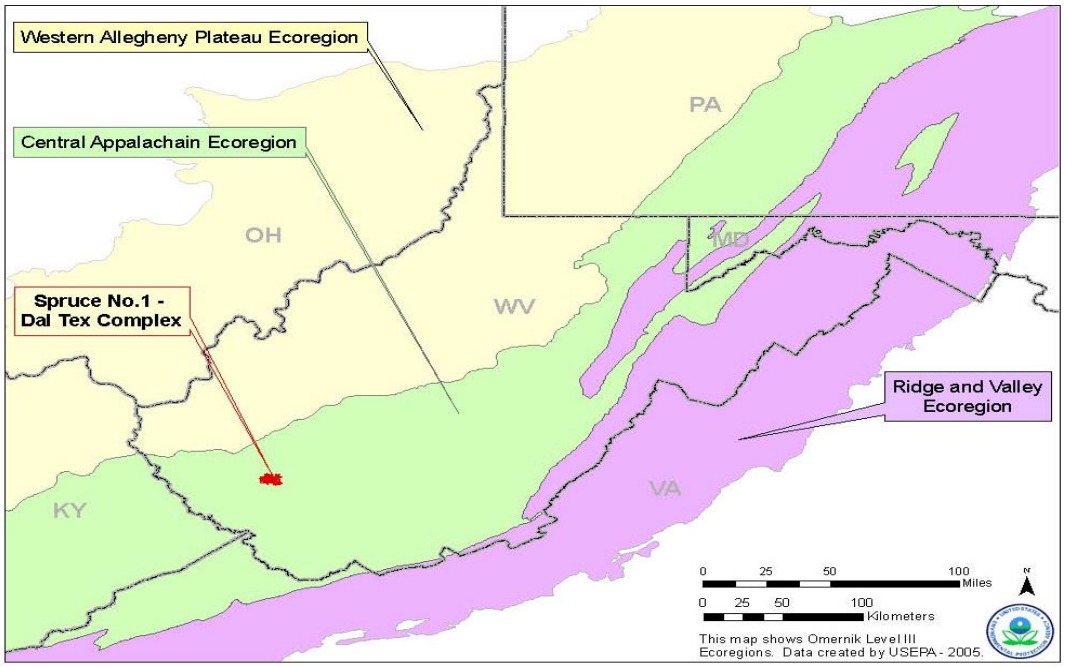

Figure 5. Map of Central Appalachian ecoregion showing Spruce No. 1 Mine location

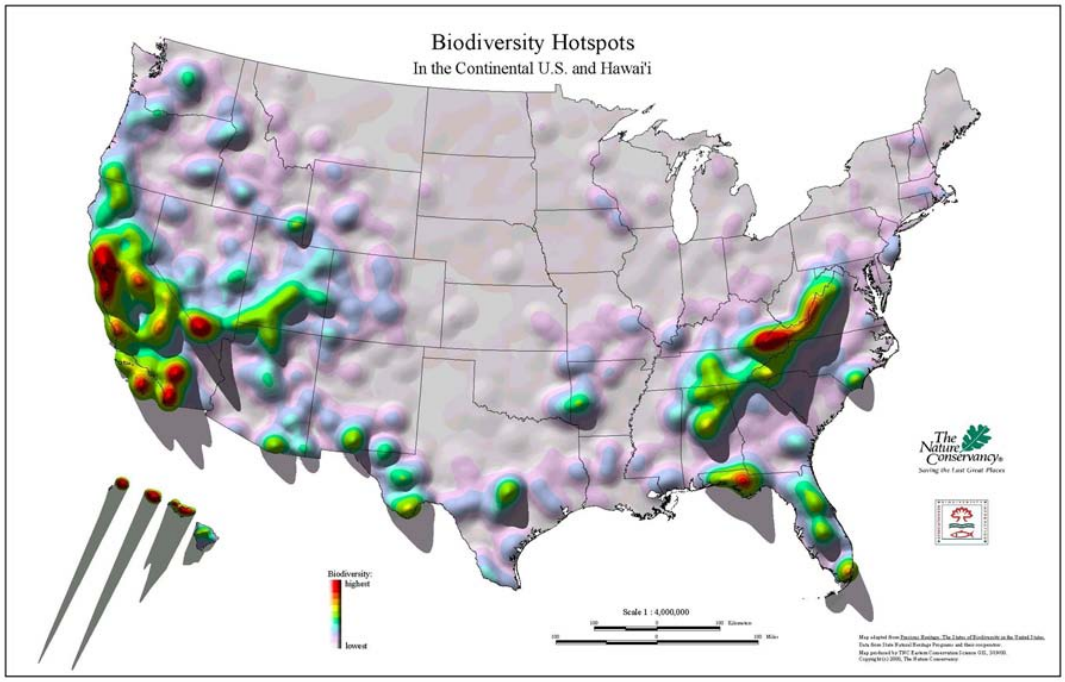

Figure 6. Biodiversity Hotspots in the Continental United States and Hawaii
Map adapted from Precious Heritage: The Status of Biodiversity in the United States.
© The Nature Conservancy http://www.nature.org/wherewework/northamerica/states/westvirginia/science/

IV.B.1. Macroinvertebrates

In a body of water, benthic macroinvertebrates are the bottom-dwelling (benthic) organisms that are large enough to be seen without the aid of microscopes (macro), and do not have backbones (invertebrate). As stated in EPA's Wadeable Stream Assessment (EPA 841-B-06-002 December 2006), macroinvertebrates are good indicators of biological integrity "because of their inherent capacity to integrate the effects of the stressors to which they are exposed, in combination and over time. Stream macroinvertebrates generally cannot move very quickly or very far; therefore, they are affected by, and may recover from, a number of changes in physical conditions (e.g., habitat loss), chemical conditions (e.g., excess nutrients), and biological conditions (e.g., the presence of invasive or non-native species). Some types of macroinvertebrates are affected by these conditions more than others." In addition to their role as indicators of biological integrity or ecosystem health, stream macroinvertebrates, which include aquatic insects, mollusks and crayfishes, play a vital role in food webs and in the processing and transfer of energy and nutrients in river systems. Because of these functions, macroinvertebrates are essential wildlife within the food web, supporting the health of the entire aquatic ecosystem (Figure 7).

Freshwater macroinvertebrates are a critical component of aquatic and riparian food webs, and the loss of these taxa can lead to cascading effects on other trophic levels, with implications for downstream stream ecosystems and sport fisheries. Aquatic macroinvertebrates feed on algae and leaf litter, and this consumption not only cleans excess living and nonliving organic material from stream systems, but the processing of this organic matter makes essential nutrients available to organisms downstream. Additionally, conversion of plant material into nutrient-rich biomass, in the form of fats and proteins, makes these invertebrates a major food source for the fish and amphibian populations within the stream ecosystem. In addition to their role in the aquatic food web, emerging adult aquatic insects are important prey for foraging terrestrial vertebrates, including birds, bats, reptiles, amphibians, and small mammals (Baxter et al. 2005). Many of these terrestrial vertebrates, including ducks and water shrews, have also been known to consume aquatic insect larvae from the stream before emergence as adults (Baxter et al. 2005). Macroinvertebrates, therefore, are necessary components of a functioning aquatic and riparian food web; and they fulfill a critical ecological niche by delivering nutrients along the stream continuum to both aquatic and terrestrial members of the food chain.

EPA recognizes macroinvertebrates as wildlife, along with many other organizations, including the USFWS, USDA Forest Service, The Nature Conservancy, State Natural Heritage programs, and the West Virginia Division of Natural Resources (WVDNR). Currently, within the U.S., the USFWS lists 50 species of insects as endangered under the Endangered Species Act (ESA), and another 10 species as threatened under the ESA. The State of West Virginia also includes insects, mollusks and crayfishes on its list of rare, threatened and endangered species, including 12 species of stoneflies, two species of mayflies, and 73 species of dragonflies and damselflies (West Virginia Natural Heritage

Program 2007). Several States, including West Virginia and Virginia, require a permit to collect macroinvertebrates for scientific sampling.

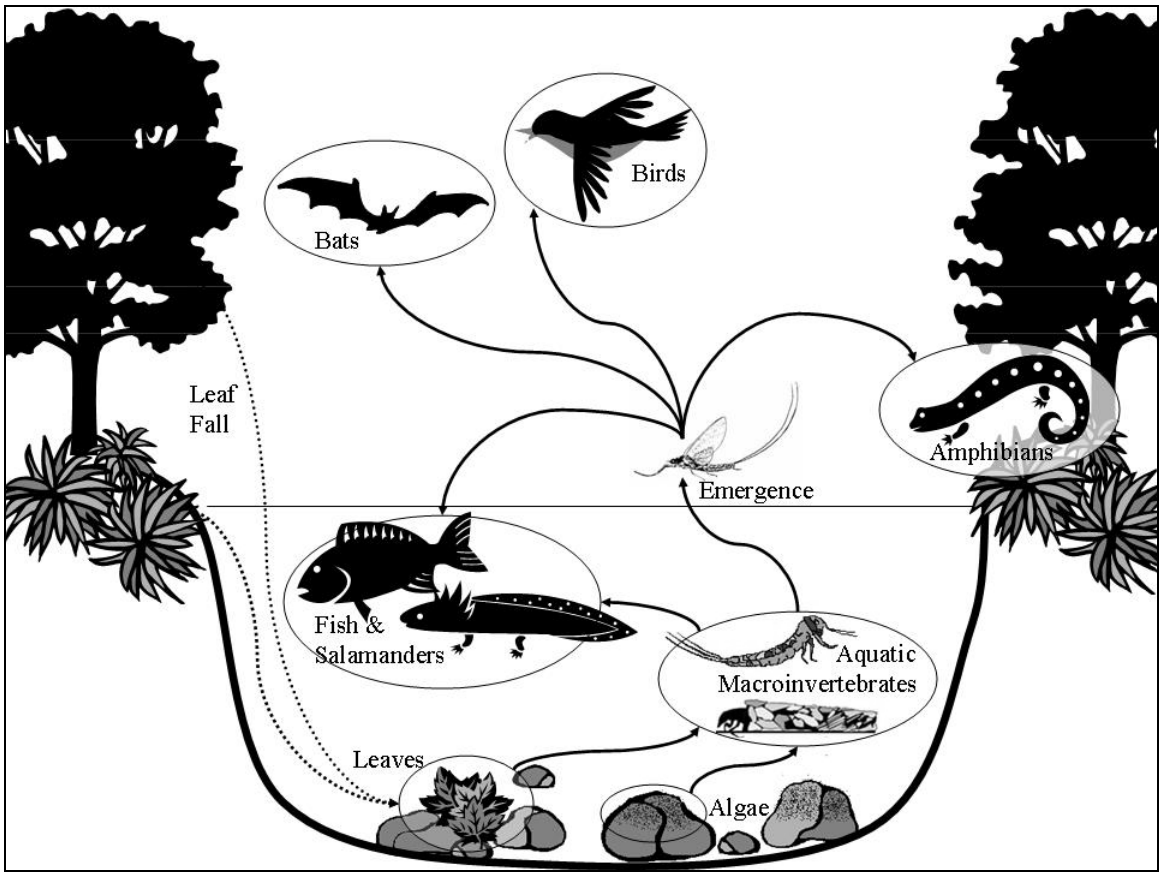

Figure 7: Illustration of a simplified stream food web, highlighting the importance of aquatic macroinvertebrates to other stream and riparian wildlife (adapted from Baxter et al. 2005).

According to Morse et al. (1997), the Central Appalachian ecoregion has many endemic and rare species of benthic macroinvertebrates in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).[9] This diversity and unique assemblage has been attributed to the unique geological, climatic, and hydrological characteristics of this region. The Spruce No. 1 Mine project area has been found to be very rich in macroinvertebrate species. Data from the PEIS, the Spruce No. 1 EIS and from the WVDEP monitoring database indicate that high macroinvertebrate diversity exists in Pigeonroost Branch and Oldhouse Branch. Species diversity boosts ecosystem productivity, maintains ecosystem functionality, and is typically seen as an indicator of overall health.

Mayflies are most popularly known among fly-fishermen, where anglers rely on the seasonal hatches of mayflies that coincide with catching trout and other game fish species. Not only do trout rely on mayflies and stoneflies, but a group of colorful benthic fishes known as Darters (Percidae) also feed on mayflies. Darters are an important part of

[9] The orders Ephemeroptera, Plecoptera and Trichoptera (EPT taxa) contain pollution sensitive groups and are used by natural resource agencies such as the WVDEP to assess watershed health.

the fish assemblage and many are hosts for mussel larvae. Five darter species inhabit Spruce Fork in the immediate vicinity of the project area.

Stoneflies also represent an important group of aquatic insects in the structure and functioning of stream ecosystems, filling important trophic roles in stream ecosystems, including detritivory (consumption of dead or decaying organic matter) and predatory functional feeding group designations. As with mayflies, stoneflies are valued and imitated by fly-fishermen and serve as an abundant food source for many salamanders and fishes. Stoneflies are primarily stenothermic, meaning they inhabit cool to cold waters that provide the higher dissolved oxygen concentrations required for their survival.

Pigeonroost Branch and Oldhouse Branch support diverse and healthy communities of benthic macroinvertebrates, which are comparable to WVDEP reference sites. Macroinvertebrate data collected in Oldhouse Branch and Pigeonroost Branch indicate that the quality of the mayfly (Ephemeroptera) and stonefly (Plecoptera) communities in these streams ranks very high in the Central Appalachia ecoregion and statewide. In 1999-2000, EPA collected eighty-four (84) macroinvertebrate genera in riffle complexes of Pigeonroost Branch and Oldhouse Branch (see Table 11 for a complete taxa list by genus).[10] Collectively, Pigeonroost Branch and Oldhouse Branch contain a high number of mayfly and stonefly taxa and individuals (Tables 1 and 2). A total of 19 genera of mayflies and 16 genera of stoneflies have been identified from these headwater streams indicating these systems offer high water quality and optimal habitat.

Based on a comparison of macroinvertebrate communities, Oldhouse Branch and Pigeonroost Branch are of comparable quality to White Oak Branch, a neighboring WVDEP-designated reference site. Using the West Virginia Stream Condition Index (WVSCI), an assessment method developed for use in West Virginia to help evaluate the health of benthic macroinvertebrate communities at the family level in wadeable streams (and used as a measure of the health of stream communities overall), both Oldhouse Branch and White Oak Branch scored comparably well.[11] Oldhouse Branch and White Oak Branch also scored comparably well at the more sensitive genus level (as opposed to family), sharing 55 total genera, many of which are intolerant of pollution, indicating a diverse and healthy aquatic community in Oldhouse Branch similar to the high quality communities of White Oak Branch. The WVSCI assessment of Pigeonroost Branch indicates water quality is relatively good despite the presence of localized historic mining in the watershed. Pigeonroost Branch and White Oak Branch also share many pollution-intolerant macroinvertebrate genera, indicating that the health of Pigeonroost Branch's aquatic community is similar.

Oldhouse Branch and Pigeonroost Branch contain 19 genera of mayflies (Table 1). As many as nine genera of mayflies have been collected in Oldhouse Branch in any one

[10] Riffle and pool complexes are considered special aquatic sites under 40 CFR 230.1(d) and as such the degradation or destruction of these sites is considered to be among the most severe environmental impacts covered by the § 404(b)(1) Guidelines.
[11] For a more detailed discussion of WVSCI, see Section V.B.2.a.iii.

season-specific sample, with an average of seven genera across multiple samples. This observation ranks in the 95th percentile of all samples taken in the Central Appalachian ecoregion (937 samples) by the WVDEP. Out of more than 4000 samples collected statewide in West Virginia, Oldhouse Branch ranks in the 90th percentile. Pigeonroost Branch contained eight mayfly genera in a season-specific sample, ranking it in the 90th percentile in the Central Appalachian ecoregion and 83rd percentile statewide from among more than 4000 single-sample observations.

Table 1. Presence/absence of mayfly (Ephemeroptera) genera in the permit area (Compiled from EPA, WVDEP, and the applicant's consulting firms (Sturm Environmental Services, BMI, Inc.))

Order	Family	Genus	Oldhouse	Pigeonroost
Ephemeroptera	Ameletidae	*Ameletus*	X	X
Ephemeroptera	Baetidae	*Acentrella*	X	X
Ephemeroptera	Baetidae	*Baetis*	X	X
Ephemeroptera	Baetidae	*Diphetor*		X
Ephemeroptera	Baetiscidae	*Baetisca*		X
Ephemeroptera	Ephemerellidae	*Attanella*		X
Ephemeroptera	Ephemerellidae	*Dannella*		X
Ephemeroptera	Ephemerellidae	*Drunella*	X	X
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	X
Ephemeroptera	Ephemerellidae	*Eurylophella*	X	X
Ephemeroptera	Ephemeridae	*Ephemera*	X	X
Ephemeroptera	Heptageniidae	*Cinygmula*	X	X
Ephemeroptera	Heptageniidae	*Epeorus*	X	X
Ephemeroptera	Heptageniidae	*Heptagenia*		X
Ephemeroptera	Heptageniidae	*Maccaffertium*	X	X
Ephemeroptera	Heptageniidae	*Stenacron*	X	
Ephemeroptera	Isonychiidae	*Isonychia*		X
Ephemeroptera	Leptophlebiidae	*Choroterpes*	X	
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	X	

Note: Siphlonurus and Pseudocloeon reported by Sturm Environmental Services are likely erroneous identifications. These genera have been excluded from this list.

Oldhouse Branch and Pigeonroost Branch contain 11 genera of stoneflies (Table 2). A single collection in Oldhouse Branch by EPA (Spring 2000) included 9 genera of stoneflies, which ranks greater than the 98th percentile of all Central Appalachian streams sampled by the WVDEP (937 samples). This means that only 2% of stream samples in this ecoregion had more stonefly taxa than Oldhouse Branch within a single sampling event. Pigeonroost Branch had as many as six stonefly genera in any one season-specific sample, ranking it at the 83rd percentile among 937 Central Appalachian streams, and 72nd percentile statewide.

Table 2. Presence/absence of stonefly (Plecoptera) genera in the permit area (Compiled from EPA, WVDEP, and the applicant's consulting firms (Sturm Environmental Services, BMI, Inc.))

Order	Family	Genus	Oldhouse	Pigeonroost
Plecoptera	Capniidae	*Allocapnia*	X	X
Plecoptera	Chloroperlidae	*Alloperla*		X
Plecoptera	Chloroperlidae	*Haploperla*	X	

Plecoptera	Chloroperlidae	*Sweltsa*	X	
Plecoptera	Leuctridae	*Leuctra*	X	X
Plecoptera	Nemouridae	*Amphinemura*	X	X
Plecoptera	Nemouridae	*Ostrocerca*	X	X
Plecoptera	Nemouridae	*Paranemoura*		X
Plecoptera	Peltoperlidae	*Peltoperla*	X	
Plecoptera	Perlidae	*Acroneuria*	X	X
Plecoptera	Perlodidae	*Isoperla*	X	
Plecoptera	Perlodidae	*Remenus*		X
Plecoptera	Perlodidae	*Yugus*	X	
Plecoptera	Pteronarcyidae	*Pteronarcys*	X	X
Plecoptera	Taeniopterygidae	*Taenionema*		X
Plecoptera	Taeniopterygidae	*Taeniopteryx*		X

Note: Podmosta, Paraleuctra, Megaleuctra,and Beloneuria reported by Sturm Environmental Services are likely erroneous identifications. These genera been excluded from this list.

Two Cambarus species of crayfish were collected incidentally during the macroinvertebrate sampling events. Although crayfish were not specifically sampled for, a list of crayfish species potentially present within the Headwaters Spruce Fork sub-watershed can be found in Table 3. Other macroinvertebrates, including mollusks and flatworms (plathyelminthes), are fairly rare in these systems, as aquatic insects make up the majority of the macroinvertebrate taxa in these streams.

Table 3: List of potential crayfish species occurring within permit area

Common Crayfish (*Cambarus bartonii bartonii*)	Upland Burrowing Crayfish (*Cambarus dubius*)
Appalachian Brook Crayfish (*Cambarus b. cavatus*)	Big Water Crayfish (*Cambarus robustus*)

IV.B.2. Salamanders & Other Herpetofauna

There are 46 species of herpetofauna that have been documented as occurring on the project site or in Logan or Boone County, WV, including a wide variety of salamanders (Table 4). The Central Appalachian ecoregion contains one of the richest concentrations of salamander fauna in the world (Petranka 1998, Stein et al. 2000). Nearly ten percent of global salamander diversity is found within streams in the ecoregion (Green and Pauley 1987). Salamanders are a diverse and unique form of Appalachian wildlife that depend on forested headwater habitat and that decline or disappear from surface mined areas. Many species of salamanders are aquatic or semi-aquatic and utilize headwater streams at some point in their life histories. Most of the species found in the project area are water-dependent and belong to the family Plethodontidae, the lungless salamanders, which require high moisture retaining leaf-litter, dense shade, and cool flowing streams to survive and reproduce. Typically, salamanders occupy small, high-gradient headwater streams while fish occur farther downstream.

Salamanders are an important ecological component in the temperate hardwood forests of the ecoregion and are often the most abundant group of vertebrates in both biomass and number (Burton and Lykens 1975, Hairston 1987). Ecologically, salamanders are intimately associated with forest and adjacent aquatic ecosystems acting as predators of

small invertebrates and serving as prey to larger aquatic and terrestrial predators, including fish, birds, mammals and reptiles (Pough et al. 1987, Davic and Welsh 2004). Because of their low energy demand, long life span, slow growth rates, and large abundance, salamanders help to maintain long-term ecosystem function and resilience by providing abundant biomass and nutrients for top predators in forest and adjacent aquatic ecosystems (Davic and Welsh 2004). As such, salamanders play a large role in the cycling of nutrients and transfer between terrestrial and aquatic systems via trophic pathways (Davic and Welsh 2004). Some species of salamanders split their lives between forests and headwaters and depend on a close connection to move between the two (Petranka, 1998). The PEIS identified thirty-one species of salamanders in the West Virginia portion of the study area. Of these, twenty-five species are known to occupy mixed mesophytic hardwood forests, like those present within portions of the Spruce No. 1 Mine site.

Table 4: List of documented herpetofauna species occurring in Logan County or Boone County, WV. Source: Spruce EIS and WV Biological Survey, Marshall University, 2010

Eastern hognose snake (*Heterodon platirhinos*)*	Five-lined skink (*Eumeces fasciatus*)*
American toad (*Bufo americanus*)*	Spring peeper (*Hyla crucifer*)*
Spring salamander (*Gyrinophilus porphyriticus*)*	Southern two-lined salamander (*Eurycea cirrigera*)*
Seal salamander (*Desmognathus monticola*)*	Northern dusky salamander (*Desmognathus fuscus*)*
Mountain dusky salamander (*Desmognathus ochrophaeus*)*	Mole salamander (*Ambystoma*)*
Red-spotted newt (*Notophthalmus viridescens*)*	Green salamander (*Aneides aenus*)*
Red salamander (*Pseudotriton ruber*)*	Mountain Chorus Frog (*Pseudacris brachyphona*)
Ring-necked Snake (*Diodophus punctatus*)	Fowler's Toad (*Bufo fowleri*)
Eastern Wormsnake (*Carphophis amoenus*)	Mudpuppy (*Necturus maculosus*)
Box Turtle (*Terrapene carolina*)	Spiny Soft-shelled Turtle (*Apalone spinifera*)
Timber Rattlesnake (*Crotalis horridus*)	Eastern Racer (*Coluber constrictor*)
Northern Slimy Salamander (*Plethodon glutinosus*)	Gray Treefrog (*Hyla versicolor*)
Eastern Fence Lizard (*Sceloporus undulatus*)	Rough Green Snake (*Opheodrys aestivus*)
North American Bullfrog (*Rana catesbeiana*)	Northern Two-lined Salamander (*Eurycea bislineata*)
Painted Turtle (*Chrysemys picta*)	Pickerel Frog (*Rana palustris*)
Snapping Turtle (*Chelydra serpentina*)	Little Brown Skink (*Scincella lateralis*)
Common Garter Snake (*Thamnophis sirtalis*)	Green Frog (*Rana clamitans*)
Northern Water Snake (*Nerodia sipedon*)	Ravine Salamander (*Plethodon richmondi*)
Spotted Salamander (*Ambystoma maculatum*)	Cope's Gray Treefrog (*Hyla chrysoscelis*)
Queen Snake (*Regina septemvittata*)	Coal Skink (*Eumeces anthracinus*)
Black Mountain Salamander (*Desmognathus welteri*)	Marbled Salamander (*Ambystoma opacum*)
Mud Salamander (*Pseudotriton montanus*)	Copperhead (*Agkistrodon contortix*)
Long-tailed Salamander (*Eurycea longicauda*)	Four-toed Salamander (*Hemidactylium scutatum*)
* Documented within the permit area	

With respect to areas in or immediately adjacent to the project area, stream-dwelling salamanders have been surveyed in White Oak Branch (see Appendix B in Patnode et al. 2005). White Oak Branch had good numbers of Northern Dusky (9 adult, 7 larvae), Appalachian Seal (15 adult, 12 larvae), Northern Spring (4 adult), and Two Lined salamanders (1 adult and 15 larvae). These samples were recorded from a 12 square-meter plot that includes dry and wetted portions of the stream channel. Because Oldhouse Branch and Pigeonroost Branch are very close geographically and have similar

features as White Oak Branch, salamander populations in Pigeonroost Branch and Oldhouse Branch can be expected to be similar to those in White Oak Branch. Williams (2003) found mean densities within reference reaches of Pigeonroost Branch, Bend Branch (another tributary of Spruce Fork), and Ash Fork (a tributary of the Gauley River) to be more than six salamanders per square meter. In the Williams' study, the majority of the total salamanders were found in Pigeonroost Branch. Using these numbers from White Oak Branch and Pigeonroost Branch, EPA estimates aquatic salamanders are abundant (~5-6 per square meter) along stream channels in Pigeonroost Branch and Oldhouse Branch.

IV.B.3. Fish

Five fish species have been sampled in Pigeonroost Branch, Oldhouse Branch, and White Oak Branch, and the assemblages are typical of small streams in the Coal River sub-basin (Table 5). As fish diversity generally increases with stream order (Meyer et al. 2007), the low diversity in these streams is typical of low order headwater streams. The fish populations are good quality, and are not indicative of impairment. Based upon several sampling efforts, it has been found that Pigeonroost Branch supports a fish assemblage that includes blacknose dace, creek chub mottled sculpin, stonerollers and smallmouth bass; and Oldhouse Branch supports a fish assemblage of blacknose dace and creek chub. The presence of smallmouth bass in Pigeonroost Branch indicates at least seasonal, and possible spawning use of this stream by smallmouth bass.

Fish species collection in Oldhouse Branch, Pigeonroost Branch and White Oak Branch has been variable, likely due to a drought that occurred in 1999. It is likely that perennial reaches of Pigeonroost Branch and Oldhouse Branch were dewatered during this drought period, and thus provided only ephemeral or intermittent habitat at that time. As discussed in Stauffer and Ferreri (2002), drought can act as a major perturbation on fish communities. While fish can recolonize an area after a drought, recolonization rates vary between fish species, and it may take years before the community resembles that which was in place before the drought.

As outlined in the PEIS (Stauffer and Ferreri 2002), a study that was conducted by the U.S. Fish and Wildlife Service in 1998 recorded sculpin (Cottus spp.) in benthic invertebrate samples from White Oak Branch, as well as many fishes in the pools of Oldhouse Branch. Subsequent sampling in May 2000 revealed only blacknose dace (Rhinichthys atratulus) in White Oak Branch, and none in Oldhouse Branch. Stauffer and Ferreri (2002) attributed this to the effects of the drought in 1999. Sampling for the PEIS occurred in 1999, the same year as the drought. When sampled for the PEIS, only blacknose dace and creek chubs were present in Pigeonroost Branch. Similarly, White Oak Branch was also drought-affected and it contained only blacknose dace at the time of sampling. No samples were collected in Oldhouse Branch for the PEIS. Blacknose dace are typically a headwater species that are tolerant of disturbance and can recolonize an area quickly after a drought. Sculpins (Cottus spp.), however, are bottom-dwelling species that typically have a restricted home range, which hinders the dispersal rate and makes it more difficult for them to recolonize an area after a drought.

Additional fish sampling data were collected in 2008 and 2009 by Decota Consulting and revealed a fish assemblage similar to that found by the U.S. Fish and Wildlife Service prior to the drought. Mottled sculpin, as well as sporadic populations of smallmouth bass and stonerollers were collected in Pigeonroost Branch. Similarly, creek chubs and mottled sculpin were collected from White Oak Branch. Data from Oldhouse Branch indicate that blacknose dace and creek chubs are the only species present.

In an analysis of fish community data from Spruce Fork, EPA assessed the small streams impacted by the Spruce No. 1 Mine and three reaches of Spruce Fork: 1) Upstream of Seng Camp Creek, 2) Seng Camp Creek to Spruce Laurel, and 3) Downstream of Spruce Laurel. Other data analyzed included data collected for the PEIS, unpublished data included in the West Virginia Department of Natural Resources (WVDNR) database (including USEPA, WVDNR, and consulting firm data), and data from Decota Consulting supplied to the WVDNR collecting permit program. The data consisted of samples that were intended to assess community composition and were judged to have sufficient numbers of individuals to render a fair assessment.

Table 5: List of fish species occurring within Spruce Fork from samples in 2007 and 2010 (WVDNR unpublished data) (*) represents species also present in Pigeonroost Branch and Oldhouse Branch within the project area

rock bass (Ambloplites rupestris)	striped shiner (Luxilus chrysocephalus)
central stoneroller (Campostoma anomalum)*	smallmouth bass (Micropterus dolomieu)*
mottled sculpin (Cottus bairdii)*	golden redhorse (Moxostoma erythrurum)
greenside darter (Etheostoma blennioides)	silverjaw minnow (Notropis buccatus)
rainbow darter (Etheostoma caeruleum)	silver shiner (Notropis photogenis)
johnny darter (Etheostoma nigrum)	rosyface shiner (Notropis rubellus)
variegate darter (Etheostoma variatum)	sand shiner (Notropis stramineus)
banded darter (Etheostoma zonale)	mimic shiner (Notropis volucellus)
bigeye chub (Hybopsis amblops)	bluntnose minnow (Pimephales notatus)
northern hog sucker (Hypentelium nigricans)	western blacknose dace (Rhinichthys obtusus)
American brook lamprey (Lampetra appendix)	brown trout (Salmo trutta)
green sunfish (Lepomis cyanellus)	creek chub (Semotilus atromaculatus)*
bluegill (Lepomis macrochirus)	blacknose dace (Rhinichthys atratulus)*

For the PEIS, Fulk et al. (2003) used the Mid-Atlantic Highlands (MAHA) Index of Biotic Integrity (IBI), a multi-metric index used to assess biotic health, with some minor modification, to assess the impacts of mountaintop mining and valley fills to fish assemblages. Using this same index, the assemblage upstream of Seng Camp Creek ranged from fair to excellent condition.

The fish assemblage in the main stem of Spruce Fork is in relatively good condition (Table 5) and is made up of 26 species. Spruce Fork is a locally important rock bass and smallmouth bass fishery. Rock Bass and Smallmouth Bass are moderately sensitive gamefish species. While sampling Spruce Fork in 2010, recreational fishing was observed in the lower reaches of the stream and there was evidence of fishing in the upper reaches as well. Species present in Spruce Fork upstream and downstream of Seng Camp Creek are typical of streams of this size within the Coal River sub-basin.

IV.B.4. Birds[12]

Many bird species depend on headwater streams like those of the Spruce Fork for their survival. The ecotone, or transition area, between terrestrial and aquatic habitats results in diverse flora and fauna. This phenomenon is particularly noticeable among bird species. For example, unique avifauna assemblages can be found along the riparian zone of headwater streams, and are often attracted to headwater streams for breeding areas because of the diversity of the habitat and the availability of emergent aquatic insects. Hence Appalachian headwater streams, like Pigeonroost Branch and Oldhouse Branch, support a wide array of sensitive bird species (Table 6) and are an important natural habitat for supporting these species' breeding populations.

Table 6: List of potential bird species occurring within permit area

Ruffed Grouse (*Bonasa umbellus*)	Whip-poor-will (*Caprimulgus vociferous*)
Red-tailed Hawk (*Buteo jamaicensis*)	Hairy Woodpecker (*Picoides villosus*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	Pileated Woodpecker (*Dryocopus pileatus*)
Chimney Swift (*Chaetura pelagica*)	Acadian Flycatcher (*Empidonax virescens*)
Belted Kingfisher (*Megaceryle alcyon*)	Yellow-throated Vireo (*Vireo flavifrons*)
Downy Woodpecker (*Picoides pubescens*)	Red-eyed Vireo (*Vireo olivaceus*)
Northern Flicker (*Colaptes auratus*)	American Crow (*Corvus brachyrhynchos*)
Eastern Wood-Pewee (*Contopus virens*)	Carolina Chickadee (*Poecile carolinensis*)
Eastern Phoebe (*Sayornis phoebe*)	White-breasted Nuthatch (*Sitta carolinensis*)
White-eyed Vireo (*Vireo griseus*)	Blue-gray Gnatcatcher (*Polioptila caerulea*)
Blue Jay (*Cyanocitta cristata)*	Wood Thrush (*Hylocichla mustelina*)
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	Gray Catbird (*Dumetella carolinensis*)
Tufted Titmouse (*Baeolophus bicolor*)	European Starling (*Sturnus vulgaris*)
Carolina Wren (*Thryothorus ludovicianus*)	Brewster's Warbler (hybrid) (*Vermivora cyanoptera x V. chrysoptera*)
Eastern Bluebird (*Sialia sialis*)	Northern Parula (*Parula Americana*)
American Robin (*Turdus migratorius*)	Yellow-throated Warbler (*Dendroica dominica*)
Blue-winged Warbler (*Vermivora cyanoptera*)	Cerulean Warbler (*Dendroica caerulea*)
Golden-winged Warbler (*Vermivora chrysoptera*)	American Redstart (*Setophaga ruticilla*)
Yellow Warbler (*Dendroica petechia*)	Swainson's Warbler (*Limnothlypis swainsonii*)
Prairie Warbler (*Dendroica discolor*)	Louisiana Waterthrush (*Parkesia motacilla*)
Black-and-white Warbler (*Mniotilta varia*)	Common Yellowthroat (*Geothlypis trichas*)
Worm-eating Warbler (*Helmitheros vermivorum*)	Yellow-breasted Chat (*Icteria virens*)
Ovenbird (*Seiurus aurocapilla*)	Chipping Sparrow (*Spizella passerina*)
Kentucky Warbler (*Oporornis formosus*)	Song Sparrow (*Melospiza melodia*)
Hooded Warbler (*Wilsonia citrina*)	Scarlet Tanager (*Piranga olivacea*)
Eastern Towhee (*Pipilo erythropthalmus*)	Indigo Bunting (*Passerina cyanea*)
Field Sparrow (*Spizella pusilla*)	Brown-headed Cowbird (*Molothrus ater*)
Northern Cardinal (*Cardinalis cardinalis*)	House Sparrow (*Passer domesticus*)
Red-winged Blackbird (*Aegelaius phoeniceus*)	Northern Bobwhite (*Colinus virginianus*)

[12] Much of the discussion related to avian and bat species is based upon communications with the U.S. Fish and Wildlife Service.

American Goldfinch (*Spinus tristis*)	Yellow-billed Cuckoo (*Coccyzus americanus*)
Mourning Dove (*Zenaida macroura*)	Wild Turkey (*Meleagris gallopavo*)
Woodcock (*Scolopax minor*)	Red-bellied Woodpecker (*Melanerpes carolinus*)

Among the many migratory birds likely to breed in the project area, there are six species that the USFWS has designated as Birds of Conservation Concern (BCC) within the Appalachian Mountains Bird Conservation Region (AMBCR). These include the Cerulean Warbler (*Dendroica caerulea*), Kentucky Warbler (*Oporornis formosis*), Swainson's Warbler (*Lymnothlypis swainsonii*), Worm-eating Warbler (*Helmitheros vermivorus*), Wood Thrush (*Hylocichla mustelina*), and the Louisiana Waterthrush (*Seiurus motacilla*). The first five of these are also designated as BCC species within the USFWS's Northeast Region as a whole and nationally (U.S. FWS 2008). The first four are also considered to be among the 100 most at-risk bird species in North America (Wells 2007).

The Louisiana Waterthrush, a neotropical migrant song bird, is considered an obligate headwater riparian songbird (an example of water-dependent wildlife) because its diet is comprised predominantly of immature and adult aquatic macroinvertebrates found in and alongside headwater streams and because it builds its nest in the stream banks. Breeding waterthrushes nest and forage primarily on the ground along medium- to high-gradient, first- to third-order, clear, perennial headwater streams flowing through closed-canopy forest. Good water quality is a key component of the species' breeding habitat. By these criteria, headwater streams like Pigeonroost Branch and Oldhouse Branch that support healthy macroinvertebrate communities provide excellent foraging and breeding habitat for species such as the Louisiana Waterthrush.

The West Virginia population of the Louisiana Waterthrush may serve as a source population within the species' breeding range. The Appalachian Mountain Bird Conservation Region (AMBCR), which extends from southeastern New York south to northern Alabama, is thought to support as much as 45 percent of the Louisiana Waterthrush's breeding population (Mattson and Cooper 2009, Smith, USFWS 2010, personal communication). West Virginia, the only state that lies entirely within the AMBCR, encompasses the largest contiguous area of high relative breeding abundance over the species' entire breeding range, based on North American Breeding Bird Survey (BBS) data from 1994-2003.

The Louisiana Waterthrush is also an area-sensitive species, requiring undisturbed forest tracts of at least 865 acres to sustain a population (Robbins, C.S., J.R. Sauer, R.S. Greenburg**,** and S. Droege. 1989). The most effective management protocol for the Louisiana Waterthrush includes the protection of forest tracts and water systems that it inhabits in its breeding range. The protection of moderate- to high-gradient headwater streams, which compose 75-80% of stream length in a typical watershed, is therefore of particular importance for this species.

Bird species that rely on mature forest habitats and that are on the Audubon watch list as declining species include the Swainson's Warbler, Kentucky Warbler, and Cerulean Warbler. According to the West Virginia Breeding Bird Atlas, all of these species are likely breeders in and around the project area (Buckelew and Hall 1994).

The Cerulean Warbler is considered to be particularly sensitive to landscape-level changes in habitat, more so than most other North American bird species. A canopy-foraging insectivorous neotropical migrant songbird, the Cerulean Warbler breeds in mature deciduous forests with broken, structurally diverse canopies across much of the eastern United States and winters in middle elevations of the Andes Mountains of northern South America. Robbins (1989) noted that Cerulean Warblers prefer large-blocks of mature interior forest habitat with tall trees and a dense upper canopy.

Important among a number of stressors to the Cerulean's breeding populations are the loss of mature deciduous forest, particularly along stream valleys, and the fragmentation and increasing isolation of remaining mature deciduous forest. The USFWS has designated the Cerulean Warbler a Species of Management Concern and a Species of Conservation Concern throughout its range. It has also been preliminarily designated by the Appalachian Mountains Joint Venture as a Species of Highest Conservation Priority within the Appalachian Mountains Bird Conservation Region, which encompasses West Virginia. The AMBCR is thought to support about 80 percent of the Cerulean Warbler's entire breeding population and as a comprehensive four-year study of the species' breeding population shows, West Virginia is an important source population for Cerulean Warblers (Rosenberg et al.2000).

The Acadian Flycatcher (*Empidonax virescens*) is another bird species that is primarily restricted to forested tracts with understory vegetation along small headwater streams. Acadian flycatchers feed primarily on emergent aquatic insects in riparian forest habitat like Spruce Fork and its tributaries. In addition, many other neotropical migrant songbird species are also often attracted to headwater streams for breeding areas because of the diversity of the habitat and the availability of emergent aquatic insects. Hence Appalachian headwater streams, like Pigeonroost Branch and Oldhouse Branch, support a wide array of sensitive bird species and are an important natural habitat for supporting these species' breeding populations.

IV.B.5. Bats & Other Mammals

Thirteen species of bats are found in West Virginia; and all of these species are insectivorous and either capture their prey by foraging in flight, catch flying insects from a perch, or collect insects from plants. Species that have potential to occur in the area of south-Central West Virginia that encompasses the Spruce No. 1 Mine include the Northern Bat (*Myotis septentrionalis*), Big Brown Bat (*Eptesicus fuscus*), Red Bat (*Lasiurus borealis*), Eastern Small-footed Bat (*Myotis leibii*), Virginia Big-eared Bat (*Corynorhinus townsendii virginianus*), Northern Long-eared Bats *(Myotis septentrionalis)* and the Indiana Bat (*Myotis sodalis*) (Table 7).

Both the Indiana Bat and Virginia Big-eared Bat are listed as endangered under the Endangered Species Act (ESA). The USFWS was also recently petitioned to list the Eastern Small-footed Bat and the Northern Long-eared Bat under the ESA. Both of these species have been documented in the Spruce No. 1 Mine project area. In 2004, five Eastern Small-footed Bats and 16 Northern Long-eared Bats were captured during mist net surveys conducted at the Spruce No. 1 Mine site, representing 7.6 and 24.2 percent, respectively, of all bats captured (U.S. Army Corps of Engineers Huntington District 2006, DEIS Spruce No. 1 Mine. Appendix M).

Indiana Bats are found over most of the eastern half of the United States. Between 1960 and 2001, biologists have documented a 56% population decline in Indiana Bats (Clawson 2002). Indiana Bats feed solely on emerged aquatic and terrestrial flying insects. They are habitat generalists and their selection of prey reflects the environment in which they forage. In a study in the Allegheny Mountains, activity in non-riparian upland forest and forests in which timber harvest had occurred was low relative to forested riparian areas (Owen et al. 2004). This evidence suggests that the forested riparian zones of the project area would be more suitable habitats for Indiana Bat populations than active or restored mining sites.

Mist net surveys were conducted in the project area in 2000 and 2004, and no federally listed bats were captured. Although the capture of bats confirms their presence, failure to catch bats does not absolutely confirm their absence (U.S. Fish and Wildlife Service 2007). The project area occurs roughly halfway between known hibernacula (shelters used for hibernation) in northeastern Kentucky and southeastern West Virginia. Since the most recent surveys at the Spruce No. 1 Mine site, maternity roosts have been documented in central and north-central Boone County within 15 miles of the project area (WVDNR 2010, USFWS 2005).

Table 7: List of potential mammal species occurring within permit area

hoary bat (*Lasiurus cinereus*)	Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)
eastern small-footed bat (*Myotis leibii*)	big brown bat (*Eptesicus fuscus*)
little brown bat (*Myotis lucifugus*)	silver-haired bat (*Lasionycteris noctivagans*)
Northern long-eared bat (*Myotis septentrionalis*)	eastern red bat (*Lasiurus borealis*)
Eastern pipistrelle bat (*Pipistrelle subflavus*)	evening bat (*Nycticeius humeralis*)
Indiana bat (*Myotis sodalist*)	Virginia big-eared bat (*Corynorhinus townsendii virginianus*)
tri-colored bat (*Perimyotis subflavus*)	showshoe hare (*Lepus americanus*)
woodland jumping mouse (*Napaeozapus insignis*)	raccoon (*Procyon lotor*)
deer mouse (*Peromyscus maniculatus*)	red fox (*Vulpes vulpes*)
gray fox (*Urocyon cinereoargenteus*)	bobcat (*Lynx rufus*)
mink (*Mustela vison*)	white-tailed deer (*Odocoileus virginianus*)
opossum (*Didelphis virginiana*)	eastern cottontail (*Sylvilagus floridana*)
muskrat (*Ondatra zibethicus*)	Appalachian cottontail (*Sylvilagus obscures*)
black bear (*Ursus americanus*)	white-footed mouse (*Peromyscus leucopus*)
striped skunk (*Mephitis mephitis*)	southern red-backed vole (*Clethrionomys gapperi*)
woodchuck (*Marmota monax*)	meadow vole (*Microtus pennsylvanicus*)

masked shrew (*Sorex cinereus*)	pine vole (*Microtus pinetorum*)
northern short-tailed shrew (*Blarina brevicauda*)	eastern chipmunk (*Tamias striatus*)
hairy-tailed mole (*Parascalops breweri*)	eastern gray squirrel (*Sciurus carolinensis*)
least Weasel (*Mustela nivalis*)	fox squirrel (*Sciurus niger*)
long-tailed weasel (*Mustela frenata*)	red squirrel (*Tamiasciurus hudsonicus*)
wild boar/ feral pig (*Sus scrofa*)	southern flying squirrel (*Glaucomys volans*)
american beaver (*Castor canadensis*)	

IV.C. Summary

Based on the foregoing information, EPA finds that Pigeonroost Branch and Oldhouse Branch contain high quality, important wildlife resources and habitat. EPA bases this conclusion on several factors including the similarity of macroinvertebrate communities in Pigeonroost Branch and Oldhouse Branch to the reference-quality White Oak Branch; the high-ranking mayfly and stonefly diversity, both within the Central Appalachian ecoregion and statewide; and the use of these streams and associated riparian ecotone by numerous salamander, bird, and mammal species. These streams support least-disturbed conditions and represent some of the last remaining high quality stream and riparian resources within the Headwaters Spruce Fork sub-watershed and the Coal River sub-basin.

V. Basis for Final Determination

V.A. Section 404(c) Standards

CWA § 404(c) provides

> The Administrator is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site, and he is authorized to deny or restrict the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever he determines, after notice and opportunity for public hearings, **that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas**. Before making such determination, the Administrator shall consult with the Secretary. The Administrator shall set forth in writing and make public his findings and his reasons for making any determination under this subsection. [emphasis added]

While EPA strongly prefers to initiate the § 404(c) process prior to issuance of a permit, § 404(c) and EPA's implementing regulations authorize EPA to initiate the § 404(c) process after a permit has been issued by withdrawing specification of a disposal site (See 40 CFR 231.1(a); see also definition of "withdraw specification," 40 CFR 231.2(a)). In this case, Pigeonroost Branch and Oldhouse Branch were specified as disposal sites in DA Permit No. 199800436-3.

§ 404(c) does not define the term "unacceptable adverse effect." EPA's regulations at 40 CFR 231.2(e) define "unacceptable adverse effect" as

> Impact on an aquatic or wetland ecosystem which is likely to result in significant degradation of municipal water supplies or **significant loss of or damage to** fisheries, shellfishing, or **wildlife habitat** or recreation areas. In evaluating the unacceptability of such impacts, consideration should be given to the relevant portions of the § 404(b)(1) Guidelines (40 CFR 230). [emphasis added]

V.B. Evaluation of Impacts

To evaluate the impacts of the Spruce No. 1 Mine, EPA has reviewed the DA Permit No. 199800436-3 (Section 10: Coal River), the Spruce No. 1 Mine EIS, the PEIS, peer-reviewed literature, and available data documenting impacts from similar projects. In addition, EPA communicated with the US Fish and Wildlife Service on impacts to fish and wildlife resources in the project area. EPA also has examined impacts caused by the portion of the Spruce No. 1 Mine that has already been constructed in the Seng Camp Creek watershed (specifically, Valley Fill 1A). In addition, EPA reviewed the nearby Mingo Logan Dal-Tex operation. The data indicate that for the most part, the formations are repeated from the Dal-Tex mine complex to the proposed Spruce No. 1 mine location and all of the formations in the Dal-Tex complex that had in the past showed high

selenium levels and have led to environmental releases are present at the Spruce No. 1 Mine. EPA is, therefore, on sound technical footing to use existing data from the Dal-Tex complex as a basis to predict what may happen when mining occurs at Spruce No. 1 Mine. This was acknowledged by the Corps in the Spruce No. 1 EIS, which stated "[t]he past and present impacts to topography, geology, and mineral resources of the previous mining along the western side of Spruce Fork are similar to the anticipated impacts of the Spruce No. 1 Mine, as mining is to occur in the same strata."

EPA completed a review of rock cores and corresponding cross sections for the Dal-Tex mines including the Gut Fork mine, which lies immediately to the west across Spruce Fork from Spruce No.1 (Figure 8) and compared them to those from the Spruce No. 1 Mine. This review, which is set forth in Appendix 4, indicates that the formations are essentially repeated from the Dal-Tex mine complex to the Spruce No. 1 Mine location. According to the EIS, the same coal beds are to be developed for the Spruce No. 1 Mine as for the Dal-Tex mine. These coal bed sequences are also similar to those described in the literature for southern West Virginia coal bed sequences and the geologic column for the Spruce No. 1 Mine.

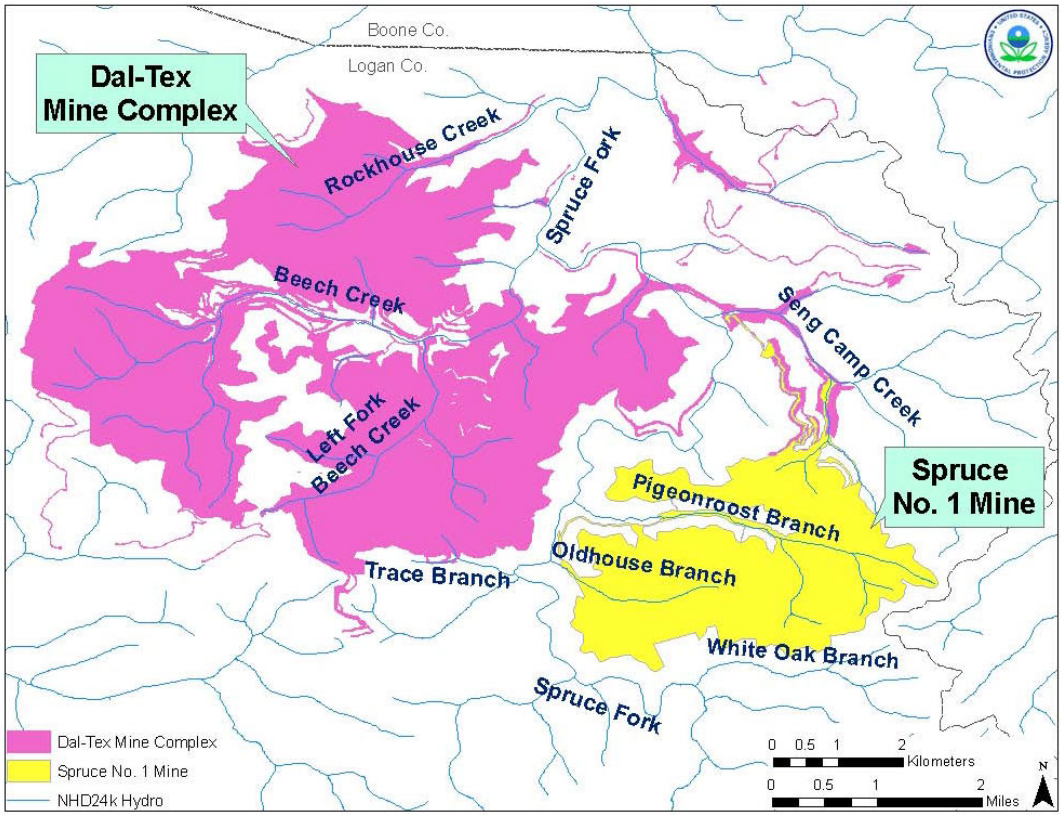

Figure 8. Spruce No. 1 Mine and the Dal-Tex Mine Operation

V.C. Unacceptable Adverse Impacts on Wildlife within the Spruce No. 1 Mine Project Area

The unacceptable adverse impacts from the specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for the discharge of dredged or fill material from the Spruce No. 1 Mine will occur through several different pathways. This section discusses the direct impacts to wildlife and wildlife habitat.

Direct impacts will occur as a result of the discharges of dredged or fill material from the construction of valley fills and sediment ponds that will bury much of Pigeonroost Branch and Oldhouse Branch, including all wildlife living in these streams, their tributaries, and associated riparian areas. Burial of Pigeonroost Branch and Oldhouse Branch also will eliminate habitat for wildlife that depend upon those streams. The loss of these portions of Pigeonroost Branch and Oldhouse Branch will also adversely impact wildlife within this watershed that depend on headwater streams for all or part of their life cycles.

Construction of valley fills and other discharges of dredged or fill material associated with the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch will result in a significant loss of wildlife habitat. The direct effects of the Spruce No. 1 Mine, as authorized, include permanent placement of fill in approximately 6.6 miles of stream in Pigeonroost Branch and Oldhouse Branch. Based on stream information from the National Hydrography Dataset, this loss represents 5.6% of the total stream length in the Headwaters Spruce Fork sub-watershed. The destruction of 6.6 miles of high quality stream habitat in a watershed where there is little remaining high quality stream habitat, and the subsequent loss of many populations of macroinvertebrates, salamanders, fish and other wildlife dependent upon that aquatic habitat area for survival, including water-dependent birds, will result in a loss of regional biodiversity and the broader ecosystem functions these populations provide.

V.C.1. Macroinvertebrates

Construction of valley fills and other discharges of dredged or fill material authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will impact the native macroinvertebrate community directly through loss of stream habitat as a result of fill. Because the macroinvertebrate assemblages in these streams represent least-disturbed conditions within the Coal River sub-basin, the loss of these communities and their habitat will adversely impact regional native biodiversity.

As set forth in Section IV.B.1. above, benthic macroinvertebrates are diverse and healthy in the Spruce No. 1 Mine area and represent an important component of the aquatic community in Pigeonroost Branch and Oldhouse Branch. Also, direct burial of these populations will likely affect food webs and the processing and transfer of energy and nutrients downstream. As primary consumers, macroinvertebrates play an important role in the breakdown of organic matter, allowing for the transport of fine particulate organic matter to downstream organisms, and converting algal and terrestrial plant matter into energy (biomass). Invertebrates are at the base of the faunal food web, and thus they also play a critical role in the delivery of energy and nutrients to downstream reaches (in aquatic life stages) as well as to upland terrestrial habitats (in winged adult life stages), most notably through food web pathways.

V.C.2. Salamanders & Other Herpetofauna

As stated in IV.B.2., the Central Appalachian ecoregion has one of the highest concentrations of salamander fauna in the world. Impacts from the activities authorized will have a significant adverse impact on this form of wildlife located within the project area. Based on literature values (Williams 2003) for mean densities within reference reaches of Pigeonroost Branch, Bend Branch (another tributary of Spruce Fork), and Ash Fork (a tributary of Gauley River) and a 2004 USFWS study in White Oak Branch, EPA estimates aquatic salamander density in Pigeonroost Branch and Oldhouse Branch at approximately 5-6 individuals per square meter along stream channels. The loss of this density over 6.6 miles of stream reflects a substantial loss.

It is not expected that stream salamanders will return to the site due to the burial of their existing habitat. Gingerich (2009) found no expected stream salamanders inhabiting 3-20 year-old sedimentation ditches (5 out of 5 mines) in West Virginia mountaintop mining areas. Furthermore the USFWS has indicated that, to its knowledge, it has not been demonstrated that salamanders return to mined areas at densities similar to those that occurred prior to mining. USFWS also indicated that while range-wide populations of common species may not be significantly impacted, the salamander communities in individual headwater systems behave essentially as isolated populations because there is limited interaction (immigration and emigration) with communities in adjacent watersheds (personal communication with Dr. Thomas Pauley, Marshall University and with Jim Zelenak USFWS West Virginia Field Office).

Because salamanders represent the main vertebrate predator in these headwater streams, and will be eradicated under the project, EPA believes that a key component of the aquatic food web will be lost or significantly reduced from the ecosystem within Pigeonroost Branch and Oldhouse Branch portions of the Spruce No. 1 Mine area. Additionally, the loss of these salamanders will have broader food web implications, as they also serve as prey for numerous terrestrial and aquatic species found within the Spruce No. 1 Mine site, including fish, snakes, birds, mammals, turtles, frogs, crayfish and other salamanders (Davic and Welsh 2004).

V.C.3. Fish

Pigeonroost Branch and Oldhouse Branch are considered least-disturbed streams within the Coal River sub-basin, and as such, they have good water quality and support good quality fish assemblages. While these assemblages have a naturally low diversity, consistent with low order headwater streams within the Coal River sub-basin, they are healthy and productive. Construction of valley fills and other discharges of dredged or fill material authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will lead to the total loss of over six miles of high quality, least-disturbed in-stream habitat and thus the total loss of five naturally occurring fish populations within the project area. Fish species that will be directly impacted include blacknose dace, creek chub mottled sculpin, stonerollers and smallmouth bass. Moreover, the permitted fill will reduce the

habitat available for fishes within the watershed that use these streams as refugia and seasonal foraging or spawning habitat, including smallmouth bass. Additionally, species like the mottled sculpin, a bottom-dwelling species that has a restricted home range, have a low dispersal rate, which makes it more difficult for them to recolonize an area following disturbance.

V.C.4. Water-dependent Birds

The Spruce No. 1 Mine will impact the Louisiana Waterthrush, a water-dependent bird that requires forested headwater streams for foraging on insects and nesting, by eliminating the headwater areas associated with Pigeonroost Branch and Oldhouse Branch. The Louisiana Waterthrush has been designated by USFWS as a Bird of Conservation Concern (BCC) within the Appalachian Mountains Bird Conservation Region (AMBCR) because of potential impacts from surface coal mining activities.

According to USFWS, the Louisiana Waterthrush is an area-sensitive riparian-obligate species that nests and forages along headwater streams of intact interior forests. Because it requires riparian woodland habitat to forage for macroinvertebrates along streams, approximately 6.6 miles of Louisiana Waterthrush stream and riparian habitat will be lost due to fill being placed in Pigeonroost Branch and Oldhouse Branch and their tributaries. For water-dependent birds like the Louisiana Waterthrush, preservation of large tracts of forest containing headwater streams is needed for the conservation of this species in the central Appalachians. The Waterthrush is particularly vulnerable to degradation of water quality and aquatic insect communities (Mattsson and Cooper 2006, Mulvihill et al. 2008).

V.C.5. Summary

Pigeonroost Branch and Oldhouse Branch and their tributaries are some of the last remaining streams within the Headwaters Spruce Fork sub-watershed and the larger Coal River sub-basin that represent “least-disturbed” conditions and habitat that is essential for many species in the watershed. As such, they perform critical hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role within the context of the overall Headwaters Spruce Fork sub-watershed and Coal River sub-basin. Within the streams and riparian areas of the project area, over 84 taxa of macroinvertebrates are documented to exist, as well as up to 46 species of reptiles and amphibians, 4 species of crayfish, 5 species of fish and at least one water-dependent bird species.

Construction of valley fills, sediment ponds, and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) will eliminate the headwater stream ecosystems in Pigeonroost Branch and Oldhouse Branch. The direct impacts to these headwater stream systems, through burial of these diverse and healthy wildlife communities and their habitat, will result in unacceptable adverse effects on wildlife, particularly to macroinvertebrate, amphibian, fish, and water-dependent bird populations. Through the loss of stream macroinvertebrate and salamander communities, there will be,

in turn, substantial effects to both aquatic and terrestrial vertebrate populations that rely on these communities as a food source.

In the preamble to EPA's final rules implementing § 404(c), EPA stated "[t]he term 'unacceptable' in EPA's view refers to the significance of the adverse effect -- e.g. is it a large impact and is it one the aquatic and wetland ecosystem cannot afford" (44 FR at 58078). The filling in and complete destruction of the 6.6 miles of streams at issue here is a large impact and clearly adverse to the wildlife that will be buried under thousands of tons of excess spoil. These adverse impacts are particularly large in context of the evidence that these streams are some of the last, rare and important high quality streams in the watershed. That context also leads EPA to the conclusion that this adverse impact is one that the aquatic ecosystem cannot afford. Based on this information, EPA has concluded that the discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) will have unacceptable adverse effects on wildlife in Pigeonroost Branch and Oldhouse Branch.

V.D. Unacceptable Adverse Impacts on Wildlife Downstream of the Discharge of Dredged or Fill Material from the Spruce No. 1 Mine

Unacceptable adverse impacts will also occur to wildlife downstream of the footprint of the fills and sediment ponds. These unacceptable adverse impacts will be caused by removing Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution and converting them to sources of pollution. Water quality downstream of valley fills and in sediment ditches in mined areas is typically degraded due to high concentrations of solutes, primarily because it has percolated through mine spoil. Mine spoil, made up of fragmented mine rocks, has higher rates of rock weathering than bedrock because of its exposure to air and water, and percolation of water through these exposed rocks leads to increased concentrations of solutes, including total dissolved solids and selenium, in downstream receiving waters. In turn, this will adversely affect the delivery of headwater stream ecosystem functions to downstream waters. Studies have shown a strong correlation between the construction of valley fills for surface coal mining in Appalachia and significant adverse impact on downstream macroinvertebrate communities.

EPA believes that the discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch will transform those areas into sources of contaminants (particularly TDS and selenium) contributing to degradation of downstream waters. The project as authorized also will create areas of pooled water and increased conductivity, both of which are among the conditions known to be necessary to support harmful blooms of golden algae.

V.D.1. Increases in Pollutants Harmful to Wildlife

This section identifies increased loads of selenium and TDS (measured as conductivity) that are expected to occur as a result of the discharges of coal overburden as authorized and the unacceptable adverse impacts to wildlife that will occur as a result of these increases. These impacts to water chemistry are identified because they will adversely

affect the native aquatic and water-dependent wildlife communities in the Spruce Fork watershed as discussed further below.

V.D.1.a. Selenium

Discharges from the Spruce No. 1 Mine Complex project are expected to increase selenium loading to the immediate receiving streams and downstream waters. Selenium (Se) is a naturally occurring chemical element that is an essential micronutrient, but can also have toxic effects following exposure to excessive amounts. For aquatic animals, the concentration range between essential nutrient and toxin is very narrow, being only a few micrograms per liter in water. Adverse impact of selenium residues in aquatic food chains results not just from the direct toxicity to the organisms themselves, but also from the dietary source of selenium these organisms contribute to fish and wildlife species in the food web that feed on them.

Selenium toxicity is primarily manifested as reproductive impairment and birth defects due to maternal transfer, resulting in embryotoxicity and teratogenicity in egg laying vertebrates (e.g., fish and ducks). The most sensitive toxicity endpoints in fish larvae are teratogenic deformities such as skeletal, craniofacial, and fin deformities, and various forms of edema. Embryo mortality and severe development abnormalities can result in impaired recruitment of individuals into populations (Chapman et al. 2009). The State of West Virginia has established a numeric chronic water quality criterion for selenium (5 μg/L four-day average not to be exceeded more than once every three years) to protect in-stream aquatic life. EPA's conclusion that the Spruce 1 Mine as authorized would cause unacceptable adverse effects on wildlife is not dependent on a conclusion that West Virginia's water quality standards will be violated at or downstream of the site. Rather, reference to this water quality standard provides information and context.

In West Virginia, coals that contain the highest selenium concentrations are found in a region of south-central West Virginia where the Allegheny and Upper Kanawha Formations of the Middle Pennsylvanian are mined (WVGES 2002). The WVDEP reports that some of the highest coal selenium concentrations are found in the central portion of the Coal River sub-basin in the immediate vicinity of the Spruce No. 1 Mine where significant active mining and selenium impaired streams are located. Selenium is discharged when selenium-bearing material exposed by surface mining activities comes in contact with water and contaminated water drains from the mining area to surface waters. The sediment ponds that are the usual form of water treatment at mining sites generally are not effective at treating selenium before effluent is discharged from ponds to downstream waters. The coal beds to be targeted by the Spruce No. 1 Mine include 5-Block of the Allegheny Group and down to the Upper Stockton coal bed in the eastern portion of the project area. In the western portion of the project area, the mine plan includes extraction of coal through the Middle Coalburg coal bed. These coal beds are rich in Se as evidenced by Se distribution data in the Spruce No. 1 column (DT0417) provided by the applicant for the NPDES permit application.

Total Maximum Daily Loads to address impairment from elevated concentrations of selenium have been developed for six other streams affected by mining in the Coal River sub-basin. These include nearby White Oak Creek, a tributary to the Coal River, the left Fork of White Oak Creek, Seng Creek, also a tributary to the Coal River; and Casey Creek, James Creek, and Beaver Pond Branch, all tributaries to Pond Fork. These elevated levels of selenium demonstrate that the geology in the vicinity of the Spruce No. 1 Mine will release selenium during mining activities. See Appendices 1 and 4 for further details.

To evaluate the impact of discharges into Pigeonroost Branch and Oldhouse Branch as authorized by the DA permit, EPA has compared selenium levels in Pigeonroost Branch and Oldhouse Branch with selenium levels in waters that have been impacted by the nearby Dal-Tex operation.[13] In addition, EPA has reviewed data from a mining outlet that drains, among other things, discharges from a portion of the Spruce No. 1 Mine that has been constructed in the Seng Camp Creek watershed (Figure 9).

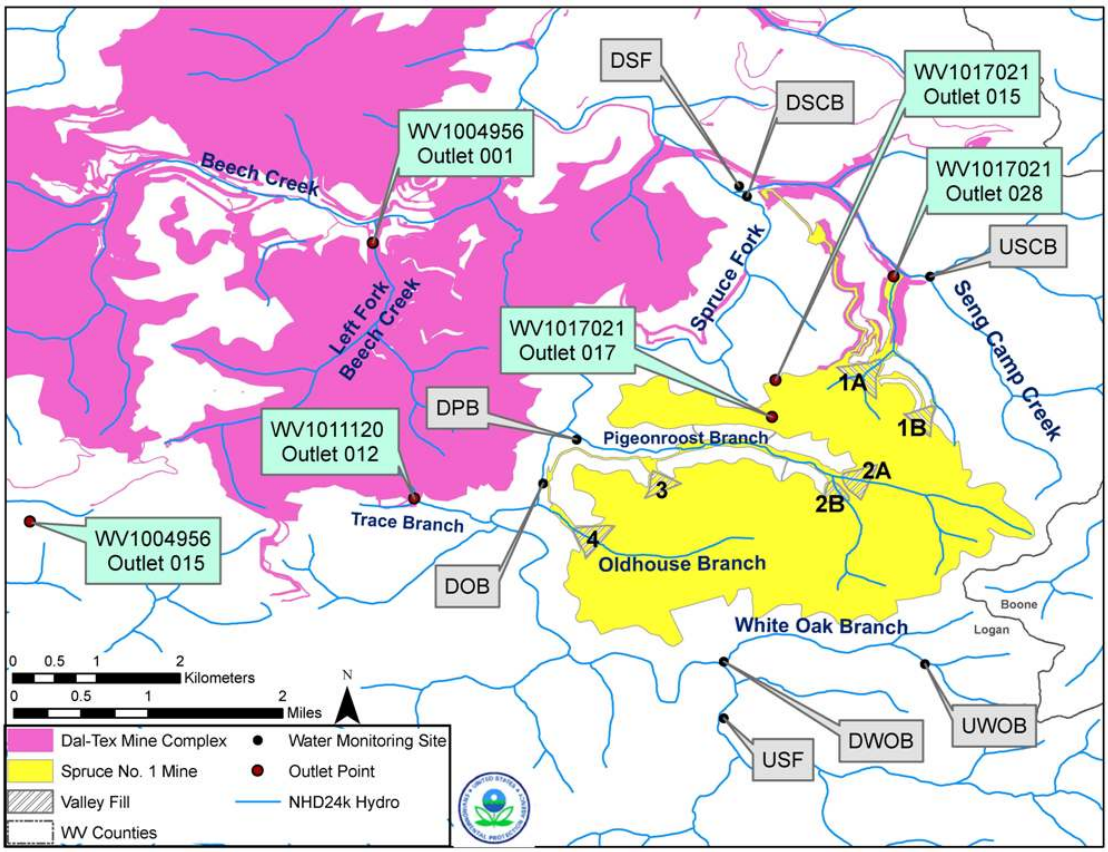

Figure 9. Spruce No. 1 Mine and the Dal-Tex Mine Outlet Locations

[13] Levels of selenium in other nearby waters that have been impacted by surface coal mining activity and generally have similar geology also support a prediction that construction of the Spruce No. 1 Mine as currently authorized will result in elevated levels of selenium in downstream waters.

EPA scientists completed a review of rock cores and corresponding cross sections for the Dal-Tex mines including the Gut Fork mine compared to the Spruce No. 1 Mine. For the most part, the formations are repeated from the Dal-Tex mine complex to the Spruce No. 1 Mine location. Table 8 provides a summary of selenium averages and ranges for Pigeonroost Branch and Oldhouse Branch and streams draining the nearby Dal-Tex operation (Left Fork Beech Creek, Beech Creek, and Trace Branch). The table also contains data for White Oak Branch (upstream of Spruce No. 1 Mine) and Seng Camp Creek (prior to 2007, when the DA permit was issued and filling associated with Spruce No. 1 commenced in that watershed). Summarizing the data in the following table, streams draining the nearby Dal-Tex operation have selenium concentrations in excess of 5 µg/L.

Table 8. Selenium Concentrations (µg/L) near Spruce No. 1 Mine

Stream Name	Sub-basin	Source and time period of data					
		PEIS (2000-2001)		WVDEP (2002-2003)		WVDEP (2005-2007)	
		Se (Avg.)	Se (Range)	Se (Avg.)	Se (Range)	Se (Avg.)	Se (Range)
Average and Range of Se in Tributaries to Spruce Fork that drain Spruce No. 1 Mine area							
White Oak Branch	Spruce Fork	<3 ND		<5 ND		NS	
Oldhouse Branch	Spruce Fork	<3 ND		<5 ND		NS	
Pigeonroost Branch	Spruce Fork	<3 ND		<5 ND		NS	
Seng Camp Creek	Spruce Fork	NS		<5 ND		NS	
Average and Range of Se in Tributaries to Spruce Fork draining Dal-Tex Operation							
Beech Creek[14]	Spruce Fork	7.5	5.6-9.5	6	5.0-9.0	12.3	6.0-22.0
Left Fork of Beech Creek	Spruce Fork	22.7	15.3-31.1	22	5.0-53.0	NS	
Trace Branch	Spruce Fork	NS	NS	7	5.0-10.0	NS	
Rockhouse Branch	Spruce Fork	5.3	3.8-8.0	< 5 ND	< 5 ND	NS	

ND: Se not detected. Detection limit shown.
NS: Not sampled. Stream was not sampled for the study shown.

The data from the Dal-Tex mine complex do not indicate any decrease in selenium concentrations over a period of several years. These data strongly suggest the construction of valley fills and other discharges of dredged or fill material (e.g., associated sediment ponds) from the Spruce No. 1 Mine into Pigeonroost Branch and

[14] In the WVDEP study on selenium bioconcentration factors, selenium was also found in fish tissue in Beech Creek (average 7.55 mg/kg).

Oldhouse Branch will result in elevated levels of selenium in the receiving waters, and lead to degradation of water quality of the receiving and downstream waters. EPA believes such degraded water quality will impact wildlife populations in the receiving and downstream waters, including fish populations.

Graphical trends of selenium concentrations from Discharge Monitoring Report (DMR) records for January 2007 to June 2010 from three outfalls from the Dal-Tex Mine operations demonstrate that the discharges from those outfalls consistently exceed 5 µg/L (Figures 10, 11 and 12).

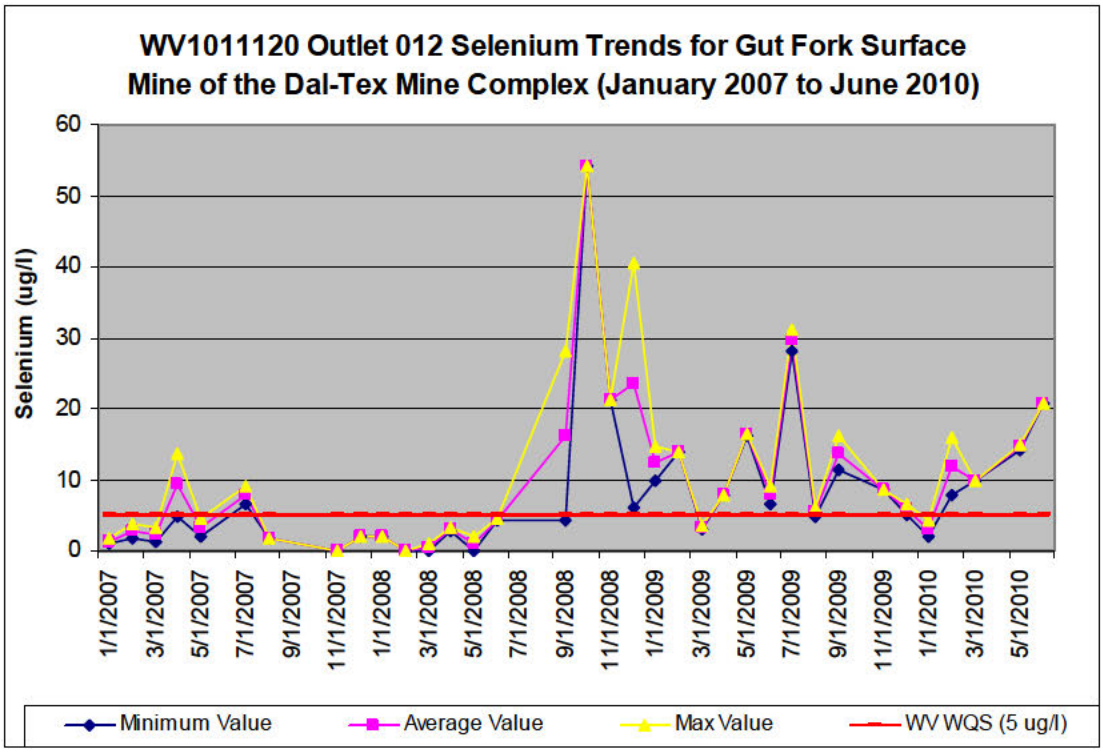

Figure 10. Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1011120 – Outlet 012 (Mingo Logan Coal Company's Gut Fork Surface Mine of the Dal-Tex Mine Complex)

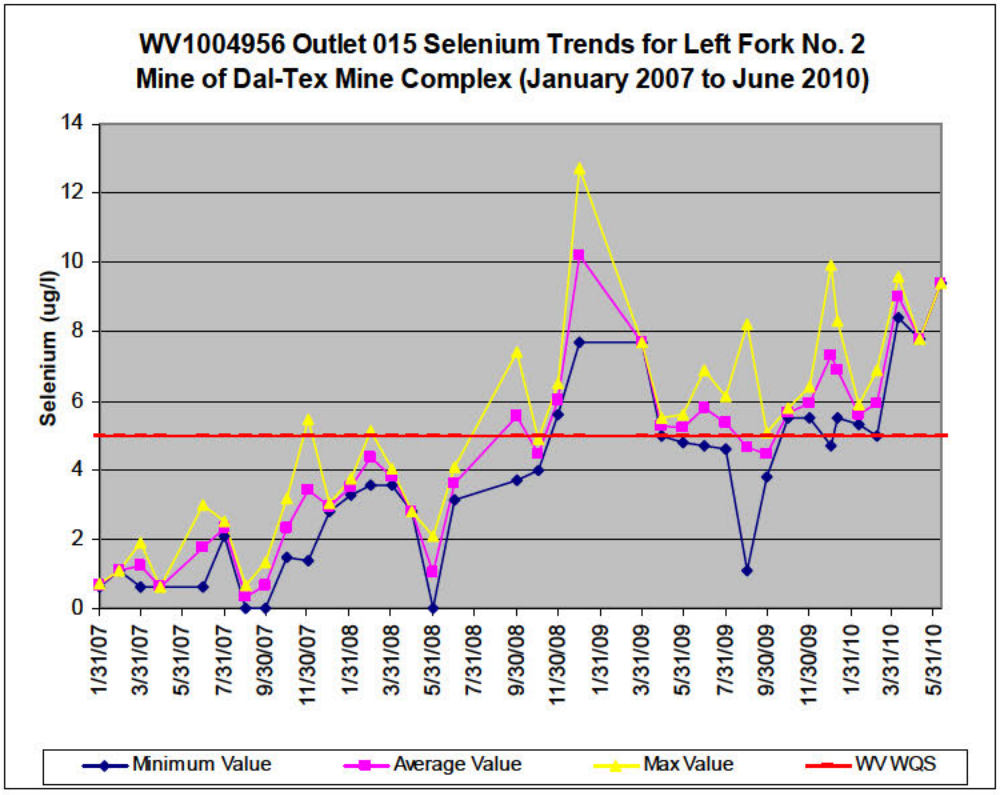

Figure 11. Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1004956 – Outlet 015 (Mingo Logan Coal Company's Left Fork No. 2 Mine of the Dal-Tex Mine Complex)

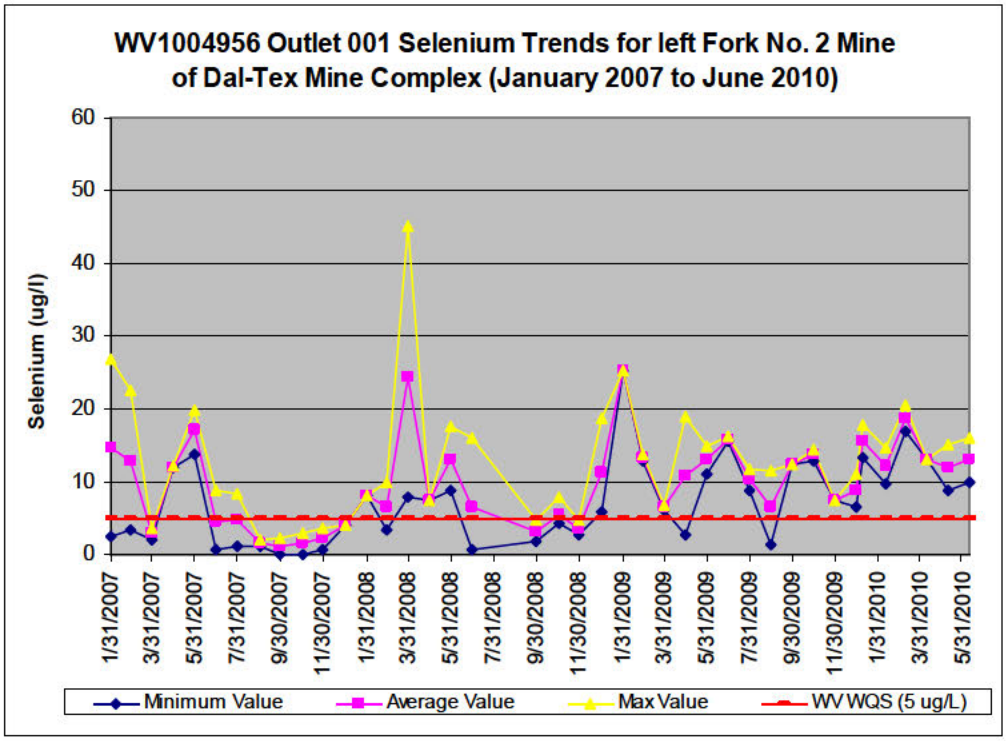

Figure 12. Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1004956 – Outlet 001 (Mingo Logan Coal Company's Left Fork No. 2 Mine of the Dal-Tex Mine Complex)

EPA also reviewed data from the portion of the Spruce No. 1 Mine that is already operational in Seng Camp Creek (Figure 13), including active mining activities in the Right Fork of the Seng Camp Creek sub-watershed. Recent NPDES discharge monitoring reports (DMRs), submitted by the permittee, over a 16-month period (December 2008 to September 2010) show that Outfall 028, which handles, among other things, discharges from Valley Fill 1A, is discharging selenium at average monthly concentrations above 5 µg/L (Table 9, Figure 13).[15] It is also noted that the September 2009 value from Outfall 017 also is elevated. These data support EPA's prediction that construction of valley fills in Pigeonroost Branch and Oldhouse Branch will result in discharges of elevated levels of selenium.

Table 9. Total Recoverable Selenium (µg/L) for Outfalls 015, 017 and 028 for NPDES Permit WV1017021, Mingo Logan Coal Company Spruce No. 1 Mine. Note: Shaded areas indicate selenium concentrations exceeding 5 µg/L.

Site Code	Site Location	Report Date	Min Value	Avg. value	Max value
015	Outlet 015	12/31/2008	0.00	0.00	0.00
017	Outlet 017	12/31/2008	0.00	0.00	0.00
017	Outlet 017	9/30/2009	19.20	19.20	19.20
028	Outlet 028	12/31/2008	5.70	5.70	5.70
028	Outlet 028	1/31/2009	9.80	9.80	9.80
028	Outlet 028	2/28/2009	3.90	3.90	3.90
028	Outlet 028	3/31/2009	0.60	1.00	1.40
028	Outlet 028	4/30/2009	1.70	1.70	1.70
028	Outlet 028	5/31/2009	2.50	2.50	2.50
028	Outlet 028	6/30/2009	3.20	3.30	3.40
028	Outlet 028	8/31/2009	1.25	3.48	5.70
028	Outlet 028	9/30/2009	4.60	6.05	7.50
028	Outlet 028	10/31/2009	3.00	3.00	3.00
028	Outlet 028	11/30/2009	1.40	1.85	2.30
028	Outlet 028	12/31/2009	1.80	1.85	1.90
028	Outlet 028	1/31/2010	3.40	3.80	4.20
028	Outlet 028	2/28/2010	3.80	4.50	5.20
028	Outlet 028	3/31/2010	4.70	6.10	7.50
028	Outlet 028	4/30/2010	3.8	4.40	5.00
028	Outlet 028	5/31/2010	4.70	7.60	10.50
028	Outlet 028	6/30/2010	11.40	11.50	11.60
028	Outlet 028	7/31/2010	6.40	8.50	10.40
028	Outlet 028	8/31/2010	4.80	10.65	14.80
028	Outlet 028	9/30/2010	4.80	9.40	11.00

[15] While Outfall 028 receives discharges from other portions of the site, it handles the discharges from valley fill 1A. EPA notes that WVDEP sampling from 2002-2003 (prior to construction of Spruce No. 1 Mine in Seng Camp Creek) found selenium levels in Seng Camp Creek to be below detection levels.

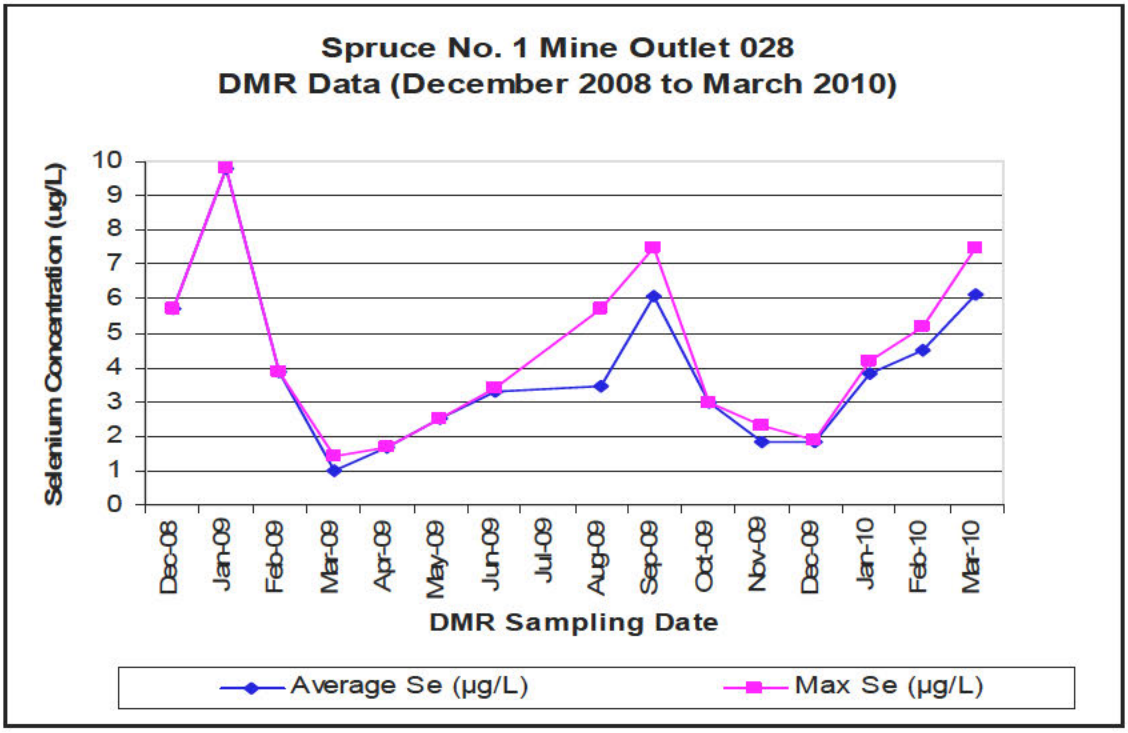

Figure 13. Selenium concentrations in discharge from outlet 028.

In addition to discharges of elevated concentrations of selenium, the project also will have the effect of increasing selenium concentrations in downstream waters by removing Pigeonroost Branch and Oldhouse Branch as sources of dilution that moderate downstream selenium concentrations. EPA evaluated the in-stream DMR monitoring data from December 2008 to March 2010 from several ambient monitoring stations associated with the Spruce No. 1 mine as authorized project: Stations DSCB (Downstream Seng Camp Creek, located at the mouth of Seng Camp Creek), USCB (Upstream Seng Camp Creek), USF (Upstream Spruce Fork), DSF (Downstream Spruce Fork, located downstream of Seng Camp Branch), DPB (downstream Pigeonroost Branch, at mouth of Pigeonroost Branch) and DOB (Downstream Oldhouse Branch, at mouth of Oldhouse Branch). As explained below, this analysis shows that Pigeonroost Branch and Oldhouse Branch are providing dilution that is helping to maintain reduced selenium concentrations in Spruce Fork.

The Spruce Fork watershed upstream of Pigeonroost Branch and Oldhouse Branch (Station USF) has average monthly selenium concentrations ranging from 0.9 µg/L to 10.90 µg/L (August 2010), with nine monthly average concentrations greater than 5 µg/L based on the in-stream DMR data for the December 2008 to September 2010 time period. It should be noted that the last 6 months of available DMR data (April 2010 to September 2010) for USF had monthly selenium concentrations above the 5 µg/L potentially indicating new selenium contamination sources. The downstream Spruce Fork (DSF) site has concentrations that are significantly lower, and does not have any average monthly selenium concentrations above 5 µg/L, with the highest monthly average selenium concentration during the time period (December 2008 to September 2010) being 2.50 µg/L (May 2010). This suggests that Pigeonroost Branch and Oldhouse

Branch (along with other tributaries that enter Spruce Fork between the monitoring stations) provide clean dilution water to the main stem of Spruce Fork. This conclusion is supported by the very low levels of selenium in Pigeonroost Branch and Oldhouse Branch. During the same December 2008 to September 2010 time frame, the DMR reports indicate almost all of the average monthly selenium measurements at both Pigeonroost Branch and Oldhouse Branch were below the detection limit of 0.6 µg/L. The single detection of selenium during the time period in Oldhouse Branch was 0.9 µg/L during July 2009 (a maximum value). All monthly average selenium concentrations in Pigeonroost Branch were below the detection limit from December 2008 through June 2010 except the monthly average in August 2009 which had a value of 1.3 µg/L (maximum value was 1.9 µg/L). However, the monthly average selenium concentrations for the July 2010 to September 2010 time period documented a developing selenium problem in Pigeonroost Branch. The monthly average selenium concentration in July 2010 was 2.7 µg/L, August 2010 was 2.6 µg/L and September 2010 was 1.4 µg/L.

By way of example, the average monthly selenium concentration at the USF monitoring location for the month of April 2010 is reported on the DMR as 10.60 µg/L. The average monthly concentration at the DSF location for April 2010 is reported on the DMR as 0.90 µg/L. For April 2010, the DMR reports average monthly selenium concentrations at Pigeonroost Branch and Oldhouse Branch as below the detection level of 0.60 µg/L. While Pigeonroost Branch and Oldhouse Branch are not the only contributing tributaries between the USF and DSF stations, this data strongly suggests that they are contributing dilution.

In summary, water quality from streams and discharges draining both the Dal-Tex Mine Complex and the current operational portions of the Spruce No. 1 Mine confirm EPA's concern that the Spruce No. 1 Mine, if constructed as authorized, would contribute additional loads of selenium to downstream waters at concentrations that, as a monthly average, will exceed 5 µg/L.

V.D.1.b. Total Dissolved Solids

To understand the water quality impacts from increased total dissolved solids (TDS), it is helpful to understand the relationship between salinity, TDS, and specific conductivity. For purposes of this action, when this document discusses increased conductivity or TDS, it refers to an increase in salinity in otherwise dilute freshwater, an increase that is inconsistent with background levels in central Appalachian streams.

Salinity is the amount of dissolved salt in a given body of water. TDS is a measure of the combined content of all inorganic and organic substances contained in a solution in molecular, ionized or micro-granular (colloidal) suspended form and is normally reported in the unit mg/l. Because the majority of TDS in many waters consist primarily of salts, salinity effectively reflects the amount of TDS in water.

Salinity is often expressed in terms of specific conductivity (hereafter referred to as conductivity). Conductivity is the ability of a solution to carry an electric current at a

specific temperature (normally 25º C) and is normally reported as microsiemens per centimeter (µS/cm). Whereas "salinity" refers to the environmental property that is being measured, "conductivity" refers to the *measure* of salinity. Conductivity and TDS both increase as the concentration of ions in a solution increase and are very strongly correlated. Conductivity itself is not a pollutant, but is an excellent indicator of the total concentration of all ions, and is typically reported by state and federal monitoring agencies because it is an instantaneous measurement that can be collected in situ with a meter, does not require a laboratory analysis, and is precise and accurate.

Data from the WVDEP indicate that average conductivity values for Pigeonroost Branch and Oldhouse Branch are very low and are consistent with dilute background conditions in central Appalachian headwater streams. Construction of valley fills and other discharges of dredged or fill material from the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch will cause an increase in conductivity and TDS in those receiving waters downstream of such discharges. These discharges will have two effects: first, they will eliminate Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution to downstream waters, including Spruce Fork; and second, they will transform Pigeonroost Branch and Oldhouse Branch into sources of increased conductivity and TDS to downstream waters. Sediment ponds, which are a typical form of water treatment for surface coal mines, appear to be ineffective in removing TDS and decreasing conductivity. For example, average conductivity and sulfate levels are highly elevated in other tributaries to Spruce Fork where historical mining has occurred compared with Pigeonroost Branch and Oldhouse Branch (Table 10) (see Appendix 1).

Table 10. Average conductivity and sulfate values for streams in project area

Stream	**Conductivity Values (µS/cm)**	**Sulfate Values (mg/l)**
Rockhouse Creek	1012	407
Left Fork of Beech Creek	2426	1019
Beech Creek	1432	557
Trace Branch	971	569
Oldhouse Branch	90	28
Pigeonroost Branch	199	99

Average conductivity and sulfate concentrations in the main stem of Spruce Fork into which Pigeonroost Branch and Oldhouse Branch flow are elevated to as much as ten times above natural background levels in Oldhouse Branch. Average conductivity at almost every monitoring site on the main stem Spruce Fork exceeded 500 µS/cm. Only one site had an average conductivity of less than 500 µS/cm, which was located upstream of the project area, upstream of Adkins Fork, and southeast of Blair, WV.

EPA expects that these additional conductivity increases will have significant adverse effects on native aquatic macroinvertebrates and other wildlife that are not tolerant to increased conductivity. Invertebrate health depends upon an organism's ability to maintain certain concentrations of ions in their blood and tissues, which they pull from the water via specialized cells on their gills and body surfaces and lose through

defecation/urination and diffusion. Native headwater invertebrates are adapted to streams with low dissolved solids (i.e., conductivity). In Central Appalachian surface coal mining, the ionic mixture emanating from valley fills is fairly predictable, and tends to be alkaline or circumneutral (pH 5.5-7.4), have highly elevated concentrations of four major ions (SO_4, HCO_3, Mg, Ca) and have only slightly elevated concentrations of K, Na, and Cl. Elevated levels of ions can be individually toxic, but mixtures of these ions can be more toxic than the individual ions, since more than one ion is a potential toxicant. Elevated ion concentrations can also create a general osmoregulatory stress on organisms that are adapted to environments with low dissolved solids (i.e., conductivity) (Pond et al. 2008). Elevated conductivity can have a toxic effect because the ions, regardless of type, can overwhelm the respiratory system and other physiological processes leading to impaired breathing, dehydration, and decreased survival or reproduction. Thus, native Appalachian taxa adapted to naturally dilute streams can be harmed by elevated conductivity for these physiological reasons. See Appendix 1 for further detail on water quality and wildlife.

EPA modeled post-mining conductivity levels in Spruce Fork downstream of the project area using a watershed area weighted deterministic model with two post-mining average (500 and 1000 µS/cm) and maximum (1000 and 1500 µS/cm) conductivity values for Oldhouse Branch, Pigeonroost Branch and Seng Camp Creek. These values likely underestimate the post-mining conductivity values. For example, when compared to Left Fork Beech Creek, which is completely mined and filled, the average and maximum conductivity values are 2425 and 3000 µS/cm respectively. In Beech Creek, which is partially mined and filled, the respective average and maximum conductivity values are 1432 and 1776 µS/cm based on 2002-2003 WVDEP data. In every case, since the measured average and maximum conductivity levels in Spruce Fork are currently greater than 500 µS/cm pre-mining, the modeled post-mining conductivity values are also greater than 500 µS/cm. When using the maximum post-mining values identified above, EPA predicts that average conductivity in Spruce Fork downstream of Seng Camp Creek could increase from 552 µS/cm pre-mining to 748 µS/cm post-mining and maximum conductivity could increase from 960 µS/cm pre-mining to 1228 µS/cm post-mining.

Thus, EPA has determined that that the construction of the Spruce No. 1 Mine will cause changes to water quality downstream of the mine site, particularly with regard to selenium and total dissolved solids. The following subsections discuss the adverse impacts on specific fauna caused by these changes in water quality.

V.D.2. Macroinvertebrates

Construction of valley fills and other discharges of dredged or fill material authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will impact the native macroinvertebrate community downstream of the fill due to adverse changes in water quality. These adverse changes, such as increased selenium and conductivity, will result in subsequent changes in the aquatic community. Sensitive species of mayflies, stoneflies, and caddisflies currently inhabiting downstream waters will be extirpated following increasing chemical loading of contaminants, and the remaining taxa will likely serve as vectors for selenium bioaccumulation in higher trophic levels. Vertebrates

dependent upon macroinvertebrates as a food source, including salamanders, fish, birds and bats, will be subsequently affected, not only by the bioaccumulation of selenium, but also by the reduction in prey availability. Additionally, shifts in macroinvertebrate communities will likely affect important stream ecosystem functions, including organic matter breakdown (Fritz et al. 2010).

V.D.2.a. Impacts Due to Changes in Water Chemistry

Construction of valley fills and other discharges of dredged or fill material associated with the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch will result in altered and degraded macroinvertebrate communities in downstream environments (Appendix 2). The downstream effects of mining on macroinvertebrate communities include non-lethal effects and bioaccumulation of selenium, and extirpation of native, sensitive taxa. These effects can be significant, and are largely influenced by degraded water quality conditions downstream of valley fills. If the Spruce No. 1 Mine is constructed as authorized, these effects will occur in the receiving waters, including the unfilled portions of Pigeonroost Branch and Oldhouse Branch, and also further downstream in Spruce Fork. This conclusion is supported by numerous peer-reviewed studies, as well as empirical data collected and analyzed for the PEIS and permit application and discussed below.

Although there is little research on the direct effects of increased selenium loading on aquatic macroinvertebrates, some studies indicate the potential for macroinvertebrate populations to be adversely affected by selenium, even at concentrations below water quality thresholds established to protect fish and bird populations. For example, a review by Debruyn and Chapman (2007) found that the range of selenium water quality thresholds established to protect higher trophic levels consuming selenium-contaminated invertebrates could, in some cases, have substantial toxic effects on invertebrates, including reduced growth, reduced abundance, and mortality. Similarly, this review estimated that sublethal toxic effects can be associated with a range of water concentrations of 1-30 μg Se/L, which is consistent with experimental studies that found that some macroinvertebrate taxa exhibited approximately 50% reduction in abundance at Se water concentrations in the range of 5-10 μg Se/L. The remaining individuals that do survive accumulate the contaminants, thus exposing higher trophic levels (e.g., fish and amphibians) to concentrations that have the potential to cause population-level effects. Both the lethal and non-lethal effects on macroinvertebrate prey will result in significant impacts to higher trophic level organisms and food webs in the downstream ecosystem.

As outlined in Section V.D.1.b above, construction of valley fills and other discharges from the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch will cause an increase in salinity and TDS in receiving waters immediately downstream of valley fills. Bryant et al. (2002) found substantially higher average measurements of alkalinity, calcium, sulfate and total dissolved solids in nearby streams affected by mining than in streams unaffected by mining streams in the Spruce No. 1 project area. Increased concentrations of TDS can have significant implications for native wildlife. While many

of the elements that comprise mineral salts are essential nutrients, aquatic organisms are adapted to specific ranges of salinity and experience toxic effects from excess salinity.

Due to the sensitivity of native macroinvertebrate wildlife to elevated and increasing levels of conductivity, the predicted levels of these contaminants will have significant adverse effects on these biological communities. While changes in community composition downstream of mined sites are likely due to a combination of factors, it is likely that water quality changes, including water quality degradation from valley fills and in-stream mining impoundments, are the primary cause of aquatic life impacts below valley fills (Appendix 2). EPA's draft report, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (USEPA 2010a), also recognizes stream aquatic life impacts associated with conductivity, concluding that impacts to the biological community can occur at conductivity levels as low as 300 µS/cm.

The effects of mining on macroinvertebrate communities are evident when comparing the least-disturbed streams in the project area (Oldhouse Branch and Pigeonroost Branch) with nearby streams directly affected by valley fills (Beech Creek and Left Fork Beech Creek). Collectively, Pigeonroost Branch and Oldhouse Branch support 84 unique macroinvertebrate genera, in contrast with Beech Creek and Left Fork Beech Creek, which only support 56 unique macroinvertebrate genera. Additionally, many Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) genera (collectively known as EPT taxa)[16] were extirpated from these nearby streams affected by mining (Table 11). Pigeonroost Branch and Oldhouse Branch support 42 EPT genera (14 mayfly genera, 12 stonefly genera and 14 caddisfly genera), in contrast with Beech Creek and Left Fork Beech Creek, which only support 12 EPT genera (2 mayfly genera, 3 stonefly genera, and 7 caddisfly genera).

At Beech Fork and Left Fork Beech Fork, in addition to the presence of relatively pollution-tolerant mayfly and stonefly genera, there were also several tolerant taxa that were not found in the Spruce project area. These taxa, which are indicative of altered environmental conditions (i.e., atypical of Appalachian headwater streams), include highly tolerant snails (Lymnaeidae, *Physella*, *Helisoma*), as well as other tolerant beetles and fly larvae (Table 11). Similar patterns of taxonomic loss were observed at 20 other West Virginia sites downstream of valley fills when conductivity was greater than 500 µS/cm (Pond et al. 2008) and in the eastern Kentucky coalfields (Pond 2010), and it is likely that these effects on wildlife taxa and their habitat will occur following the Spruce No. 1 Mine operations (Appendix 2).

[16] EPA focused on genus-level taxa richness (i.e., the number of genera) of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa (EPT taxa), as it can be used to detect shifts in community composition and extirpation of sensitive taxa (Appendix A2.7).

Table 11. Comparison of macroinvertebrate taxa identified on the Spruce No. 1 Mine site and Dal-Tex site.

			Oldhouse +Pigeonroost	Beech + Left Fork Beech
Order	**Family**	**Genus**	**Spruce No. 1 Mine**	**Dal-Tex Mine**
Oligochaeta	Oligochaeta	Oligochaeta	X	X
Nematoda	Nematoda	Nematoda		X
Proseriataoela	Plagiostomidae	*Hydrolimax*	X	
Tricladida	Planariidae	Planariidae	X	
Basommatophora	Lymnaeidae	Lymnaeidae		X
Basommatophora	Physidae	Physella		X
Basommatophora	Planorbidae	*Helisoma*		X
Coleoptera	Dryopidae	*Helichus*	X	
Coleoptera	Elmidae	*Dubiraphia*		X
Coleoptera	Elmidae	*Macronychus*		X
Coleoptera	Elmidae	*Microcylloepus*		X
Coleoptera	Elmidae	*Optioservus*	X	X
Coleoptera	Elmidae	*Oulimnius*	X	X
Coleoptera	Psephenidae	*Ectopria*	X	
Coleoptera	Psephenidae	*Psephenus*	X	X
Decapoda	Cambaridae	*Cambarus*	X	
Diptera	Ceratopogonidae	*Atrichopogon*		X
Diptera	Ceratopogonidae	*Bezzia/Palpomyia*	X	X
Diptera	Ceratopogonidae	*Dasyhelea*	X	X
Diptera	Chironomidae	*Acricotopus*		X
Diptera	Chironomidae	*Chaetocladius*	X	X
Diptera	Chironomidae	*Corynoneura*	X	X
Diptera	Chironomidae	*Cricotopus*	X	X
Diptera	Chironomidae	*Diamesa*	X	X
Diptera	Chironomidae	*Eukiefferiella*	X	X
Diptera	Chironomidae	*Metriocnemus*		X
Diptera	Chironomidae	*Micropsectra*	X	X
Diptera	Chironomidae	*Microtendipes*	X	
Diptera	Chironomidae	*Orthocladius*	X	X
Diptera	Chironomidae	*Parachaetocladius*	X	
Diptera	Chironomidae	*Parametriocnemus*	X	X
Diptera	Chironomidae	*Paraphaenocladius*		X
Diptera	Chironomidae	*Paratanytarsus*		X
Diptera	Chironomidae	*Polypedilum*	X	X
Diptera	Chironomidae	*Rheotanytarsus*	X	X
Diptera	Chironomidae	*Smittia*		X
Diptera	Chironomidae	*Stempellinella*	X	
Diptera	Chironomidae	*Stenochironomus*		X
Diptera	Chironomidae	*Stilocladius*	X	
Diptera	Chironomidae	*Sympotthastia*	X	
Diptera	Chironomidae	*Tanytarsus*	X	
Diptera	Chironomidae	*Thienemanniella*		X
Diptera	Chironomidae	*Thienemannimyia*	X	X
Diptera	Chironomidae	*Tvetenia*	X	X
Diptera	Chironomidae	*Zavrelimyia*	X	
Diptera	Empididae	*Chelifera/Metachela*	X	X
Diptera	Empididae	*Clinocera*	X	
Diptera	Empididae	*Hemerodromia*		X
Diptera	Simuliidae	*Prosimulium*	X	
Diptera	Simuliidae	*Simulium*	X	X

Diptera	Tabanidae	Tabanidae		X
Diptera	Tipulidae	*Antocha*		X
Diptera	Tipulidae	*Cryptolabis*	X	
Diptera	Tipulidae	*Dicranota*	X	
Diptera	Tipulidae	*Hexatoma*	X	
Diptera	Tipulidae	*Limnophila*	X	
Diptera	Tipulidae	*Limonia*	X	X
Diptera	Tipulidae	*Pseudolimnophila*	X	
Diptera	Tipulidae	*Tipula*	X	X
Ephemeroptera	Ameletidae	*Ameletus*	X	
Ephemeroptera	Baetidae	*Acentrella*	X	
Ephemeroptera	Baetidae	*Baetis*	X	X
Ephemeroptera	Baetiscidae	*Baetisca*	X	
Ephemeroptera	Ephemerellidae	*Drunella*	X	
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	
Ephemeroptera	Ephemerellidae	*Eurylophella*	X	
Ephemeroptera	Ephemeridae	*Ephemera*	X	
Ephemeroptera	Heptageniidae	*Cinygmula*	X	
Ephemeroptera	Heptageniidae	*Epeorus*	X	
Ephemeroptera	Heptageniidae	*Stenacron*	X	
Ephemeroptera	Heptageniidae	*Maccaffertium/ Stenonema*	X	
Ephemeroptera	Isonychiidae	*Isonychia*	X	X
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	X	
Megaloptera	Corydalidae	*Corydalus*		X
Megaloptera	Corydalidae	*Nigronia*	X	X
Odonata	Aeshnidae	*Boyeria*		X
Odonata	Gomphidae	*Lanthus*	X	X
Plecoptera	Capniidae	Capniidae	X	
Plecoptera	Chloroperlidae	*Haploperla*	X	
Plecoptera	Leuctridae	*Leuctra*	X	
Plecoptera	Nemouridae	*Amphinemura*	X	X
Plecoptera	Nemouridae	*Ostrocerca*	X	
Plecoptera	Nemouridae	*Prostoia*		X
Plecoptera	Peltoperlidae	*Peltoperla*	X	
Plecoptera	Perlidae	*Acroneuria*	X	
Plecoptera	Perlodidae	*Isoperla*	X	
Plecoptera	Perlodidae	*Remenus*	X	
Plecoptera	Perlodidae	*Yugus*	X	
Plecoptera	Pteronarcyidae	*Pteronarcys*	X	
Plecoptera	Taeniopterygidae	*Taenionema*	X	
Plecoptera	Taeniopterygidae	*Taeniopteryx*	X	X
Trichoptera	Glossosomatidae	*Agapetus*	X	
Trichoptera	Glossosomatidae	*Glossosoma*	X	
Trichoptera	Goeridae	*Goera*	X	
Trichoptera	Hydropsychidae	*Ceratopsyche*	X	
Trichoptera	Hydropsychidae	*Cheumatopsyche*	X	X
Trichoptera	Hydropsychidae	*Diplectrona*	X	X
Trichoptera	Hydropsychidae	*Hydropsyche*	X	X
Trichoptera	Hydroptilidae	*Hydroptila*		X
Trichoptera	Limnephilidae	*Pycnopsyche/ Hydatophylax*	X	
Trichoptera	Philopotamidae	*Chimarra*	X	X
Trichoptera	Philopotamidae	*Dolophilodes*	X	
Trichoptera	Polycentropodidae	*Polycentropus*	X	
Trichoptera	Psychomyiidae	*Psychomyia*	X	X
Trichoptera	Rhyacophilidae	*Rhyacophila*	X	X

Trichoptera	Uenoidae	*Neophylax*	X	
		Total Distinct Taxa	**84**	**56**
		Total EPT Taxa	**42**	**12**

In order to support the determination that unacceptable adverse effects will occur downstream, EPA applied an accepted and peer reviewed approach, called an Observed/Expected index (O/E), where O/E ratios represent the number of the expected taxa that are observed in a sample (O), compared to the number of taxa expected in the sample (E), after predicting the probability that a sample site is a member of one or more fixed sets of reference site types (Hawkins 2006a, Van Sickle 2005) (Figure 14). This method uses a suite of regional reference sites to determine the number of expected taxa; and deviation from this number can be used to identify an degradation threshold (see Appendix 2 for detailed methods and results). A site that is a perfect match to the reference site O/E scores will score 1.0, while downward deviation from 1.0 indicates loss of expected taxa compared to regional reference (e.g., a score of 0.50 indicates a 50% loss of the expected taxa). Upward deviation (greater than 1.0) indicates that more taxa were collected than expected. EPA chose the 5th percentile of reference site O/E scores as a degradation threshold to correspond to the WVDEP's bioassessment threshold for aquatic life use impairment. This O/E 5th percentile was 0.64, indicating a loss of 36% of expected taxa would indicate degradation of the in-stream biota.

Based upon the O/E index, EPA found that the macroinvertebrate assemblages in Pigeonroost Branch, Oldhouse Branch and the upstream White Oak Branch are comparable to the regional reference sites, while nearby streams affected by valley fills (Dal-Tex sites) were well below the degradation threshold (O/E less than 0.64) (Table 12). Mean scores for the Dal-Tex sites were 0.26 in the summer and 0.32 in the spring, indicating they support, on average, 74% and 68% less taxa, respectively, than the regional reference sites. Thus, past mining has led to the estimated extirpation of ~70% of the native expected taxa in the adjacent Dal-Tex Mine operation.

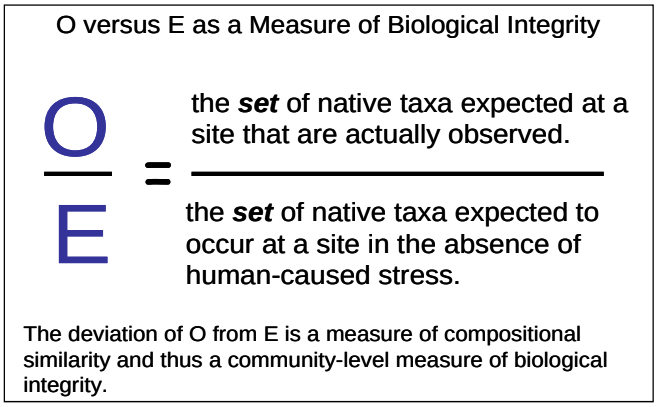

Figure 14. Measure of biological integrity; Observed vs. Expected (C.P. Hawkins, Utah State Univ.)

Extirpation of macroinvertebrate taxa, documented by the O/E index, is largely caused by water quality degradation. Using the regional reference sites and genus-level data from Pond et al. (2008), O/E scores showed a negative correlation with conductivity (R^2=0.63). Water quality degradation caused by elevated conductivity explained more than twice the

variance in O/E scores than did Rapid Bioassessment Protocol (RBP) habitat scores (R^2=0.28), confirming that conductivity is an excellent predictor of native taxa loss from Appalachian streams. Sediment deposition, substrate embeddedness, channel alteration, riparian zone width, pH, or temperature had no significant influence on O/E scores (see Appendix 2).

Table 12. Summary of West Virginia O/E null model results for the Spruce No. 1 Mine area. The biological degradation threshold is 0.64 (corresponding to the 5th percentile of WVDEP reference site distributions).

Mean (Standard Deviation) O/E			
	Spruce No. 1 Mine	**Dal-Tex**	
	Pigeonroost Branch, Oldhouse Branch, White Oak Branch	Beech Creek, Left Fork Beech Creek	Rockhouse
Spring	0.98 (0.20); n=9	0.26 (0.06); n=5	0.31 (0.10); n=3
Summer	0.85 (0.15); n=2	0.32 (0.08); n=2	0.38 (0.08); n=2

To provide additional support that aquatic life use degradation occur downstream of valley fills and that these impairments result from water quality degradation, streams that are affected by mining were compared to streams that are not affected by mining using the West Virginia Stream Condition Index (WVSCI), WVDEP's family-level multi metric index (see Appendix 2 for detailed methods and results). Currently, the WVDEP uses WVSCI index scores greater than 68 to indicate streams fully supportive of the aquatic life use.[17] Streams unaffected by mining within and near the project area, including White Oak Branch, Oldhouse Branch and Pigeonroost Branch, generally scored above the 68 threshold index value, indicating they are high quality streams that fully support the aquatic life use (see Appendix 2). The streams located in the historically mountaintop mined areas with valley fills located nearby (Rockhouse Branch, Beech Creek, and the Left Fork of Beech Creek) generally scored below the 68 threshold index value, indicating they do not fully support aquatic life use.

In Pond et al. (2008) elevated conductivity greater than 500 µS/cm caused by alkaline mine effluents was strongly associated with high probability of degradation of native biota, and 17 of the 20 mined study sites (85%) did not fully support aquatic life, based upon the family-level WVSCI index. In addition, WVDEP ambient monitoring macroinvertebrate data from the Cumberland Mountains of the Central Appalachians subecoregion, the subecoregion where the project is located, were analyzed to determine the potential effects of elevated conductivity levels on aquatic life use. When conductivity levels were elevated above 500 µS/cm, the analysis showed that a majority of the sites were not fully supportive of aquatic life use, even when accounting for the possible confounding effects of acidic pH and habitat degradation. For example, after removing low pH sites, only 100 sites out of 417 sites attained WVSCI scores greater than 68 when conductivity levels were greater than 500 µS/cm (76% of the sites reflected WVSCI scores less than 68). When the potential confounding effect of habitat

[17] This score represents the lower 5th percentile of the range of scores of the 107 reference site scores used in the 2000 report (Gerritsen et al. 2000). As noted elsewhere, in its 2008 Section 303(d) List, WVDEP identified a WVSCI score of 68 as the lowest score at which a waterbody was considered to "fully support" aquatic life. A score of less than 68 indicates degradation of the aquatic life use.

degradation was completely removed (this subset includes only sites with Rapid Bioassessment Protocol habitat scores greater than 140, indicating reference quality habitat), 62% of the sites still had WVSCI scores less than 68.

In addition to changes in community structure and loss of sensitive taxa, functional feeding group composition (based on WVDEP group designations) is also significantly altered below mountaintop mining operations with valley fills. An analysis of functional feeding groups revealed categorical dose-response for unmined, low (<500), medium (500-1000), and high (>1000) conductivity (Table 13; data from Pond et al. 2008). Functional feeding group relative abundance of scrapers (herbivorous grazers) and functional feeding group richness for scrapers, shredders, and collector-gatherers was higher at unmined sites and declined with increasing conductivity category, while the relative abundance of collector-filterers increased. In a comparison of sites with conductivity <500 µS/cm (n=17) to sites with conductivity >500 µS/cm (n=20), there were significant alterations of trophic composition, with increased %collector-filterer abundance and declines in genus-level scraper richness, shredder richness, collector-gatherer richness and %scraper abundance at sites with higher conductivity (Table 13). Further, several functional feeding group metrics were strongly correlated to specific conductance (Table 13).

Table 13. Mean richness and relative abundance of functional feeding groups among conductivity categories (data from Pond et al. 2008). Additional comparisons of sites (<500 µS/cm and >500 µS/cm) include P-values for Mann-Whitney U-tests shown. Spearman correlations of FFGs with conductivity are also shown. Bold values are significant (p<0.05).

FFG (Richness)	Unmined	Low	Medium	High	Combined Unmined + Mined (low)	Combined Mined (Medium+ High)	Mann-Whitney U-test	*P*	Correlation to Conductivity: Spearman *r*
# Scraper Genera	**7.4**	**5.0**	**2.1**	**0.9**	**6.4**	**1.4**	**333.5**	**0.000**	**-0.85**
# Shredder Genera	**4.5**	**3.4**	**2.0**	**2.0**	**4.1**	**2.6**	**244.0**	**0.021**	**-0.50**
# Coll-Gatherer Genera	**10.5**	**9.1**	**7.3**	**7.3**	**9.9**	**7.9**	**240.0**	**0.031**	**-0.48**
# Coll-Filterer Genera	3.0	4.7	3.6	3.6	3.7	3.9	143.0	0.389	0.10
# Predator Genera	7.2	4.7	3.7	3.7	6.2	4.3	232.0	0.057	**-0.44**
# Piercer-Herb Genera	0.1	0.0	0.0	0.1	0.1	0.1	171.5	0.907	-0.03

FFG (Rel. Abundance)	Unmined	Low	Medium	High	Combined Unmined +Mined (low)	Combined Mined (Medium+ High)	Mann-Whitney U-test	*P*	Correlation to Conductivity: Spearman *r*
% Scraper	**29.1**	**7.6**	**9.1**	**1.6**	**18.4**	**5.4**	**304.0**	**0.000**	**-0.79**
% Shredder	24.8	43.0	28.8	19.3	33.9	24.1	224.5	0.097	-0.23
% Coll-Gatherer	29.5	28.5	32.3	33.7	29.0	33.0	149.0	0.437	0.04
% Coll-Filterer	**7.7**	**14.6**	**17.5**	**41.2**	**11.2**	**29.4**	**78.5**	**0.005**	**0.60**
% Predator	8.4	6.0	11.9	3.9	7.2	7.9	199.0	0.376	-0.40
% Piercer-Herbivores	0.1	0.0	0.0	0.2	0.1	0.1	167.0	0.920	0.01

Construction of valley fills, sediment ponds, and other discharges of dredged or fill material into Pigeonroost Branch and Oldhouse Branch as authorized by the DA permit

will contribute increased loadings of TDS to downstream receiving waters within the Headwaters Spruce Fork sub-watershed and Coal River sub-basin, further exacerbating biological impairments. The WVDEP data from the Spruce Fork, Pond Fork and Little Coal River watersheds indicate that nearby streams affected by mines, as well as the main stem of Spruce Fork, Pond Fork and the Little Coal River currently do not fully support aquatic life use (see Appendix 1). The adverse impacts in the main stem of Spruce Fork, Pond Fork, and the Little Coal are likely due to a combination of stressors, including mining and residential stressors (WVDEP 1997a). Because these downstream waters have existing biological impairments, increased loading of TDS from this project will further reduce the ability of these waters to support aquatic life use.

V.D.2.b. Food Web Effects of Altered Macroinvertebrate Communities

The direct burial of streams and subsequent water quality changes downstream associated with the authorized project will significantly alter macroinvertebrate assemblages, as well as the overall abundance and productivity of macroinvertebrate communities; and thus, through cascading food web effects, likely adversely impact vertebrate species which depend upon the macroinvertebrate community within these streams for nourishment (Figure 7). Project impacts on these aquatic invertebrates will likely alter in-stream functions (e.g., organic matter processing and transport, and nutrient cycling and transport), in part because research has shown that processing rates of terrestrial plant material inputs are reduced in mine-affected streams with altered macroinvertebrate assemblages (Fritz et al. 2010). Also, it is likely that impacts to aquatic invertebrates will have adverse effects on animals dependent on insect larvae and emergent adults as prey, including fish, amphibians, bats, birds, reptiles and small mammals (Baxter et al. 2005). In particular, mayflies (Ephemeroptera) tend to be a preferred prey item for juvenile Smallmouth Bass (Easton et al. 1996), an important sport fish in Spruce Fork, and anticipated declines in mayfly immediately downstream of valley fills will have adverse effects on this sport fishery, as reduced mayfly populations will be present and there will be a reduced pool of colonizers to repopulate areas where populations were impacted.

In addition, research has shown that selenium often has non-lethal effects on macroinvertebrates, allowing them to act as vectors in the movement of selenium to higher levels of the food chain.

V.D.3. Salamanders & Other Herpetofauna

Impacts from the activities authorized will have a significant adverse impact on salamanders and other herpetofauna downstream of the project area due to changes in water chemistry, as well as subsequent food web effects. Adverse impacts to salamanders as a result of construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will not be localized to the area to be filled. Because construction of the valley fills and other discharges will increase conductivity and selenium levels in the downstream receiving waters (see Section V.D.1.), salamanders that are not directly buried and killed beneath the fills will also be impacted; directly via exposure to these contaminants and indirectly via impacts

of contaminants on food sources and reduced prey abundances. Studies have documented elevated selenium levels in salamander tissue downstream of valley fills and that salamander assemblages were more likely to be impaired downstream of valley fills than in other locations (Patnode, et al. 2005). Such impacts will occur as far downstream as elevated conductivity, selenium or other contaminants persist, and to affect any salamanders that spend some part of their life in the aquatic environment or in immediately adjacent riparian terrestrial habitats.

Furthermore, as set forth in Section V.D.4.a., the construction of valley fills, sediment ponds, and other discharges into Pigeonroost Branch and Oldhouse Branch will create conditions considered favorable to the growth of golden algae *(Prymnesium parvum)*, which can produce a toxin that is highly toxic to aquatic life and was associated with an extensive aquatic life kill of both fish and lungless salamanders in Dunkard Creek in West Virginia in September 2009.

V.D.4. Fish

The fish assemblages in Pigeonroost Branch and Oldhouse Branch downstream of the project area, as well as in Spruce Fork, are neither impaired nor representative of pristine or reference condition. Basin size is a particularly important factor when assessing the potential effects of valley fills on streams because small streams (less than 10 square kilometer) have shown effects to the fish assemblage while larger streams have not (e.g., Fulk et al. 2003). Nevertheless, Fulk et al. (2003) found significant differences in total IBI scores between streams that are affected by mines and those that are not. This difference was attributed to changes in cyprinid species richness and the percent of the assemblage composed of benthic invertebrate feeders.

Studies have shown that mountaintop mining for coal and construction of valley fills has had a harmful effect on the composition of stream fish communities (Fulk et al., 2003, Stauffer and Ferreri, 2002). Comparison of streams without mining in the watershed and sites downstream of valley fills in Kentucky and West Virginia indicate that streams affected by mining had significantly fewer total fish species and fewer benthic fish species than streams without mining in the same areas (Stauffer and Ferreri, 2002), likely due to changes in water quality. Surface coal mining and associated increases in conductivity and total dissolved solids and construction of sediment ponds have been shown to create conditions considered favorable to the growth of golden algae (*Prymnesium parvum)*, which has caused large aquatic life kills; and conditions favorable to golden algae growth will occur in Pigeonroost Branch and Oldhouse Branch. Fish also will be exposed to increases in selenium concentrations, which will lead to bioaccumulation in fish tissues and to reproductive effects (see Section V.D.1.a.). Additionally, increases in conductivity and total dissolved solids will have a significant adverse effect on aquatic macroinvertebrates, some of which are preferential prey items for the fish species present in these streams, and, as a result, these fish will likely be similarly adversely affected (see Section V.D.2.b.).

V.D.4.a. Potential to Promote the Growth of Golden Algae

Construction of valley fills and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch as authorized will create in-stream conditions in or near Spruce Fork favorable to the growth of golden algae (*Prymnesium parvum),* which releases toxins that kill fish and other gill-breathing aquatic organisms. *P. parvum* is a haptophyte (flagellated) algae now distributed worldwide. This alga has been known to occur in North America since the 1980s (Baker et al., 2007) and has since become established in rivers and reservoirs in several states. *P. parvum* is responsible for harmful algal blooms that have killed millions of fish in Texas and Oklahoma, and has been implicated in kills from North Carolina to Arizona.

P. parvum has also been associated with an extensive and severe aquatic life kill in the central Appalachians, in which thousands of fish, mussels and other aquatic organisms were destroyed in Dunkard Creek in West Virginia and Pennsylvania (Roelke et al.2010, Sager et al.2008). During September 2009, biologists reported observations of thousands of dead fish, mussels and salamanders in Dunkard Creek (Hambright 2010). Mud puppies, an aquatic salamander that lives its entire life underwater, crawled out of the water and onto rocks and the shoreline in an attempt to escape from the toxic water. Field biologists observed numerous individuals as dried up carcasses on rocks and along the shoreline. Fish were observed avoiding the main stem of Dunkard Creek by practically "stacking up" in the mouths of tributaries, subjecting themselves to feeding by blue heron rather than remaining in the toxic water of main stem Dunkard Creek. The identification of *P. parvum* in 2009 in Dunkard Creek was the first identification of this invasive aquatic species in the Mid-Atlantic States (Roelke et al.2010).

The factors that are most closely associated with supporting growth of *P. parvum* are believed to be:

1. Proximity to a known source of *Prymnesium parvum*.
2. TDS in high enough concentrations to support *P. parvum* (estimated to be between 500 and 1000 mg/L (conductivity 714-1428 μS/cm).
3. Nutrients in concentrations high enough to initiate a bloom of *P. parvum* (Baker et al. 2009)
4. pH greater than 6.5. Risk increases with increasing pH (Baker et al. 2009).
5. Areas of habitat that are pooled (large beaver dams, natural residual pools, or manmade ponds)

EPA believes that the Spruce No. 1 Mine will increase the probability that all five factors are met within the Headwaters Spruce Fork sub-watershed, as outlined below.

Proximity to Known Source: P. parvum was identified (in very high numbers) in Cabin Creek of the Kanawha drainage, only 25 miles to the East. Because these algae can easily move with waterfowl, the risk of introducing *P. parvum* in the Spruce Fork drainage is high. Although not currently found in Spruce Fork, the WVDEP has identified Spruce Fork as a "water of concern" because of its potential (due to already

high levels of TDS/conductivity) to support *P. parvum* blooms consistent with the factors shown above.

High TDS: The lower TDS limits for the growth of *P. parvum* appears to be ~500 mg/l TDS, or ~700µS/cm conductivity for the ion mixtures typical of alkaline mine drainage (Hambright 2010). Recent data indicate that growth of *P. parvum* increases 200-300% when conductivity increases from 500 µS/cm to 1000 µS/cm (unpublished data, WVDEP, 2010, Hambright 2010). The waters draining the nearby Dal-Tex Mine operation have conductivity levels greater than these values. Many of the sampling sites on the main stem of Spruce Fork, Pond Fork and the Little Coal River also have conductivity levels exceeding these endpoints. Other waters of concern near the Spruce No. 1 Mine include the Little Coal River and West Fork/Pond Fork. As described in SectionV.D.1.b., construction of valley fills and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch is expected to increase levels of TDS/conductivity in Spruce Fork, thus creating conditions more favorable to *P. parvum*.

Suitable Nutrient Levels: Nutrient levels in the Spruce Fork are very similar to those in Dunkard Creek and other watersheds with *P. parvum* algae present (e.g. Whitely Creek, PA). Phosphorous in Spruce Fork was over 100 µg/L on two sampling occasions during the PEIS.

High pH: Discharges from Spruce No. 1 Mine are likely to be alkaline, consistent with pH of discharges from Dal-Tex and other operations.

Existence of Pooled Habitats: Pooled habitats with little to no flow are common in streams like Spruce Fork in low flow conditions of September and October, when TDS is highest. In addition, DA Permit No. 199800436-3 (Section 10: Coal River) authorizes construction of numerous sediment ponds in Pigeonroost Branch and Oldhouse Branch which will create areas of pooled habitat more favorable to *P. parvum.* During low flows, conductivity is typically highest, increasing the possibility that blooms could occur in very slow moving residual pools within the channel.

V.D.4.b. Increased Exposure to Selenium

The construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will result in elevated levels of selenium in the receiving waters. While selenium is a naturally occurring chemical element that is an essential micronutrient, excessive amounts of selenium can have toxic effects on fish. Selenium toxicity is primarily manifested as reproductive impairment and birth defects due to maternal transfer, resulting in embryonic physical mutations and death in egg laying vertebrates such as fish and ducks.

Several nearby streams in the Coal River sub-basin have available data that indicate that construction of the Spruce mine and associated discharges can result in impacts to wildlife. According to the WVDEP's study, "Selenium Bioaccumulation among select

stream and lake fishes in West Virginia" (WVDEP 2009), Seng Creek had the highest average water column concentration (27.20 ppb) and a corresponding average fish tissue concentration of 8.16 ppm, while Beech Creek had a water concentration of 12.30 ppb with a corresponding average fish tissue concentration of 7.55 ppm. In Seng Creek, creek chub egg/ovary tissue (mean = 19.9 ppm; range = 16.4 - 23.7 ppm; n= 4) and water measurements (mean = 15.8 ug/L; range = 8-45 ug/L; n = 11) indicate that both fish tissue and water numbers would exceed 5 ug/L and these levels have been documented to resulted in unacceptable tissue concentrations in the reproductive tissue. Similarly, water and fish tissue samples from Mud River also show unacceptable impacts to fish. Creek chub egg ovary (composite measurement of 17.6 in egg/ovary tissue) and water measurements (mean = 9.5 ug/L; range = 4-22 ug/L; n = 21) in Mud River show that selenium concentrations exceed 5 ug/L and has resulted in unacceptably high tissue concentrations in fish.

As discussed in Section V.D.1.a., construction of the Spruce No. 1 Mine will disturb selenium bearing strata consistent with the strata disturbed by the Dal-Tex complex, will remove Pigeonroost Branch and Oldhouse Branch as sources of dilution, and will increase in-stream selenium concentrations to levels comparable with the Dal-Tex complex. The foregoing data supports EPA's view that the increased selenium resulting from the Spruce No. 1 Mine will elevate fish tissue concentrations to levels that will result in unacceptable adverse impacts in wildlife.

V.D.5. Water-dependent Birds

The indirect effects on Louisiana Waterthrush populations are attributable to the loss of aquatic macroinvertebrate food sources and water quality impacts associated with construction of the Spruce No. 1. Mine. As stated in Section IV.B.4. above, the Louisiana Waterthrush is an area-sensitive riparian-obligate species whose breeding success depends on the diverse and productive assemblage of aquatic insects supported by healthy headwater systems (Mattson and Cooper 2009). Birds dependent on aquatic insect larvae and emergent adults as prey, such as the Louisiana Waterthrush, will be adversely affected by the project due to food web effects associated with altered aquatic macroinvertebrate communities (see Section V.D.2.a.).

Studies indicate that breeding territory density and occupancy are reduced along streams where benthic macroinvertebrate communities had been degraded due to anthropogenic land uses including mining (Mulvihill 1999, 2008, Mattsson and Cooper 2009, O'Connell et al. 2003). For example, lower breeding territory densities have occurred along streams impacted by acid mine drainage more so than along circumneutral streams (Mulvihill 1999, 2008). The driver behind these lower densities is decreased food availability, as acid mine drainage has a similar effect on macroinvertebrate populations as alkaline drainage and salinity (Mulvihill 2008). Similarly, some indices of benthic macroinvertebrate integrity are shown to be higher where breeding Louisiana Waterthrushes are present than areas from which they are absent (O'Connell et al.2003). Stream reaches where breeding waterthrushes were present also had a greater proportion of pollution-sensitive benthic macroinvertebrates than reaches where waterthrushes were

absent, supporting the concept that good water quality is a key component of the species breeding habitat (Mulvihill 2008).

In addition to impacts resulting from the loss of macroinvertebrate food sources, studies also indicate that the Louisiana Waterthrush will be adversely affected by increased exposure to selenium through prey consumption. Since Waterthrush diet is comprised of aquatic and terrestrial insects, as well as small fish and amphibians, where selenium levels are elevated in macroinvertebrate and salamander populations, Waterthrush will be exposed in a majority of their prey (Patnode et al. 2005) .

As the scientific literature demonstrates, Louisiana Waterthrush populations are vulnerable to impairments in water quality downstream of mining operations. EPA believes that there will be unacceptable adverse impacts to Louisiana Waterthrush populations downstream of the Spruce No. 1 project area as the result of indirect water quality impacts from the filling of Pigeonroost Branch and Oldhouse Branch and their tributaries.

V.D.6. Summary

Construction of valley fills, sediment ponds, and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) in Pigeonroost Branch and Oldhouse Branch will eliminate headwater stream systems that support some of the last remaining least-disturbed conditions within the Coal River sub-basin and will therefore result in a significant loss of wildlife habitat. The burial of these streams will lead to discharges of TDS and selenium, which will result in unacceptable adverse effects on wildlife in downstream waters. Increased salinity levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. Through the loss of stream macroinvertebrate and salamander communities, there will be, in turn, substantial effects to both aquatic and terrestrial vertebrate populations that rely on these communities as a food source.

It is well recognized that the loss of a certain number of individuals of a species in a local ecological community can be tolerated, provided that the species continues to reproduce to replace lost individuals. However, when species are impacted by both acute stressors (e.g., food web changes, algal blooms) and exposure to reproductive toxicants, there is an increased risk of the loss of an entire species within an area. The loss of macroinvertebrate prey populations, increased risk of harmful golden algal blooms, and additional exposure to selenium will have an unacceptable adverse effect on the 26 fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on downstream waters for food or habitat.

Based on this information, EPA has concluded that the discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) will have unacceptable adverse effects on wildlife downstream of the Spruce No. 1 Mine.

V.E Compliance with Relevant Portions of the § 404(b)(1) Guidelines

EPA has broad discretion under § 404(c) in evaluating and determining whether a discharge will result in "unacceptable adverse effects." EPA has concluded, in this case, that burying 6.6 miles of rare and important high quality streams will have an unacceptable adverse impact on the wildlife that rely on those streams for all or part of their life cycles, and that the discharges of TDS and selenium, loss of freshwater dilution from these buried streams, and significant alteration of aquatic macroinvertebrate communities will have an unacceptable adverse effect to aquatic wildlife downstream of the mining operation. Each of these determinations on its own is a sufficient basis to withdraw the specification of these streams as disposal sites and to prohibit the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine

In addition, EPA's § 404(c) regulations at 40 CFR 231.2(e) provide that in evaluating the "unacceptability" of impacts, consideration should be given to the "relevant portions of the § 404(b)(1) Guidelines." As discussed further below, EPA has identified numerous inconsistencies with the requirements of the § 404(b)(1) Guidelines. In Sections V.C. and V.D., EPA determined that there are unacceptable adverse impacts to wildlife, and the Agency's evaluation of compliance with relevant portions of the Guidelines in this section provides support and confirmation of the conclusion that the impacts are unacceptable.

For purposes of the Spruce No. 1 Mine, the relevant portions of the § 404(b)(1) Guidelines that are particularly important for assessing the unacceptability of environmental impacts include:

- Less environmentally damaging practicable alternatives (40 CFR 230.10(a))
- Significant degradation of waters of the United States (40 CFR 230.10(c))
    - Cumulative effects (40 CFR 230.11(g))
    - Secondary effects (40 CFR 230.11(h))
- Minimization of adverse impacts to aquatic ecosystems (40 CFR 230.10(d))

V.E.1. Less Environmentally Damaging Alternatives/Failure to Minimize Impacts

The § 404(b)(1) Guidelines state at 40 CFR 230.10(a) that no permit may be issued if there is a practicable alternative that would result in less damage to aquatic resources while still meeting the basic project purpose, provided it would not result in other significant adverse environmental impacts. Similarly, 40 CFR 230.10(d) states that steps should be taken to minimize all remaining unavoidable impacts. These two required elements of the Guidelines are typically fulfilled with a thorough analysis of alternatives, including evaluation of alternative project sitings, changes to project design, implementation of best management practices, and adaptive management plans to

minimize the risk of adverse impacts. EPA's determination that the Spruce No. 1 Mine will result in unacceptable adverse impacts to wildlife does not depend on the presence or absence of alternatives that would result in less severe environmental impacts to waters of the United States, or on whether there are or are not further opportunities to minimize the impacts from the project. Nonetheless, EPA's evaluation of these portions of the § 404(b)(1) Guidelines serves to strengthen EPA's determination about the unacceptability of the significant impacts that would occur from Spruce No. 1 Mine.

In discussions with the permittee before and during the § 404(c) process, EPA has repeatedly stated its belief that there are alternative mine design and construction practices that would further reduce aquatic resource impacts, while allowing the majority of coal present on site to be mined in a cost effective and technically feasible manner. As referenced in Section III.C., the permittee has presented only limited alterations to the permitted project that it believes would likely result in environmental improvements. These proposals included additional compensatory mitigation projects, new mine construction practices, and increased water quality monitoring.

EPA maintains, however, that there appear to be additional practicable alternative project configurations and practices that would significantly reduce and/or avoid anticipated environmental and water quality impacts to Pigeonroost Branch and Oldhouse Branch. Moreover, § 230.10(a) establishes rebuttable presumptions that, in the case of non-water dependent projects (such as this), practicable, less environmentally damaging alternatives exist. EPA does not believe the permittee has carried its burden to clearly demonstrate that such alternatives do not exist.

EPA is working effectively with mining companies to identify alternative mining configurations and practices to reduce the nature and extent of anticipated adverse environmental and water quality impacts. EPA and mining companies have, for example, coordinated to reduce the volume of excess spoil being placed in valley fills, minimize rainwater and groundwater contact with pollutant-bearing strata, divert stormwater away from streams and other surface waters, phase mining construction to assess the effectiveness of best management practices designed to protect water quality, eliminate and consolidate valley fills, remove treatment ponds from stream beds, compact excess spoil and cant fills to reduce rainwater infiltration, and other cost effective actions for reducing or avoiding environmental and water quality impacts without significantly affecting coal recovery. Mingo Logan Company has expressed a willingness to take some additional steps focusing on best management practices to reduce impacts, but has been consistently unwilling to consider needed actions to further reduce the 35,000 feet of direct impacts of valley fills on headwater streams or to phase valley fill construction in a manner that would allow for effective assessment of, and an adaptive management response to, adverse impacts to wildlife habitat and anticipated water quality problems.

Because the scope of this Final Determination is limited to withdrawal of specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged or fill material in connection with the Spruce No. 1 Mine, as well as future discharges, within the defined area constituting Pigeonroost Branch, Oldhouse Branch

and their tributaries, associated with surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine, EPA takes no position as to whether other, less damaging alternatives would be likely to result in acceptable effects on wildlife or satisfy the § 404(b)(1) Guidelines. However, the facts that such alternatives appear to exist based on extensive experience with other mining operations in Appalachia, and that the permittee has not clearly demonstrated to the contrary, further enhance EPA's assessment of the unacceptability of the impacts that were previously described.

V.E.2. Significant Degradation

The § 404(b)(1) Guidelines direct that no discharge of dredged or fill material shall be permitted if the discharge will cause or contribute to significant degradation of waters of the United States (40 CFR 230.10(c)). Of particular relevance in this instance, the Guidelines state that effects contributing to significant degradation considered individually or collectively, include:

> (1) Significantly adverse effects of the discharge of pollutants on human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites.
>
> (2) Significantly adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, including the transfer, concentration, and spread of pollutants or their byproducts outside of the disposal site through biological, physical, and chemical processes; and
>
> (3) Significantly adverse effects of the discharge of pollutants on aquatic ecosystem diversity, productivity, and stability. Such effects may include, but are not limited to, loss of fish and wildlife habitat or loss of the capacity of a wetland to assimilate nutrients, purify water, or reduce wave energy

As discussed in Section IV.A. above, Pigeonroost Branch and Oldhouse Branch and their tributaries are some of the last remaining streams within the Headwaters Spruce Fork sub-watershed and the larger Coal River sub-basin that represent "least-disturbed" conditions. As such, they perform important hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role with regard to providing necessary habitat for wildlife within the context of the overall Headwaters Spruce Fork sub-watershed and Coal River sub-basin.

The Spruce No. 1 Mine as authorized will bury virtually all of Oldhouse Branch and its tributaries and much of Pigeonroost Branch and its tributaries under excess spoil generated by surface coal mining operations. These discharges will result in the burial of approximately 6.6 miles of high quality Appalachian headwater streams in a watershed

that has already experienced substantial impairment. The loss of these portions of Pigeonroost Branch and Oldhouse Branch will result in a significant loss of wildlife habitat and would therefore adversely impact wildlife that depend on those headwater streams for all or part of their life cycles. As detailed in Sections V.C. and V.D., these direct impacts will result in significantly adverse effects on over 84 taxa of macroinvertebrates, as well as up to 46 species of reptiles and amphibians, 4 species of crayfish, 5 species of fish and at least one water-dependent bird species

Beyond the direct burial of wildlife species and loss of habitat, EPA has also determined that the project will result in significantly adverse effects on downstream wildlife. If constructed as permitted, the Spruce No. 1 Mine will result in increased pollutant loadings in Spruce Fork and the Little Coal River. Increased salinity levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. Further, loss of macroinvertebrate prey populations, increased risk of harmful golden algal blooms, and additional exposure to selenium will result in significantly adverse effects on the 26 fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on downstream waters for food or habitat.

The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by the streams of Pigeonroost Branch and Oldhouse Branch including maintenance of biologically diverse wildlife habitat and will critically degrade the chemical and biological integrity of downstream waters. Impacts to these functions at the scale associated with this project will result in significant degradation (40 CFR 230.10(c)) of the Nation's waters, particularly in light of the extensive cumulative stream losses in the Spruce Fork and Coal River watersheds discussed in more detail below.

V.E.2.a Cumulative Effects

Fundamental to the § 404(b)(1) Guidelines "is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." 40 CFR 230.1(c).

The § 404(b)(1) Guidelines (at 40 CFR 230.11(g)) also direct that factual findings be made regarding cumulative effects on the aquatic ecosystem and that those findings be considered in determining whether the discharge complies with the foregoing restriction. To that end, the § 404(b)(1) Guidelines describe the factual finding that must be made with respect to cumulative effects as follows:

> Cumulative impacts are the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can

> result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems.
>
> Cumulative effects attributable to the discharge of dredged or fill material in waters of the United States should be predicted to the extent reasonable and practical. The permitting authority shall collect information and solicit information from other sources about the cumulative impacts on the aquatic ecosystem. This information shall be documented and considered during the decision-making process concerning the evaluation of individual permit applications, the issuance of a general permit, and monitoring and enforcement of existing permits.

As has been described in Section IV.A., the Coal River sub-basin and the Headwaters Spruce Fork sub-watershed are already impacted by mining activity. Based upon the National Land Cover Database (NLCD) change product for 1992-2001 and the WVDEP's GIS mine permit data, more than 257 past and present surface mining permits have been issued in the Coal River sub-basin, and the corresponding mines collectively occupy more than 13% of the land area. In the Spruce Fork watershed, more than 34 past and present surface mine permits have been issued, and the corresponding mines collectively occupy more than 33% of the land area. The project will affect an additional 2,278 acres (3.56 mi^2), which is equivalent to approximately 2.8% of the Spruce Fork watershed. This percentage of land cover affected by surface mines will continue to increase in the Coal River sub-basin, as additional projects are proposed and authorized.

A 1997 WVDEP ecological assessment of the Coal River sub-basin indicated that because the sub-basin is becoming increasingly impaired due to stressors such as mining, there is a need to protect the remaining quality resources, highlighting the need to "[l]ocate and protect the few remaining high quality streams in the Coal River watershed.…" (WVDEP 1997a). Pigeonroost Branch and Oldhouse Branch, two of the streams directly affected by the Spruce No. 1 Mine, are high quality resources that support an exceptionally high number of mayfly taxa, both within the Central Appalachian Region and statewide (see Appendix 2). By directly impacting these streams, which serve as refugia for aquatic life and potential sources for recolonizing nearby waters, the action will have a significant adverse effect on the aquatic ecosystem integrity in the sub-basin.

For purposes of this analysis, EPA considered cumulative effects to the Coal River sub-basin (891 square miles) and the Headwaters Spruce Fork sub-watershed (126.4 square miles) if the Spruce No. 1 Mine is constructed as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) and other reasonably foreseeable (proposed and/or authorized but not constructed) surface mining projects within the Coal River sub-basin are constructed. This cumulative effects analysis also takes into consideration the past and present mining projects within the sub-basin and sub-watershed, and the extent to which they have affected the current baseline conditions within the sub-basin and sub-watershed (Figure 15).

EPA is aware of at least 11 additional mining operations either proposed or authorized but not constructed in addition to Spruce No.1 in the Coal River sub-basin. Construction of valley fills and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) along with these additional projects in the Coal River sub-basin, if constructed, would directly impact approximately 29.4 miles of stream channels, and will have significant secondary and cumulative effects on downstream waters in the Coal River sub-basin. Downstream impacts from these projects can be expected to include reduced freshwater dilution, reduced headwater stream functional inputs, increased discharges of pollutants, including TDS and selenium, and the potential to contribute to existing water quality impairments within the Spruce Fork watershed and the Coal River sub-basin.

The Coal River sub-basin contains 743 miles of impaired streams, 33% of the total stream length in the sub-basin (WVDEP 2010b). The WVDEP has listed certain of these stream segments for selenium and biological impairment, among other pollutants. The additional fills associated with the Spruce No. 1 Mine, in combination with past and present mining by the applicant and other mining in the sub-basin, will cause or contribute to significant cumulative adverse impacts to the stream resources in the Coal River sub-basin, and will contribute to current water quality impairments within the sub-basin, and result in unacceptable adverse effects on wildlife and their habitat.

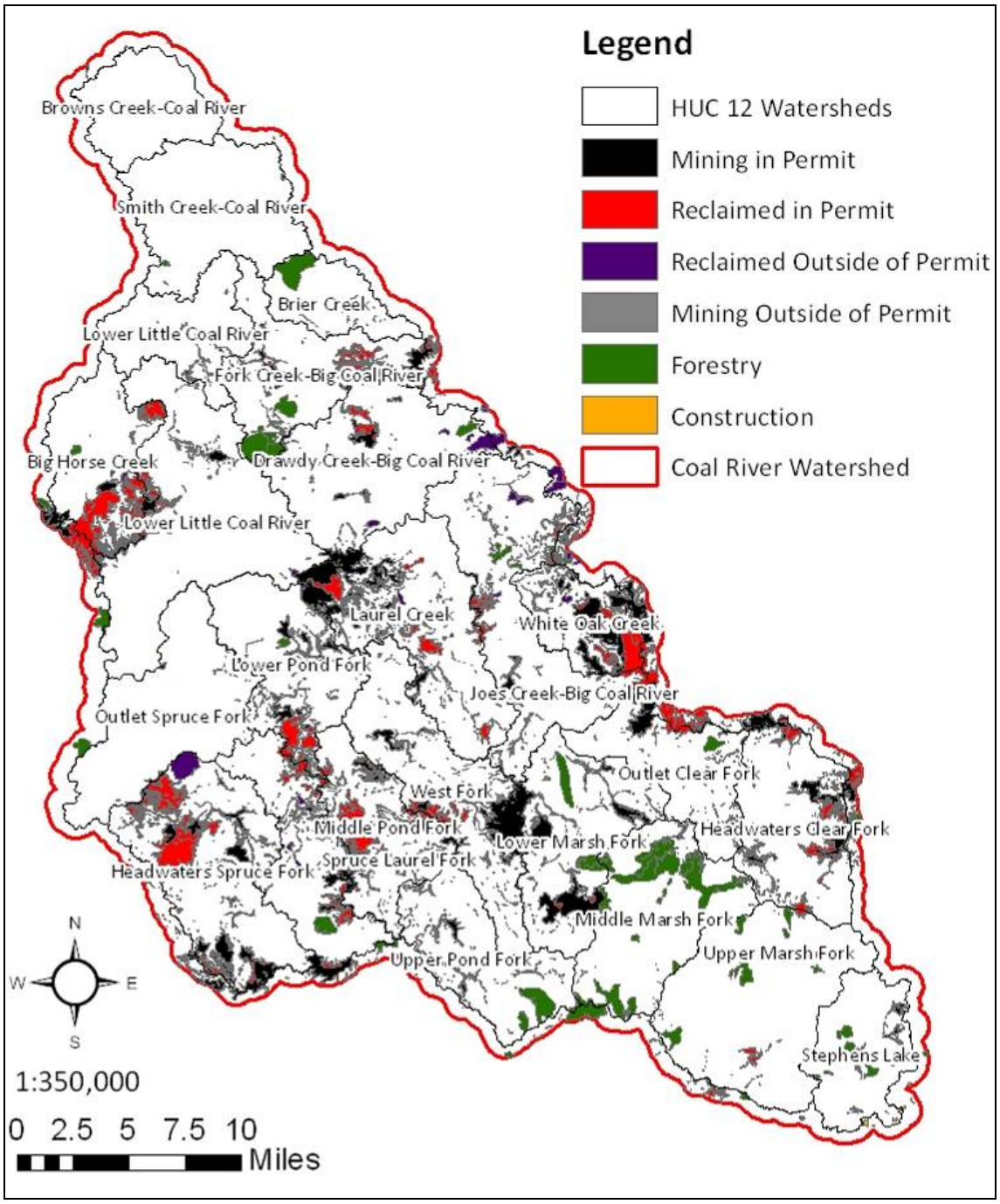

Figure 15. Illustration of the types of disturbance currently found in the Coal River sub-basin

In order to predict cumulative effects from the Spruce No. 1 Mine in conjunction with historic activities, as well as these foreseeable surface mining projects, EPA used mapped landscape data generated from remote sensing techniques and site-specific stream data generated from field sampling techniques to determine the relationship between mining activity and downstream conductivity. This analysis was then used to develop levels of mining activity, measured as percent mining in a watershed, associated with increasing

levels of conductivity that reflect increasing extirpation of aquatic life communities (see Appendix 5 for detailed methods and results).

Results of this analysis indicate that there are significant and strong quantitative relationships between mining activities in a watershed and downstream conductivity condition (See also USEPA 2010a, Appendix A and F). The majority of development-only sites had stream conductivity less than 500 µS/cm, with no development-only sites measuring higher than 800 µS/cm (Figure 16). The two regression curves based on the combined mining/development and mining-only sites were similar to each other. The mining-only regression was used to identify percent mining levels related to increasing conductivity conditions.

Using these calculations, a watershed network modeling system was constructed to estimate downstream chemical response to mining activities upstream within the Coal River sub-basin. The calculated percent mining levels were embedded in an alternative futures analysis and used to quantify changes in stream conductivity conditions under three development scenarios; current condition, full construction of the Spruce No. 1 Mine, and full construction of the Spruce No. 1 Mine plus full construction of currently WVDEP-permitted surface mines.[18] For each scenario, the number of stream segments and length of stream were calculated and classified into conductivity ranges.

Based on the results of this model, EPA estimates that summer conductivity is currently below 300 µS/cm in 5.3% (4.6 miles) of the 86.7 miles of stream segments within or downstream of the Spruce No. 1 Mine site to the mouth of the Coal River. If the Spruce No. 1 Mine is constructed as permitted, this analysis shows that there will be no stream segments with conductivity less than 300 µS/cm downstream of the mine site in the Coal River sub-basin. Currently, 2.2% (1.9 mi) of the stream segments within or downstream of the Spruce No. 1 Mine site are calculated to have conductivity greater than 1000 µS/cm. Following full construction of the permitted area, 21.7% (18.8 mi) are projected to have conductivity greater than 1000 µS/cm. As this demonstrates, conductivity is predicted to significantly increase in Spruce Fork as the Spruce No. 1 Mine is constructed.

If other permitted mine areas, in addition to Spruce No. 1, are included in the analyses, the cumulative effects are predicted to result in higher conductivities in both the Little Coal and Coal Rivers. Within the Headwaters Spruce Fork sub-watershed, percent mining is predicted to increase by 15.8% over current conditions under this scenario, which will elevate conductivity from less than 750 µS/cm to greater than 1000 µS/cm at the mouth of Spruce Fork. Similarly, within the Little Coal River watershed, the calculation of full construction of all permitted mines results in percent mining increasing by 11.2% over current conditions, which results in predicted conductivity elevating from less than 750 µS/cm to as much as 1000 µS/cm within the Little Coal River. At the broadest scale analyzed, percent mining is predicted to increase by 9.3% in the Coal

[18] EPA makes no determination at this time regarding whether these other mines comply with the § 404(b)(1) Guidelines or may result in unacceptable adverse impact under § 404(c).

River sub-basin with full construction of all permitted mines. This also resulted in conductivity increasing from less than 750 µS/cm to as much as 1000 µS/cm within the Coal River.

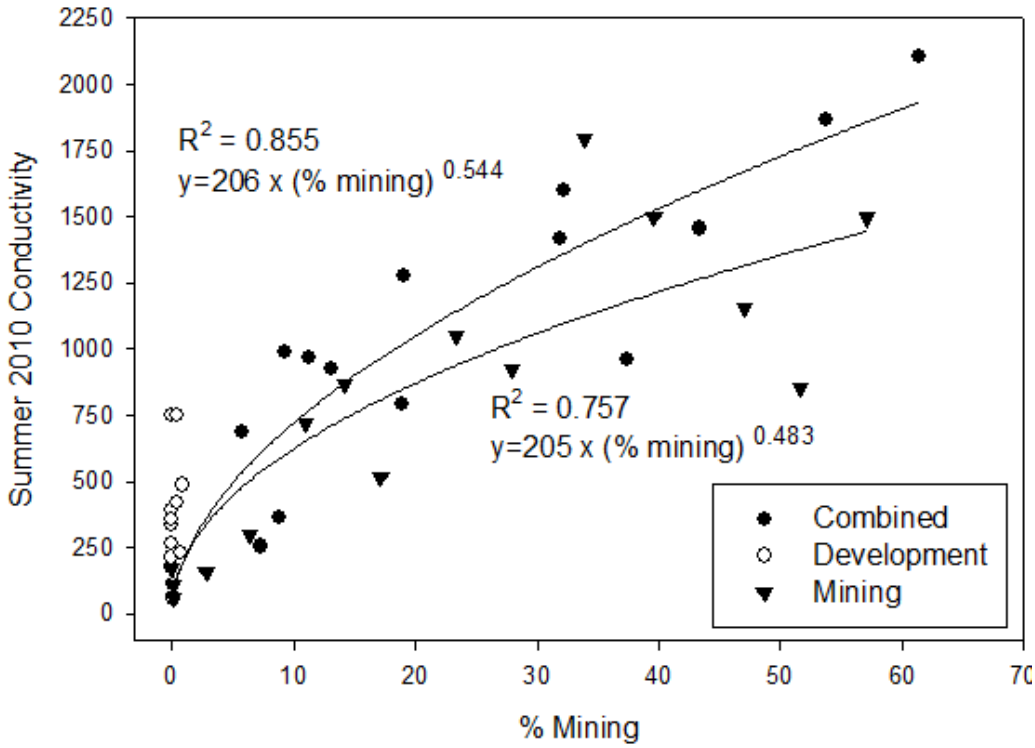

Figure 16. Model of the relationship between percent mining within a watershed and conductivity. The lower regression line is for mining-only sites, and the upper line is for combined mining/development sites.

As detailed in Section V.D.2.a., these conductivity levels have been associated with the impairment and extirpation of macroinvertebrate aquatic life. At this watershed scale, shifts in macroinvertebrate communities, and the loss of the primary food sources that these communities represent for higher trophic levels, will result in cascading ecosystem changes downstream.[19] Combined with increased levels of selenium and other mining-related pollutants, EPA believes these adverse effects will cause or contribute to significant degradation within the Coal River sub-basin. The severity of the cumulative impacts further strengthens EPA's conclusion that this project will result in unacceptable adverse impacts to wildlife and its habitat.

V.E.2.b. Secondary Effects

The § 404(b)(1) Guidelines (at 40 CFR 230.11(h)) also direct that factual findings be made regarding secondary effects on the aquatic ecosystem and that those findings be

[19] In the 2008 West Virginia Integrated Water Quality Monitoring And Assessment Report, WVDEP stated "A "shift" in the benthic macroinvertebrate community of a stream can constitute biological impairment pursuant to 47CSR2 – 3.2.i, and the WVSCI (recognized as a "best science method" in the PEIS) provides a sound scientific basis for assessment."

considered in determining whether the discharge will cause or contribute to significant degradation of the Nation's waters. To that end, the § 404(b)(1) Guidelines describe the factual finding that must be made with respect to secondary effects as follows:

> Secondary effects are effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material. Information about secondary effects on aquatic ecosystems shall be considered prior to the time final section 404 action is taken by permitting authorities.
>
> Some examples of secondary effects on an aquatic ecosystem are fluctuating water levels in an impoundment and downstream associated with the operation of a dam, septic tank leaching and surface runoff from residential or commercial developments on fill, and leachate and runoff from a sanitary landfill located in waters of the U.S.

Section V.D. includes a discussion and analysis of the secondary effects of the Spruce No. 1 Mine including the degradation of downstream water quality by 1) removing streams that currently provide sources of freshwater dilution and 2) transforming those stream areas into sources of contaminants (particularly TDS and selenium). The downstream water quality changes associated with the authorized project would significantly reduce the functional diversity, as well as the overall abundance and productivity of macroinvertebrate communities, thus, through cascading food web effects, adversely impact an extensive list of vertebrate species which depend upon the macroinvertebrate community within these streams for nourishment.

The adverse secondary effects discussed in Section V.D. include substantial changes in aquatic communities, such as loss of fish and salamander diversity and sensitive mayfly and stonefly taxa, as well as shifts to more pollution-tolerant taxa. Through the loss of stream macroinvertebrate and salamander communities, there will be, in turn, substantial effects to both aquatic and terrestrial vertebrate populations that rely on these communities as a food source. In addition, the discharges will increase loading of pollutants to downstream receiving waters, increasing the risk of harmful golden algal blooms and causing or contributing to fish and bird impairments due to selenium exposure.

V.E.3. Mitigation Will Not Adequately Offset Anticipated Impacts

If constructed as authorized the Spruce No. 1 Mine will result in direct impacts through discharge of dredged or fill material to approximately 6.6 miles of stream in Pigeonroost Branch and Oldhouse Branch. The impacts from these discharges are discussed in Sections V.C. While recognizing that the project includes mitigation efforts (including stream creation and enhancement of existing streams) to compensate for unavoidable adverse impacts, EPA believes that known compensatory mitigation techniques will not replace the high quality resources of Pigeonroost Branch and Oldhouse Branch that will be impacted by the project. Additionally, EPA believes that the current mitigation plan

does not adequately account for the quality and function of the impacted resources.

Under § 404(c), EPA has discretionary authority to prohibit or withdraw the specification of a defined area as a disposal site whenever the Administrator determines that the discharge will have an unacceptable adverse effect on a number of identified categories. Therefore, as a legal matter, EPA can make a determination that a discharge of dredged or fill material will cause unacceptable adverse effects without consideration of compensatory mitigation. The statutory standard does not mention mitigation directly and authorizes EPA to determine what constitutes an unacceptable adverse effect. In other words, EPA does not need to determine that mitigation is somehow flawed or insufficient in order to conclude that a proposed or authorized discharge would have unacceptable adverse effects. EPA's conclusion that there is noncompliance with the Guidelines with respect to mitigation confirms the unacceptability of the adverse impacts on wildlife within the project area and downstream.

The Compensatory Mitigation Plan (CMP) submitted by Mingo Logan describes on-site and off-site, in-kind mitigation. On-site compensation would include the restoration of 7,132 linear feet of stream segments temporarily impacted by the sediment ponds, and the creation of 43,565 linear feet of on-bench stream channel within the project area. On-bench sedimentation ditches are SMCRA-required Best Management Practices (BMPs) to control runoff. Off-site compensation includes stream enhancements to Spruce Fork and Rockhouse Creek through a combination of physical, aquatic habitat, and stream stabilization improvements. The CMP also proposes to direct surface water flow from the project area in existing drainage ways to promote the development of more defined channels, thus creating 26,625 linear feet of streams.

Both EPA and the USFWS have repeatedly identified problems with the mitigation techniques that are part of the CMP for the Spruce No. 1 Mine. EPA Region III's comments on the 2006 draft and final EISs for the Spruce No. 1 Mine expressed concerns that the compensatory mitigation plan did not adequately mitigate all adverse impacts and was inadequate in terms of its lack of functional assessment, as well as whether proposed headwater stream creation would in fact replace the functions of impacted resources. EPA Region III emphasized the importance of headwater stream functions that would be lost and likely not replaced, particularly by the conversion of existing drainage channels to streams as described in the CMP. In its December 4, 2001, letter the USFWS expressed similar concerns that the proposed mitigation was unlikely “to provide sufficient mitigation for permanent stream and riparian habitat loss and for the losses of the functions and values of the stream to aquatic species in the fill footprint and to the downstream ecosystem.” These concerns were reiterated by the USFWS in its June 2, 2010, and December 16, 2010, letters commenting on the EPA Region III Proposed Determination and Recommended Determinations, respectively.

As discussed below and in Appendix 3, the project fails to include all appropriate and practicable steps to minimize and compensate for the project’s adverse impacts on the aquatic ecosystem as required by 40 CFR 230.10(d). Further, EPA believes that the anticipated level of adverse impacts associated with the Spruce No. 1 Mine will not be

offset by the required compensatory mitigation to the extent necessary to prevent significant and unacceptable effects on wildlife and their habitat.

V.E.3.a. Proposed Mitigation Will Not Replace High Quality Resources in Pigeonroost Branch and Oldhouse Branch

There is no evidence in the peer-reviewed literature that the type of stream creation included in the CMP will successfully replace lost biological function and comparable stream chemistry to high quality stream resources, such as Pigeonroost Branch and Oldhouse Branch. Scientific research has demonstrated that replacement of streams is among the most difficult and frequently unsuccessful forms of mitigation (Bernhardt et al.2007). Even if stream structure and hydrology can be replaced, it is not clear that replacing structure and hydrology will result in true replacement of functions, especially the native aquatic community and headwater functions. Based upon this research, the Corps and EPA stated in the response to comments on the 2008 Compensatory Mitigation for Losses of Aquatic Resources Final Rule:

> We recognize that the scientific literature regarding the issue of stream establishment and re-establishment is limited and that some past projects have had limited success (Bernhardt et al.2007). Accordingly, we have added a new paragraph at 33 CFR 332.3(e)(3) [40 CFR 230.93(e)(3)] that specifically notes that there are some aquatic resources types that are difficult to replace and streams are included among these. It emphasizes the need to avoid and minimize impacts to these 'difficult-to-replace' resources and requires that any compensation be provided by in-kind preservation, rehabilitation, or enhancement to the extent practicable. This language is intended to discourage stream establishment and re-establishment projects while still requiring compensation for unavoidable stream impacts in the form of stream corridor restoration (via rehabilitation), enhancement, and preservation projects, where practicable.[20]

An additional 26,625 feet of high gradient stream credit is sought for connectivity channels. Connectivity channels are areas where surface water flows from the on-bench ditches, passes through NPDES outfalls, and runs downhill to eventually "form a hydrological connection to a surface tributary of a navigable water" (USACE 2007). The premise is that, if properly placed, connectivity channels will enable mine runoff water to travel down natural, steep hill slopes and ephemeral channels and into naturally non-flowing receiving segments. However, based on the changes to water quality discussed in Section V.D.1., they will receive selenium and dissolved solids from the mined area, resulting in degraded water quality and an inability of these channels to provide meaningful ecological functions and values to replace the affected streams. In addition,

[20] EPA recognizes that the effective date of the regulations governing compensatory mitigation that were promulgated at 73 Fed. Reg. 19594 (April 10, 2008) is June 9, 2008, and therefore were not in effect when the Corps of Engineers issued DA Permit No. 199800436-3 (Section 10: Coal River). Nevertheless, the above-quoted statement, taken from the preamble to those regulations, represents the most recent regulatory statement by the agencies regarding types and effectiveness of mitigation and summarizes scientific research and literature that is applicable to consideration of the likely efficacy of the compensatory mitigation proposed for the Spruce No. 1 Mine.

these channels will function as sources of pollutants, delivering additional selenium and total dissolved solids to downstream headwater streams.

As discussed in this document, the streams of Pigeonroost Branch and Oldhouse Branch have been shown to exhibit high water quality and high functional capacity. Given the difficulty of stream re-establishment to mitigate for impacts to streams in general, EPA believes it is extremely unlikely that high-value streams such as these can be replaced by on-site stream creation techniques involving conversion of sedimentation ditches fed by mine spoil runoff and seepage. As explained further in Appendix 3, EPA believes that the mitigation for the Spruce No. 1 Mine will not offset the anticipated impacts to an acceptable level.

V.E.3.b. The Compensatory Mitigation Plan is Based upon a Misclassification of the Impacted Resources

The starting point for an adequate compensatory mitigation plan is accurate characterization of the impacted resources. EPA believes that the Spruce No. 1 Mine CMP is based upon a misclassification of impacts to perennial and intermittent streams, thereby resulting in an insufficient baseline from which to design adequate stream compensation.

The USGS documented the flow origin, drainage areas and hydrologic characteristics of perennial and intermittent streams in this region in 2000 and 2001 (Paybins 2003). A field reconnaissance by EPA during dry conditions in September 1998 (Green and Passmore 1999) found distinct perennial benthic communities (i.e., long-lived taxa representative of perennial conditions) in the upper reaches of Pigeonroost Branch and Oldhouse Branch. Through these onsite visits and biological data collection, combined with USGS drainage estimates, EPA estimates that, within the mine footprints of Pigeonroost Branch, and Oldhouse Branch, approximately four miles of stream (~20,000 feet) are perennial. In this case, "perennial" refers to streams that have either 1) perennial flow and indicator biota requiring at least a 6 month life cycle, or 2) non-contiguous surface flow during drought conditions but indicator biota requiring at least a 6 month life cycle.

This is in contrast to the DA Permit estimation of 165 feet of perennial waters within the entire project area. This misclassification has a critical impact upon the type of mitigation that would be required to offset these impacts. The resource type plays an important role in the types of expected aquatic communities, the degree in which each resource provides structure and function, and the amount of organic matter and nutrients (and contaminants) ultimately retained or loaded to receiving streams. This misclassification means that the compensatory mitigation plan does not properly account for, and therefore will not offset, the full range of adverse impacts related to the project. A more detailed description of EPA's analysis of stream type is described in Appendix 3.

V.E.3.c. The Compensatory Mitigation Plan Lacks an Adequate Functional Assessment

In addition to being based on a misclassification of resource type, the CMP also is based upon an inadequate functional assessment of the impacted resources. The goal of compensatory mitigation is to replace the aquatic resource function lost or adversely affected by authorized activities. Therefore, to ensure that the functions are being replaced, the compensatory mitigation must create or restore streams that sustain comparable biological communities and chemical and physical characteristics and provide comparable physical, chemical and biological functions to the streams that have been eliminated. The § 404(b)(1) Guidelines require the permitting authority to make certain factual determinations addressing the potential short-term or long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment. See, 40 CFR 230.11. Among the factual determinations required of the permitting authority is the following:

> *(e) Aquatic ecosystem and organism determinations*. Determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystem and organisms.

This provision of the Guidelines requires the permitting authority to determine the nature and degree of effect that the proposed discharge will have on both the structure and function of the aquatic ecosystem and organisms. This principal from the Guidelines was reiterated and clarified in a joint Department of the Army/EPA guidance memo, focused specifically on the review of permit applications for Appalachian surface coal mining.[21]

In order to ensure adequate replacement of both structure and function, the impacted streams must be accurately assessed and the proposed compensation must be evaluated using comparable standards for assessment. As discussed above, the baseline assessment of the existing and impacted streams on the site missed and misclassified well over twenty thousand linear feet of headwater streams, which prevented the USACE from identifying the appropriate compensation needs of this project.

In addition, the assessment method used by the permittee was inadequate and led to an improper valuation of compensation needs and proposals. The CMP utilized an assessment method referred to as the Stream Habitat Unit (SHU) method to calculate mitigation debits and credits. This assessment entails a combination of linear lengths of impact, habitat assessment scores, and stream hydrological status.[22] The limitations of the

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[21] EPA recognizes that the effective date of this memorandum is July 30, 2010, and therefore was not in effect at the time the Corps issued DA Permit No. 199800436-3 (Section 10: Coal River). Nevertheless, the requirement in the Guidelines regarding the factual determination of the impact to the structure and function of the aquatic ecosystem is applicable and relevant to EPA's evaluation of the Spruce No. 1 compensatory mitigation plan, and the July 30, 2010 memorandum reflects the agencies most recent statement about the meaning of that requirement.

[22] Even though the Corps did not finally rely solely on the SHU for mitigation requirements, the Corps did not categorically prevent the permittee from using this approach as a basis for its mitigation plan, and thereby allowed Mingo Logan to use this approach to help justify their mitigation performance and success criteria.

SHU and need for an adequate functional assessment are further explained in Appendix 3. The SHU as presented in the CMP only accounts for the physical aspects of stream condition and fails to account for the interrelationship of water chemistry and biological resources in stream functioning.

As a result of this EPA believes the current CMP does not adequately account for or replace the structure and function of the lost streams. EPA does not believe that increased ratios of intermittent or ephemeral streams offset this inadequacy. While DA Permit No. 199800436-3 (Section 10: Coal River) refers to biological success criteria and the use of a yet-to-be developed functional assessment method for mitigation monitoring, the permit conditions do not clearly require the replacement of lost biological function and comparable stream chemistry or adequate compensatory mitigation success criteria.

V.E.3.d. Conversion of Erosion Control Channels Will Not Successfully Replace the Impacted Resources

Based on observations of other on-bench SMCRA drainage or erosion control ditches (Kirk 1999a, Green et al. 2000, and Gingerich 2009), EPA believes the CMP's proposed conversion of these ditches will not successfully replace the impacted resources, alone or in concert with other mitigation contained in the CMP. Over 50% of the linear stream length in the Spruce mitigation plan relies on conversion of on-bench SMCRA drainage or control ditches. Data show that water quality in these types of sedimentation ditches in the Appalachian region is typically highly degraded, as a result of the water in these ditches percolating through mine spoil (Gingerich 2009). Even when the sedimentation ditches are enhanced for benthic substrata and riparian vegetation, such as by adding boulder clusters, the resulting water quality will be so degraded that the ditches will not meet pre-mining water chemistry baselines, especially in the case of high quality streams such as Pigeonroost Branch and Oldhouse Branch.

As described previously, degraded water chemistry caused by the addition of TDS and selenium typically leads to degraded biological communities. The proposed constructed stream channels will not meaningfully reduce the concentrations of these ions in the water flowing through them. Because of this degraded water chemistry, any created waterbodies would not support the healthy and diverse biological communities that they are intended to replace. Moreover, the water quality (e.g., salinity) would be so degraded that it will foster conditions favorable to the establishment of toxic Golden Algae.

A comparison of family-level macroinvertebrate data between sediment ditches and Pigeonroost Branch and Oldhouse Branch reveals marked differences in species richness and very little taxonomic overlap. Based upon Kirk (1999a) and EPA data, total familial richness in sediment ditches ranged between 4 to 11 taxa, with 0 to 3 families of Ephemeroptera, Plecoptera or Trichoptera (EPT) taxa present. In contrast, total familial richness at Oldhouse Branch and Pigeonroost Branch was 40, with 26 families of EPT taxa present.

Of the taxa collected in the sediment ditches, only seven were also present in Oldhouse Branch and Pigeonroost Branch. With regards to the taxa present in the sediment ditches that were not found in Oldhouse Branch and Pigeonroost Branch, Pond et al. (2008) found that these taxa do not generally occur at sites unaffected by mining. These data demonstrate that taxonomic assemblages in sediment ditches are not only less diverse than streams unaffected by mining, but include a suite of organisms not found in high quality headwater streams unaffected by mining, such as Oldhouse Branch and Pigeonroost Branch.

EPA believes these created streams converted from erosion control channels would be considered degraded and will not successfully replace Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution with healthy biological communities and water quality, either alone or in concert with other mitigation contained in the CMP.

A more detailed discussion of the limitations of on-bench sedimentation ditches for mitigation is provided in Appendix 3.

V.E.3.e. The Compensatory Mitigation Plan Does Not Account for the Loss of Ecological Services Provided by Headwater Streams

EPA is also concerned with the separation of the ecological elements into single, separate aspects of the ecology in the Spruce No. 1 Mine CMP, with limited consideration for the interconnectedness of the entire ecosystem. The forested slopes and coves located within the Spruce No. 1 Mine area are drained by a dendritic mosaic of ephemeral, intermittent and perennial headwater streams and watercourses. The watershed is inextricably linked with the stream system that drains it. The overwhelming bulk of the organic matter that sustains the stream biota in Spruce Fork is a function of the upstream environment. While compensatory mitigation is required for the impacts to waters of the United States under the § 404 program, EPA believes that a well-designed compensatory mitigation plan should take into account this terrestrial-aquatic linkage and ensure that restored or created channels provide greater functions than simply service as water conveyance structures.

In a pre-mined condition, these headwater streams are recipients of allochthonous material (i.e., material originating from outside of the stream system) and water inputs (i.e., surface, subsurface, and groundwater) from the surrounding forested communities. The post-mined environment, however, creates severely altered conditions in stream courses that are not destroyed by valley fills. Those alterations include:

a. Elimination of water and processed organic material from former upstream tributaries that will be under valley fills.

b. Altered contributions of water and allochthonous material from the surrounding upland watershed, due to the altered character of the soil and vegetation communities in a post-mine environment.

c. Altered hydrograph with new flow regimes that markedly depart from that under which the streams have evolved.

d. Altered timing, temperature and chemical composition of post-mine discharges of water to receiving streams.

The permittee proposes to restore or create 71 acres of riparian forest as part of its reclamation and stream creation and restoration activities. While EPA agrees that planting trees along any newly created stream channels better recreates pre-mining riparian conditions than no riparian vegetation, EPA has not seen evidence that such practices can effectively replace lost natural riparian ecosystems. The current riparian zone consists largely of basswood, beech, tulip poplar, buckeye, sugar maple, white oak and red oak, yet out of the 11 tree species listed in the Compensatory Mitigation Plan, only two are found within or near the project area. Riparian systems created through this plan are likely to function differently from buried streams because their vegetation communities will differ from those present on the project site.

The Spruce No. 1 Mine will profoundly alter the contributing watershed. Effectively the new landscape widely departs from that within which the stream network has evolved. The subsequent ecosystem is an entirely new system. Based on available information, the mitigation will not replace the structure and function of the pre-mined conditions including those elements that are dependent on contributions from the surrounding watershed. These concerns regarding the mitigation are shared by the USFWS whose comment letter to EPA regarding the Recommended Determination states "…the currently-proposed mitigation for these impacts is unlikely to adequately compensate for the loss and degradation of these streams, their biological productivity and diversity, or their ecological integrity."

V.E.4. Summary

The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by the streams of Pigeonroost Branch and Oldhouse Branch including maintenance of biologically diverse wildlife habitat and profoundly alter the contributing watershed. EPA maintains that impacts to these functions at the scale associated with this project will result in significant degradation (40 CFR 230.10(c)) of the Nation's waters, particularly in light of the extensive cumulative stream losses in the Spruce Fork and Coal River watersheds, and that such degradation will result in unacceptable adverse impacts on wildlife and wildlife habitat. EPA does not believe these impacts can be adequately mitigated to reduce the impacts to an acceptable level by the compensatory mitigation described in the CMP. Finally, the possibility that additional practicable alternative project configurations and practices exist that would significantly reduce and/or avoid much of the discharges to Pigeonroost Branch and Oldhouse Branch further enhances EPA's assessment of the unacceptability of the impacts that were previously described.

VI. Other Considerations

As set forth above, EPA has determined that the impacts from the discharges to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) described in Section V. will have an unacceptable adverse effect on wildlife both within the project area and downstream of the project area, and that the project does not comply with the requirements of the § 404(b)(1) Guidelines. This section identifies other, additional considerations that are of concern to EPA but are not part of the basis for EPA's conclusion that the impacts will have an unacceptable adverse effect on wildlife.

EPA includes this discussion to recognize additional significant environmental, public health, and environmental justice impacts associated with the Spruce No. 1 Mine that are relevant to EPA's and the Corps' broader responsibilities in reaching permit decisions under the Clean Water Act and other statutes and policies, including the National Environmental Policy Act and the Environmental Justice Executive Order (E.O. 12898). EPA understands that the impacts identified in Section VI are not directly relevant to the Agency's determination under § 404(c). However, EPA includes this section to emphasize for the public the broader impacts of the project as they relate to EPA's legal responsibilities. EPA takes seriously each of its responsibilities to assure effective protection for coalfield communities from environmental, human health, and water quality impacts associated with surface coal mining activities.

VI.A. Impacts from Activities Dependent upon Specification of Pigeonroost Branch and Oldhouse Branch as Disposal Sites for the Discharge of Dredged or Fill Material for the Spruce No. 1 Mine

The following sections discuss impacts that depend upon specification of Pigeonroost Branch and Oldhouse Branch for construction of valley fills and sediment ponds for the Spruce No. 1 Mine, but occur as a result of discharges of excess spoil to areas outside of jurisdictional waters, or occur as a result of other mining-related activities, such as deforestation.

VI.A.1. Migratory Birds

The Spruce No. 1 Mine will destroy approximately 2,278 acres of deciduous forests. Among the many migratory birds likely to breed in the project area, there are six species that the USFWS has designated as Birds of Conservation Concern within the Appalachian Mountains Bird Conservation Region that may be impacted. These include the Cerulean, Kentucky, Swainson's and Worm-eating Warblers, the Wood Thrush, and the Louisiana Waterthrush. The water-dependent Louisiana Waterthrush was discussed in Sections V.C.4. and V.D.5. above. The other five avian species are also designated as BCC species within the USFWS's Northeast Region as a whole and nationally (U.S. Fish and Wildlife Service 2008). The first four are also considered to be among the 100 most at-risk bird species in North America (Wells 2007).

Cerulean and Worm-eating Warblers are also both area-sensitive species that rely on large blocks of intact, mature, interior forest habitats to support productive breeding populations. The Cerulean Warbler breeding population is thought to have declined by about 75% over the past 45 years – the most dramatic decline of any North American warbler monitored by the Breeding Bird Survey (Sauer et al. 2005). Both species are threatened by the loss and fragmentation of these habitats (U.S. Fish and Wildlife Service 2007, Wells 2007). Deforestation associated with the Spruce No. 1 Mine can be expected to adversely impact their breeding populations (Weakland and Wood 2005, Wells 2007).

The project also will impact other bird species that rely on mature forest habitats. Bird species that rely on mature forest habitats that are abundant in the Appalachian region are Kentucky warblers in the understory; and Wood Thrush, Swainson's Warbler, Acadian Flycatcher, and Ovenbirds in mesic hardwoods. These and many other avian species are all impacted by forest fragmentation and habitat loss, such as that which would occur in connection with the Spruce No. 1 Mine. Spatial analyses of the effect of Appalachian mountaintop mining on interior forest indicate that interior forest is lost at a rate 1.75-5.0 times greater than the direct rate of loss of overall forest cover due to mountaintop mining (Wickham et al. 2007).

The Spruce No. 1 Mine will impact mature forested habitat, over a substantial timeframe, replacing the impacted areas with reclaimed areas dominated by grasses and herbaceous species. Many reclaimed areas such as those expected at Spruce No. 1 Mine show little or no regrowth of woody vegetation even after 15 years. The PEIS found significant differences in bird populations between forested and reclaimed sites, namely the loss of the above-mentioned species, and subsequent replacement by more opportunistic grassland species. Also, the loss of the healthy headwater areas of Spruce Fork will reduce the feeding and foraging areas available to specialist bird species in this ecoregion. This reduction in available habitat could potentially impact their long-term viability in the Spruce Fork watershed and the larger ecoregion.

The USFWS evaluated the terrestrial habitats of the project area and concluded that construction of the mine was likely to impact migratory birds via the loss and fragmentation of forest habitat, decreasing habitat heterogeneity, increasing isolation of populations, and increasing exposure to nest predators and parasites (USFWS 1998). The USFWS also expressed concerns specific to bird populations within the Coal River sub-basin related to adverse impacts of the Spruce No. 1 Mine. These concerns included the direct loss of habitat and direct and indirect loss of food resources, for forest interior and riparian-obligate species of migratory birds, including six species the Service considers Birds of Conservation Concern (i.e., Cerulean, Kentucky, Swainson's, and Worm-eating Warblers; Louisiana Waterthrush; Wood Thrush) (USFWS, 2008).

The USFWS continues to believe that construction of the Spruce No. 1 Mine will adversely impact these and other forest-breeding migratory birds. The valley fills will result in the permanent loss of headwater streams that may be used by Louisiana Waterthrushes. The USFWS indicates they are unaware of peer-reviewed research that suggests that these birds will simply relocate to an adjacent, unimpacted watershed and

have comparable survival and reproductive success. The downstream increases in conductivity, selenium and perhaps other contaminants are also likely to adversely affect those waterthrushes not excluded by the direct impacts of the fill via impacts to their food base. In some freshwater food webs, selenium has bioaccumulated to four times the level considered toxic, which can expose birds to reproductive failure when they eat fish or insects with high selenium levels.

While the work of the Appalachian Regional Reforestation Initiative (ARRI) shows substantial promise for better reclamation of mined lands, it has not been demonstrated that these reclaimed areas will generate and sustain forests that provide habitat characteristics and qualities comparable to those of native forest. For these reasons, the construction of the Spruce No. 1 Mine will result in permanent and/or long-term loss of breeding habitats important to several migratory bird species of conservation concern.

VI.A.2. Bats & Other Mammals

Large-scale mountaintop mining has been identified among the threats to bat species in the region according to the USFWS. Loss of the bat's habitat, foraging areas, and food sources, in conjunction with recently identified concerns related to white-nose syndrome, may result in adverse impacts to these wildlife resources. Similarly, habitat loss from land clearing will also affect numerous other mammal species within the project area that rely on forested landscapes for shelter and foraging.

As set forth in Section IV.B.5., the habitat in the project area is quite suitable for federally endangered Indiana Bats, which have been documented in adjacent counties. It is therefore quite possible that Indiana Bats occur within the project area, and that they could be impacted by the loss of forest habitat associated with the Spruce No. 1 Mine and by the loss of headwater streams, riparian areas and associated aquatic and terrestrial insects, as well as by the downstream degradation of these resources likely to be caused by the project.

In addition to Indiana Bats, the USFWS was recently petitioned to list two other bat species, the Eastern Small-footed Bat and Northern Long-eared Bat, under the Endangered Species Act (Center for Biological Diversity 2010). Both species occur in the vicinity of the Spruce No. 1 Mine, and both were captured during mist net surveys at the project site. Like Indiana Bats, these two species are susceptible to population-level impacts from White Nose Syndrome (WNS), which has devastated some populations of eastern bats. If WNS affects West Virginia bats as it has bats in other states, and if large die-offs occur, it will further complicate the already complex challenge of conserving bat species. Previous mining and logging activities and forest loss have also been identified as having adverse affects on bat populations. Traditionally used reclamation techniques, many of which are designed to minimize erosion and provide backfill stability, are incompatible with re-establishment of trees necessary for successful roosting by bats. Such reclamation techniques have the potential to further stress bat populations.

In addition to bats, forest habitat loss associated with the project could have substantial effects on other mammals that depend upon forest resources. While some mammal species are habitat generalists and will not be greatly affected by conversion to a grassland environment, others require forest habitats for protection from predation, foraging and specific habitat needs. These species will likely be adversely affected by the project. Additionally, healthy forested riparian areas can be important habitat for small mammals that feed on insects and small amphibians, as they are proximate to aquatic food sources. As such, insectivorous small mammals that feed on larval aquatic insects, emergent adult aquatic insects, and salamanders will likely be adversely affected by reduced aquatic macroinvertebrate abundances and increased levels of selenium in their prey.

VI.B. Environmental Justice

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EPA has this goal for all communities and persons across this Nation. Executive Order 12898 directs: "To the greatest extent practicable…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations…"

According to the 2000 United States Census, Spruce No. 1 Mine is located in a census block group that contains 335 people. A census block group is a geographical unit used by the U.S. Census Bureau (Bureau) that is between a census tract and a census block in size and scale. It is the smallest geographical unit for which the Bureau publishes data. Census block groups generally contain between 600 and 3,000 people, with a target size of 1,500 people.

Spruce No. 1 Mine is located in a census block group where the average per capita income is $15,411. This is more than $6,000 less than the national average of $21,587 and more than $1,000 less than the West Virginia state average of $16,477. The average median family income is also almost $13,000 less than the national average of $52,029. Moreover, 24% of the residents of Logan County live below the poverty line, which also exceeds state and national averages. Studies have highlighted that, despite the economic benefits provided by coal extraction, coal-producing counties in Central Appalachia continue to have some of the highest poverty and unemployment rates in the region (McIlmoil and Hansen 2010).

The Corps included a discussion of environmental justice in the Spruce No. 1 EIS. However, as noted in comment letters in June and October 2006, EPA's environmental justice analysis indicates that there may be a disproportionately high and adverse impact on the low-income population affected by the mining activity. Additionally, EPA remains concerned that the local community did not have the necessary information, or

the opportunity, to meaningfully participate in the EIS process. Specifically, EPA is concerned the community was not informed when changes were made to different aspects of the mine project during the permitting and EIS process and therefore was not able to meaningfully comment on the final aspects of the mine.

The mountains affected by Spruce No. 1 Mine are an important cultural resource for many residents. In many cases the mountains have helped define their culture, and they are an integral part of their daily lives. For example, the mountain ridges of southern West Virginia have for over two centuries been viewed largely as a "commons", where local residents have gathered wild medicinal herbs such as American Ginseng (*Panax quinquefolius*) and Goldenseal (*Hydrastis canadensis*) (Hufford 2003). In many cases, collection of these wild herbs provides much needed extra income to local communities during times of unemployment or economic hardship (Bailey 1999). Removing these mountains may have profound cultural changes on the residents in the area, and so it is important that cultural impacts be considered as well.

EPA considers action pursuant to § 404(c) to be within the scope of the policy directive of Executive Order 12898. A § 404(c) action has the potential to affect human health or the environment of low-income or minority populations. Accordingly, EPA evaluates environmental justice concerns when undertaking an action pursuant to § 404(c). In this case, EPA Region III conducted a public hearing on May 18, 2010 and received comments both orally and in writing. EPA has considered that members of the community expressed concern about loss of jobs and tax revenue (supporting local communities and schools) in the event that EPA's § 404(c) action would preclude any activities authorized at the Spruce No. 1 Mine. At the same time, EPA also has considered that members of the community have expressed concern regarding the adverse environmental and cultural aspects of the project described above. EPA also has received a petition from a variety of stakeholders raising concerns related to environmental justice issues associated with mountaintop mining.

In order to satisfy Executive Order 12898, EPA has considered whether there would be "…disproportionately high and adverse human health or environmental effects…" from its regulatory action. The scope of the inquiry for purposes of EPA's environmental justice analysis is directly tied to the scope of the regulatory action that EPA is taking. In the context of a Clean Water Act § 404(c) action, EPA is authorized to prohibit, restrict, or deny specification (or withdraw specification) of the discharge of dredged or fill material at defined sites in waters of the United States whenever it determines that use of such sites for disposal would have an unacceptable adverse impact on "municipal water supplies, shellfish beds, fishery areas (including spawning and breeding areas), wildlife, or recreational areas."

Accordingly, EPA has considered the potential effects on municipal water supplies, shellfish beds, fishery areas, wildlife and recreational areas (all § 404(c) resources) of the project site in its environmental justice analysis within the context of this Final Determination under § 404(c). EPA has also considered whether the effects, if any, of EPA's § 404(c) action on the § 404(c) resources will have a "disproportionately high and

adverse human health or environmental [effect]" on "minority populations and low-income populations" of the project area.

EPA concludes, after performing the EJ analysis contemplated in Executive Order 12898 to the greatest extent practicable, and incorporating public comment, that this Final Determination under § 404(c) will not have a disproportionately high and adverse human health or environmental effect on the low-income and minority populations of the project area. EPA notes that the scope of this Final Determination is limited to withdrawal of specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for the discharge of dredged or fill material for the construction of valley fills and sediment ponds associated with the Spruce No. 1 Mine as authorized, as well as the prohibition of future discharges, within the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries, associated with surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine. This action neither prohibits nor authorizes coal mining.

VI.C. Public Health

Interest in the overall environmental and human health effects from mountain top mining has been increasing during recent years. A growing body of research suggests that health disparities are not uniformly distributed across the Appalachian region, but instead are concentrated in areas where surface coal mining activity takes place (Hendryx et al. 2007, 2008, Hendryx 2008, Hitt and Hendryx 2010, Hendryx and Zullig 2009). This body of research examined study areas that include the Spruce No. 1 Mine project area. EPA has reviewed these studies, which sought to evaluate whether associations between surface coal mining and health exist. These studies do not provide direct assessments of environmental air and water quality in mining areas in relation to individual exposures and health outcomes. More comprehensive research to develop these direct assessments, including environmental chemical analyses and biological monitoring, would require significantly greater study than is appropriate for this Final Determination.

However, the authors of these studies identify significant associations between surface coal mining activity and a variety of health disparities. They indicate that mortality rates in Appalachian coal mining regions for chronic respiratory, cardiovascular, and kidney disease, and for some forms of cancer including lung cancer are disproportionately elevated when compared to other regions (Hendryx 2008, Hendryx et al. 2007, 2008, Hendryx and Zullig 2009). One study also demonstrates that higher cancer mortality rates are strongly associated with lower WVSCI scores even after accounting for smoking, poverty, and urbanization (Hitt and Hendryx 2010). Another study spatially autocorrolates cancer mortality with surface mining intensity as measured by West Virginia permit boundaries after accounting for the same factors (Hendryx et al. 2010). These studies by their nature could not and do not establish any causal linkage between surface coal mining and these elevated rates of adverse health effects, but because they point to significant associations between surface coal mining and elevated rates of adverse health impacts, the results warrant more research using rigorous epidemiological methods. The existing body of literature suggests that various negative health outcomes

are not the result of a single exposure, but may reflect chronic exposures to multiple environmental contaminants, both air and/or water, which will vary for each individual.

VII. Conclusions and Final Determination

Based on the foregoing analyses, EPA Region III's Recommended Determination, and upon consideration of the public comments received in response to EPA Region III's Proposed and Recommended Determinations, EPA has determined that discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch and their tributaries for the purposes of construction, operation, and reclamation of the Spruce No. 1 Mine as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) will have unacceptable adverse effects on wildlife. DA Permit No. 199800436-3 (Section 10: Coal River) authorizes construction of valley fills and sediment ponds and other discharges into Pigeonroost Branch and Oldhouse Branch and their tributaries that will bury approximately 6.6 miles of high quality headwater streams. Pigeonroost Branch and Oldhouse Branch support diverse and healthy biological communities comparable to nearby White Oak Branch, recognized by the WVDEP as supporting least-disturbed, reference quality conditions. Pigeonroost Branch and Oldhouse Branch represent streams within the larger Headwaters Spruce Fork sub-watershed and Coal River sub-basin that remain relatively free of water quality degradation. As such, Pigeonroost Branch and Oldhouse Branch are valuable in and of themselves and provide essential habitat for wildlife species within the Headwaters Spruce Fork sub-watershed and Coal River sub-basin.

As authorized by the DA Permit, discharges to Pigeonroost Branch and Oldhouse Branch will bury wildlife that live in those streams or within the footprint of the valley fills. Other wildlife will lose important headwater stream habitat on which they depend for all or part of their life cycles. EPA has determined that those impacts alone are unacceptable adverse impacts because of the miles of stream destroyed, the rarity of those streams, and the importance of those streams and their wildlife to the watershed. Unacceptable adverse effects on wildlife from the activities authorized by the permit will not be limited to direct burial of wildlife and significant loss of wildlife habitat. Burial of Pigeonroost Branch and Oldhouse Branch would also result in unacceptable adverse effects on wildlife downstream caused by the removal of functions performed by the buried resources and by transformation of the buried areas into sources that contribute contaminants to downstream waters. In addition, authorized discharges to Pigeonroost Branch and Oldhouse Branch would contribute to conditions that would support blooms of golden algae that release toxins that kill fish and other aquatic life. Thus, EPA has also determined that these adverse impacts on downstream wildlife by themselves are unacceptable.

In addition, these adverse impacts are not in compliance with the requirements of the Clean Water Act (CWA) and EPA's implementing regulations under § 404(b)(1). EPA has determined that the impacts described above may be avoidable and the permittee has failed to demonstrate that there are no less environmentally damaging alternatives; the discharges associated with the Spruce No. 1 Mine will cause or contribute to significant degradation of waters of the United States (especially when considered in the context of the significant cumulative losses and impairment of streams across the Central Appalachian ecoregion); and the compensatory mitigation will not adequately offset the

impacts to Pigeonroost Branch and Oldhouse Branch. These failures to comply with the Guidelines serve to strengthen EPA's judgment about the unacceptability of the significant adverse impacts that will occur.

EPA also notes that USFWS, in its comments on both the Proposed and Recommended Determinations, concurred with EPA Region III's conclusion that the project, as authorized, would result in unacceptable adverse effects on wildlife and that this conclusion is supported by the available scientific information. USFWS also notes that it has consistently expressed concerns regarding the loss of headwater streams and adjacent riparian and terrestrial habitats associated with the Spruce No. 1 Mine, as well as its likely impacts on downstream water quality, aquatic organisms, and terrestrial and aquatic wildlife that depend on those resources.

Finally, EPA notes that this Final Determination is a case-specific determination based on the facts and circumstances presented here. EPA's § 404(c) authority does not require a finding that the particular circumstances are unique, rather it requires a finding of unacceptable adverse impacts to protected resources. EPA's authority is discretionary, and the agency evaluates unacceptability based on the context of the adverse impacts, including their relative size and whether or not it is an impact the aquatic resource can incur without significant adverse environmental effects. Similarly, EPA's decision to undertake a § 404(c) action after a permit had been issued is also a case-specific one and does not threaten the tens of thousands of permits and authorizations that are issued by the U.S. Corps of Engineers every year. This determination was initiated based on the substantial number of project-specific considerations focusing on important headwater stream miles impacted in a stressed watershed where a vast majority of the impacts authorized by the permit had not occurred because of third-party litigation. This is a rare circumstance and the fact that this is only the second final determination following permit issuance in the past 40 years demonstrates that EPA does not undertake such an action lightly.

Accordingly, pursuant to § 404(c) of the Clean Water Act and its implementing regulations at 40 CFR Part 231 and for the reasons set forth herein, it is my determination that the specification embodied in DA Permit No. 199800436-3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch, and their tributaries, as disposal sites for discharges of dredged or fill material for construction, operation, and reclamation of the Spruce No. 1 Mine be withdrawn. This Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine.

Date: 1/13/11

Peter Silva
Assistant Administrator
Office of Water

Jennifer Fulton/R3/USEPA/US	To	Christine Mazzarella
01/13/2011 01:37 PM	cc	
	bcc	
	Subject	Fw: Coal Tattoo: Breaking news: EPA vetoes Spruce Mine permit

all is well (see Todd's response below).

Jennifer B. Fulton
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----- Forwarded by Jennifer Fulton/R3/USEPA/US on 01/13/2011 01:37 PM -----

From:	"Todd Petty" <jtpetty@wvu.edu>
To:	Jennifer Fulton/R3/USEPA/US@EPA, <jtpetty@wvu.edu>, <mstrager@wvu.edu>, <pziemkie@wvu.edu>
Date:	01/13/2011 12:16 PM
Subject:	Re: Coal Tattoo: Breaking news: EPA vetoes Spruce Mine permit

I have a press release in the works. Started it last night. My goal is to have something agreeable to all by tomorrow AM.

-----Original Message-----
From: <Fulton.Jennifer@epamail.epa.gov>
To: Todd Petty <jtpetty@wvu.edu>
To: Michael Strager <mstrager@wvu.edu>
To: Paul Ziemkiewicz <pziemkie@wvu.edu>

Sent: 1/13/2011 11:57:26 AM
Subject: Fw: Coal Tattoo: Breaking news: EPA vetoes Spruce Mine permit

Hi guys,
FYI, the Final Determination for the Spruce Mine went out today. Your cumulative impact work was an appendix to the FD. You might want to consider a press release?
Jen

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----- Forwarded by Jennifer Fulton/R3/USEPA/US on 01/13/2011 11:29 AM -----

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Date:
01/13/2011 10:50 AM
Subject:
Coal Tattoo: Breaking news: EPA vetoes Spruce Mine permit

Charleston Gazette's Coal Tattoo
Breaking news: EPA vetoes Spruce Mine permit
January 13, 2011 by Ken Ward Jr.

Word is just coming down that the U.S. Environmental Protection Agency has vetoed the largest single mountaintop removal permit in West Virginia history.
The move is part of an Obama administration crackdown aimed at reducing the effects of mountaintop removal coal-mining on the environment and on coalfield communities in Appalachian — impacts that scientists are increasingly finding to be pervasive and irreversible.
The final EPA decision document is available here.
EPA officials this morning were alerting West Virginia’s congressional delegation to their action, and undoubtedly preparing for a huge backlash from the mining industry and its friends among coalfield political leaders.

In making its decision to veto the U.S. Army Corps of Engineers' approval of the 2,300-acre mine proposed for the Blair area of Logan County, EPA noted that it reviewed more than 50,000 public comments and held a major public hearing in West Virginia. EPA officials said their agency is "acting under the law and using the best science available to protect water quality, wildlife and Appalachian communities who rely on clean waters for drinking, fishing and swimming."

Peter S. Silva, EPA's assistant administrator for water, said:

The proposed Spruce No. 1 Mine would use destructive and unsustainable mining practices that jeopardize the health of Appalachian communities and clean water on which they depend. Coal and coal mining are part of our nation's energy future, and EPA has worked with companies to design mining operations that adequately protect our nation's water. We have responsibility under the law to protect water quality and safeguard the people who rely on clean water.

The agency also said:

EPA's final determination on the Spruce Mine comes after discussions with the company spanning more than a year failed to produce an agreement that would lead to a significant decrease in impacts to the environment and Appalachian communities. The action prevents the mine from disposing the waste into streams unless the company identifies an alternative mining design that would avoid irreversible damage to water quality and meets the requirements of the law. Despite EPA's willingness to consider alternatives, Mingo Logan did not offer any new proposed mining configurations in response to EPA's Recommended Determination.

In addition, EPA argued:

EPA believes that companies can design their operations to make them more sustainable and compliant with the law. Last year, EPA worked closely with a mining company in West Virginia to eliminate nearly 50 percent of their water impacts and reduce contamination while at the same time increasing their coal production. These are the kinds of success stories that can be achieved through collaboration and willingness to reduce the impact on mining pollution on our waters. Those changes helped permanently protect local waters, maximize coal recovery and reduce costs for the operators.

Readers will recall that the Obama EPA began looking more closely at the Spruce Mine in September 2009. But debate over the proposed operation dates back to the late 1990s, when then-U.S. District Judge Charles H. Haden II issued an injunction that blocked the mine, which then was proposed for more than 3,000 acres. After the Haden ruling, the company reduced the size of its proposal and the operation underwent much more intense scrutiny, in the form of a full-blown Environmental Impact Statement by the Corps of Engineers, which approved the new mining configuration in January 2007.

This entry was posted on Thursday, January 13, 2011 at 10:29 am and is filed under Mountaintop Removal. You can follow any responses to this entry through the RSS 2.0 feed. You can leave a response, or trackback from your own site.

From:
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To:
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Date:
01/13/2011 10:36 AM
Subject:
Spruce is signed

For those who don't already know, Spruce was signed shortly before 9:30 this morning. The congressional notifications are going on now, and the press release should go out shortly. So, expect something on the Coal Tatoo soon.

I wanted to take a moment to thank all of you who have worked so hard on this. We've been at this for over a year now.

First -- your tremendous work on the proposed and recommended determinations laid a terrific foundation for the final determination. While we had to answer a lot of comments and make some adjustments to address comments and legal issues, the core science and thinking that went into the proposed and recommended determinations is what carried the day and remains the fundamental underpinnings of the final determination. Additional kudos to those of you who worked on the response to comments on the Proposed Determination -- the responses remained largely in tact throughout the process, which is a tribute to your excellent work.

For those of you who were not aware, as part of the regulatory "consultation" process, Mingo Logan and WVDEP submitted an additional set of comments that wound up being around 220 individual "new" comments on the recommended determination. This happened the week before Christmas, and while a bunch of people worked to respond to those -- Greg and Maggie really saved the entire endeavor and did an amazing job. I've run out of superlatives to describe the quality and speed at which they worked. I wish that you guys could hear some of the senior management briefings that I heard. The level of confidence expressed in the foundational science on conductivity and macroinvertebrates was amazing. Senior management basically was told unequivocally that nobody has any doubt that the science on the conductivity and macroinvertebrates was absolutely solid.

I also just want to thank all of you who were suddenly pulled in to pitch in at the last moment, tracking references, locating documents, running down various loose ends. Your help was invaluable and really appreciated.

In the press of reviewing references, checking numbers, scrubbing as the "legal and policy police," we sometimes forget about the resource we're actually protecting. Here's a photo (thanks, Mike) of Pigeonroost Branch -- one of the two streams that the 404(c) action protects from destruction.

David Evans/DC/USEPA/US
01/13/2011 02:03 PM

To EPA Wetlands Managers, OW-OWOW-EVERYONE

cc Ross Geredien, Palmer Hough, Matthew Klasen, Julia McCarthy, Kevin Minoli, Marcel Tchaou, Karyn Wendelowski, Stefania Shamet, Greg Pond, Margaret Passmore, Frank Borsuk, David Kargbo, John Pomponio, Jeff Lape, John Forren, Gregory Peck, Denise Keehner, Benita Best-Wong, Steven Neugeboren

bcc

Subject Spruce Coal Mine 404(c) Final Determination

Brian Frazer and I wanted to make sure we've broadly communicated to OWOW and Regional Wetlands managers completion of a 404(c) veto action of the Spruce Mine #1 permit in West Virginia. For those familiar with the 404(c) process, signature of the FD is a tremendous accomplishment, and culmination of a painstaking and demanding process. See below for a summary description from Chris Hunter.

We will provide a more complete description of the action in a couple days, allowing Chris to get some sleep! An action of this nature requires the contributions of many, from staff to the most senior leaders in the Agency. I especially want to acknowledge the yeoman's efforts by the staff members in HQ and Region III who have been working at a fever pitch and extremely long hours these past several weeks to complete more than 700+ of technical documentation that supports the FD action. Congratulations and heartfelt thanks to you all.

<u>HQ</u>
Chris Hunter (combo team leader/lead staff)
Ross Geredien
Palmer Hough
Matt Klasen
Julia McCarthy
Kevin Minoli
Marcel Tchaou
Karyn Wendelowski

<u>Region 3</u>
Stefania Shamet
Stefania Shamet
Stefania Shamet (because she did the work of three people)
Greg Pond
Maggie Passmore
Frank Borsuk
David Kargbo

David Evans, Director
Wetlands Division
Office of Wetlands, Oceans and Watersheds
(202) 566-0535

----- Forwarded by David Evans/DC/USEPA/US on 01/13/2011 01:46 PM -----

From: Christopher Hunter/DC/USEPA/US
To: OW-OWOW-WD
Date: 01/13/2011 11:53 AM
Subject: Spruce Coal Mine 404(c) Final Determination

Hello all,

this morning, the Pete Silva signed the 13th Final Determination under Section 404(c) in EPA's history. This action prohibits continued mining at one of the largest individual surface coal mines in West Virginia and protects two high quality stream systems from being buried under tons of rock and mining spoil. The final decision reflects over 14 months of work by EPA HQ and Region 3 to gather an incredible amount of scientific and technical data about mine construction and environmental impacts to water quality and wildlife habitat. Adding to the complexity is the fact that this is one of the first times that EPA has ever chosen to "veto" an already issued permit, which means this decision will be subject to a tremendous amount of negative legal, political, and public reaction. However, after working on this for the past year, I think the record demonstrates that EPA has firmly established the unacceptable adverse impacts that would have resulted from the mine's construction. If you're interested in learning more, we have about 700 pages of great late-night reading (plus a one page summary that's attached).

Thanks to Dave, Jim, and Brian for their support, and to Ross, Julia, and Marcel for their hard work on this effort.

http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/404c_index.cfm

FINAL_Spruce_Factsheet_011311.pdf

Chris Hunter
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, & Watershed
(202) 566-1454
hunter.christopher@epa.gov

EPA Action Halts Disposal of Mining Waste in Streams at Spruce No. 1 Mine to Protect Environment, Water Quality, and Appalachian Communities

EPA's Decision: Using authority provided under the Clean Water Act (CWA), the U.S. Environmental Protection Agency (EPA) completed its 15-month comprehensive review of impacts on water quality and wildlife from the Spruce No. 1 mountaintop coal mine in Logan County, West Virginia. EPA concluded, based on a substantial body of new scientific work completed since 2007, that the mine would result in significant environmental impacts from burying over 6.6 miles of ecologically valuable streams under mining waste and would also cause unacceptable adverse environmental effects to wildlife in downstream waters. As a result, EPA is acting under the CWA to protect wildlife, water quality, and Appalachian communities, who rely upon healthy streams, by prohibiting the Mingo Logan Coal Company from disposing of 110 million cubic yards of mining waste into waterways as part of proposed mountaintop coal mining at the Spruce No. 1 mine. The Spruce No. 1 Mine, among the largest mountaintop coal mines ever proposed in Appalachia, would disturb approximately 2,278 acres (about 3.5 square miles) of forestlands in southern West Virginia and bury over six miles of streams under waste rock and mining debris. Two of these streams, Pigeonroost Branch and Oldhouse Branch, are two of the last-remaining high-quality streams in the watershed and are protected by EPA's action.

Summary of EPA Findings: EPA's decision to stop mining waste discharges to high-quality streams at the Spruce No. 1 mine is based on several major environmental, water quality, and wildlife concerns:

- Burying more than 35,000 feet (more than 6 miles) of high-quality streams under mining waste, which will eliminate all fish, invertebrates, salamanders, and other wildlife that live in them;
- Polluting downstream waters as a result of burying these streams, which will lead to unhealthy levels of salinity and toxic levels of selenium;
- Causing downstream watershed degradation that will kill aquatic wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms;
- Inadequately mitigating for the mine's environmental impacts to high-quality streams , by using mining ditches, for example, to offset the functions provided by these natural streams; and
- Failure to consider cumulative watershed degradation resulting from past, present, and future mining in the area.

In addition, EPA is concerned that the Spruce mine will expose Appalachian communities to additional mining related sources of pollution in a watershed already highly impacted by mining activity.

Key Background: Under CWA section 404(c), Congress authorized EPA to prohibit or restrict activities involving the placement of pollutants in the nation's waterways where the Agency determines that these pollutants will cause unacceptable adverse effects to municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. EPA has used its Section 404(c) authority sparingly, prohibiting just 13 projects, including the Spruce mine, since 1972. In this case, EPA is taking this action because a substantial body of new scientific studies and work completed since the mine was permitted in 2007 demonstrate that the burial of Pigeonroost Branch, Oldhouse Branch and their tributaries will have direct, unacceptable adverse effects on wildlife, including fish, salamanders, and waterfowl; and will contribute to downstream water quality degradation and associated adverse impacts to wildlife.

Mountain streams within the Central Appalachian ecoregion have some of the richest aquatic animal diversity of any area in North America, including one of the highest concentrations of salamanders in the world, as well as many rare species of mayflies, stoneflies and caddisflies, which are ecologically important aquatic insects that form the foundation of stream food webs. The project will bury 6.6 miles of some of the last remaining high quality streams and riverbank areas within the Coal River watershed. These streams contain important wildlife communities and habitat and they rank extremely high in comparison to other streams in West Virginia and in Central Appalachia. Including their riverbanks

areas, the streams within the Spruce No. 1 Mine area provide important habitat for over 40 species of amphibians and reptiles, 4 species of crayfish, and 5 species of fish, as well as numerous birds, bats, and other mammals. The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by these streams and will result in the loss of salamander, fish, and other wildlife populations that depend on that habitat for survival.

Burial of Pigeonroost Branch and Oldhouse Branch will also result in unacceptable adverse effects on wildlife by increasing levels of pollution to downstream waters, where over 25 different species of fish are found. Full construction of the Spruce No. 1 Mine will bury streams on site beneath tons of broken mining waste rock that will leach pollutants, particularly total dissolved solids and selenium, into downstream waters and adversely impact the wildlife communities that live in or utilize these streams. The loss of food sources caused by these increased pollution levels, as well as additional exposure to selenium will cause adverse effects to fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on downstream waters for food or habitat.

Section 404(c) Review Process: Key steps in EPA's CWA review of the Spruce No. 1 mine:

- October 2009: EPA begins coordinating with Mingo Logan Coal Company and Corps of Engineers to identify potential corrective actions that reduce mining impacts and would eliminate need for further CWA review. Company does not agree to alternative mine configuration to avoid impacts.
- March 26, 2010: EPA Region III publishes comprehensive Proposed Determination outlining the project's environmental effects and requests public comments.
- May 18, 2010: EPA conducts Public Hearing in Charleston, West Virginia to discuss anticipated mine impacts and provide opportunity for public input. EPA receives over 50,000 public comments – most in support of EPA's review of the Spruce No. 1 mine.
- September 24, 2010: EPA Region III prepares Recommended Determination for EPA Headquarters concluding that discharges associated with the Spruce No. 1 Mine would be likely to lead to significant adverse environmental effects. Region III developed its Recommended Determination in consideration of the Corps permit record, 50,000 public comments, and extensive scientific information relevant to the Spruce No. 1 project.
- October 2010: EPA Office of Water initiates second consultation process with Corps, Mingo Logan Company, State, and landowner to identify potential corrective actions that might eliminate need for EPA action. Company expresses unwillingness to improve its mining operation.
- January 13, 2011: EPA Office of Water completes Section 404(c) review of the Spruce Mine and publishes Final Determination concluding that the project, as currently designed, would cause unacceptable environmental impacts, including water quality impacts, to waterways at the Spruce site and prohibits disposal of mining waste in streams.

A copy of the Final Determination is available at
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/404c_index.cfm

Gregory Peck/DC/USEPA/US	To	Bob Sussman
01/18/2011 04:08 PM	cc	Betsaida Alcantara, Nancy Stoner
	bcc	
	Subject	Re: NPR Spruce followup

We're doing some follow-up discussions - but mostly key Hill folks who want to help and need to understand things better.

Gregory E. Peck
Chief of Staff
Office of Water
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

202-564-5778

Bob Sussman	No mtgs planned.	----- Original Message -----	01/18/2011 04:01:45 PM

From: Bob Sussman/DC/USEPA/US
To: Betsaida Alcantara/DC/USEPA/US@EPA, Gregory Peck/DC/USEPA/US@EPA, Nancy Stoner/DC/USEPA/US@EPA
Date: 01/18/2011 04:01 PM
Subject: Re: NPR Spruce followup

No mtgs planned.

Betsaida Alcantara

----- Original Message -----
From: Betsaida Alcantara
Sent: 01/18/2011 03:28 PM EST
To: Bob Sussman; Gregory Peck; Nancy Stoner
Subject: Fw: NPR Spruce followup

Are we holding any meetings with groups on this anymore?

----- Forwarded by Betsaida Alcantara/DC/USEPA/US on 01/18/2011 03:21 PM -----

From: Elizabeth Shogren <EShogren@npr.org>
To: Betsaida Alcantara/DC/USEPA/US@EPA
Date: 01/18/2011 03:20 PM
Subject: RE: NPR Spruce followup

Hi Betsaida,

I see that the acting WV governor is holding a rally Thursday in opposition to EPA's decision. I'd like to interview some one at EPA about what message the agency is hoping to send to WVA and the other mountaintop mining states.
Is EPA holding any meetings with state or industry officials on the future of mountaintop mining?

Thanks, Elizabeth

-----Original Message-----
From: Alcantara.Betsaida@epamail.epa.gov
[mailto:Alcantara.Betsaida@epamail.epa.gov]
Sent: Friday, January 14, 2011 3:39 PM
To: Elizabeth Shogren
Subject: Spruce

Hi Elizabeth,
Here's some info for your story. Let's talk next week about who could do the interview.

General Statement:

EPA is acting under the law and using the best science to protect water quality, wildlife and Appalachian communities, who rely on clean waters for drinking, fishing and swimming. EPA reserves this authority for only unacceptable cases. EPA has used this authority to revoke an issued permit only twice since 1972. We took this action because this proposed mine would use destructive and unsustainable mining practices that jeopardize the health of Appalachian communities and clean water on which they depend. Coal and coal mining are part of our nation's energy future and EPA has worked with companies to design mining operations that adequately protect our nation's waters. Despite EPA's willingness to consider alternatives, the company did not offer any new proposed mining configurations in response to EPA's concerns based on science and the law. We have a responsibility under the law to protect water quality and safeguard the people who rely on clean water. We don't think people in West Virginia have to make the false choice between healthy waters and a healthy economy, they can have both.

We also want to push back on the claims that industry now needs to fear that their previously approved permits will be revoked, again this is on background:

The history of EPA's use of our section 404(c) authority demonstrates clearly that permits are not vulnerable to being revoked. The Corps authorizes approximately 100,000 project in the nation's waters every year, which translates to millions of permits during the past 39 years of the CWA. EPA has used 404(c) to revoke an issued permit only twice since 1972. This record demonstrates EPA's commitment to rely on 404(c) with caution and in circumstances where the environment, water quality, and public health are at risk. The determination on the proposed Spruce No. 1 mine is limited to the particular circumstances of this mine. Because of the unique combination of scale of impacts and the nature of the impacted resources both in and of themselves and within the larger context of the watershed, EPA's concerns with the Spruce No. 1 Mine are unlikely to be repeated for other permitted Appalachian surface coal mining projects.

EPA applied rigorous scientific research to the particular facts of the Spruce No. 1 Mine and determined that the environmental impacts would be unacceptable.

WHY REVIEW AFTER PERMITT WAS ISSUED?
Although we initiated the 404(c) review of this project in 2009, during the extensive ten-year permitting and environmental review process for the Spruce No. 1 Mine, EPA raised significant concerns with the environmental impacts of the proposed project that were not fully addressed. Furthermore, significant new science has been developed since the Spruce No. 1 Mine was initially proposed in 1997 and since the Spruce No. 1 permit was issued by the U.S. Army Corps of Engineers in 2007. This developing body of science provides a far better understanding of the impacts from the project. In light of this new scientific information, including published, peer-reviewed studies and significant research by EPA scientists and other Federal and State agencies, EPA initiated review of the Spruce No. 1 mine in October 2009. Our Determination references more than 100 studies on the effects of this type of discharges on the environment that were completed or published since 2007.

PRESS RELEASE

EPA Halts Disposal of Mining Waste to Appalachian Waters at Proposed Spruce Mine

Agency cites irreversible damage to clean water, environment in the region

WASHINGTON - After extensive scientific study, a major public hearing in West Virginia and review of more than 50,000 public comments, the U.S. Environmental Protection Agency (EPA) today announced that it will use its authority under the Clean Water Act to halt the proposed disposal of mining waste in streams at the Mingo-Logan Coal Company's Spruce No. 1 coal mine. EPA is acting under the law and using the best science to protect water quality, wildlife and Appalachian communities, who rely on clean waters for drinking, fishing and swimming. EPA reserves this authority for only unacceptable cases. This permit was first proposed in the 1990s and has been held up in the courts ever since.

"The proposed Spruce No. 1 Mine would use destructive and unsustainable mining practices that jeopardize the health of Appalachian communities and clean water on which they depend," said EPA Assistant Administrator for Water Peter S. Silva. "Coal and coal mining are part of our nation's energy future and EPA has worked with companies to design mining operations that adequately protect our nation's waters. We have a responsibility under the law to protect water quality and safeguard the people who rely on clean water."

EPA's final determination on the Spruce Mine comes after discussions with the company spanning more than a year failed to produce an agreement that would lead to a significant decrease in impacts to the environment and Appalachian communities. The action prevents the mine from disposing of the waste into streams unless the company identifies an alternative mining design that would avoid irreversible damage to water quality and meets the requirements of the law. Despite EPA's willingness to consider alternatives, Mingo Logan did not offer any new proposed mining configurations in response to EPA's Recommended Determination.

EPA believes that companies can design their operations to make them

more sustainable and compliant with the law. Last year, EPA worked closely with a mining company in West Virginia to eliminate nearly 50 percent of their water impacts and reduce contamination while at the same time increasing their coal production. These are the kinds of success stories that can be achieved through collaboration and willingness to reduce the impact on mining pollution on our waters. Those changes helped permanently protect local waters, maximize coal recovery and reduce costs for the operators.

EPA's decision to stop mining waste discharges to high quality streams at the Spruce No. 1 mine was based on several major environmental and water quality concerns. The proposed mine project would have:

*Disposed of 110 million cubic yards of coal mine waste into streams.
*Buried more than six miles of high-quality streams in Logan County,
West Virginia with millions of tons of mining waste from the dynamiting of more than 2,200 acres of mountains and forestlands.
*Buried more than 35,000 feet of high-quality streams under mining
waste, which will eliminate all fish, small invertebrates, salamanders, and other wildlife that live in them.

*Polluted downstream waters as a result of burying these streams, which will lead to unhealthy levels of salinity and toxic levels of selenium that turn fresh water into salty water. The resulting waste that then fills valleys and streams can significantly compromise water quality, often causing permanent damage to ecosystems and streams.

*Caused downstream watershed degradation that will kill wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms.

*Inadequately mitigated for the mine's environmental impacts by not
replacing streams being buried, and attempting to use stormwater ditches as compensation for natural stream losses.

Additionally, during the permitting process there was a failure to consider cumulative watershed degradation resulting from past, present, and future mining in the area.

Finally, EPA's decision prohibits five proposed valley fills in two streams, Pigeonroost Branch, and Oldhouse Branch, and their tributaries. Mining activities at the Spruce site are underway in Seng Camp Creek as a result of a prior agreement reached in the active litigation with the Mingo Logan Coal Company. EPA's Final Determination does not affect current mining in Seng Camp Creek.

Background on Clean Water Act Section 404(c)

Clean Water Act Section 404(c) authorizes EPA to restrict or prohibit placing dredged or fill material in streams, lakes, rivers, wetlands and other waters if the agency determines that the activities would result in "unacceptable adverse effects" to the environment, water quality, or

water supplies. This authority applies to proposed projects as well as projects previously permitted under the Clean Water Act although EPA is not considering such action for other previously permitted projects.

With today's action, EPA has exercised its Section 404(c) authority only 13 times in its history of the CWA. EPA recognizes the importance of ensuring that its Section 404(c) actions are taken only where environmental impacts are truly unacceptable and will use this authority only where warranted by science and the law.

For a copy of the Final Determination:
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/404c_index.cfm

From:Elizabeth Shogren <EShogren@npr.org>
To:Adora Andy/DC/USEPA/US@EPA
Date:01/14/2011 02:32 PM
Subject:news

Hi Adora,

I'm hoping to do a follow up on the mountaintop mining story next week, and I'm wondering if there's anyone at EPA I can talk to about the implications of that decision.

Also, do you expect to many any big announcements on other topics next week?
Thanks so much.

Elizabeth

Matthew Klasen/DC/USEPA/US
01/19/2011 09:42 AM

To Cassaundra Eades
cc Wanda Fields
bcc
Subject Response to AL-10-002-0308 for closeout

Hi Sandy,

Per our phone conversation, attached is the response letter to AL-10-002-0308. The incoming was addressed to Pete Silva, but OCIR and the AO determined that it was a more appropriate response from Shawn Garvin in R3, who signed the final response on January 7.

Please let me know if you have any questions, and thanks for your help.

Thanks,
Matt

Final Rahall Letter w_enclosure[1.7.11].pdf

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

JAN 0 7 2011

The Honorable Nick J. Rahall, II
Chairman, Committee on Natural Resources
U.S. House of Representatives
Washington, D.C. 20515

Dear Chairman Rahall:

Thank you for your December 6, 2010 letter to the U.S. Environmental Protection Agency (EPA) regarding EPA's oversight of Clean Water Act (CWA) Section 402 permits for discharges associated with surface coal mining in Appalachia.

As outlined in the CWA, EPA has an important role in overseeing state-delegated National Pollutant Discharge Elimination System (NPDES) permitting programs. A key element of this oversight role for all ten EPA regions is the review of draft state NPDES permits to help ensure they are consistent with the CWA. As outlined below, Region III regularly reviews draft state permits for many types of facilities, including surface coal mining operations.

Regarding permits for surface coal mining operations, EPA's recently conducted Permit Quality Review of NPDES permitting in Appalachian States identified several deficiencies in state permitting practices. A copy of the *Review of Clean Water Act Section 402 Permitting by Appalachian States: Findings and Recommendations*, which included permits issued by West Virginia can be found at http://www.epa.gov/owow/wetlands/guidance/pdf/Final Appalachian Mining_PQR_07-13-10.pdf. On April 1, 2010, Mr. Peter Silva, EPA's Assistant Administrator for Water, and Ms. Cynthia Giles, EPA's Assistant Administrator for The Office of Enforcement and Compliance Assurance, issued guidance to EPA Regions III, IV, and V. The guidance addresses a variety of factors that EPA regional offices take into account when considering whether permits for discharges associated with Appalachian surface coal mining projects are meeting the requirements of the CWA and implementing regulations. Based on the conclusions of this review and an increasing amount of scientific literature that documents the significant water quality consequences of surface coal mining operations, Region III is carefully evaluating state NPDES draft permits for surface coal mining operations to help ensure that these permits ensure clean and safe water for Appalachian communities.

Enclosed for your information are detailed responses to the specific questions outlined in your December 6, 2010 letter.

If you have any questions, please do not hesitate to contact me or have your staff contact Mrs. Jessica Greathouse, EPA's West Virginia Liaison, at 304-224-3181.

Sincerely,

James W. Newman

Acting for

Shawn M. Garvin
Regional Administrator

Enclosure

Enclosure

Detailed Responses Regarding West Virginia National Pollution Discharge Elimination System (NPDES) Permitting

What criteria or considerations are used in concurring or objecting to a state-issued permit?

EPA Region III reviews permits submitted by the West Virginia Department of Environmental Protection (WVDEP) pursuant to Section 402 of the Clean Water Act (CWA), 40 CFR § 123.44, and the *Memorandum of Agreement Regarding the Administration and Enforcement of the NPDES in West Virginia (1982)* (MOA). Consistent with the MOA, WVDEP is required to submit for review the following categories of draft permits:

- All major permits, including new permits, reissuances, and major amendments as established by the MOA;
- All general permits as established by the MOA;
- All permits that implement Total Maximum Daily Loads (TMDLs), pursuant to EPA's letter of September, 29, 1998 revoking its waiver of review for this category of permits;
- All significant permits for discharges into the Chesapeake Bay watershed, pursuant to EPA's letter dated June 9, 2005, revoking its waiver of review for this category of permits; and
- All coal mining permits, pursuant to EPA's letter dated July 9, 2009, revoking its waiver of review for this category of permits.

EPA's review is performed consistent with the terms of Section 402 of the CWA, 40 CFR § 123.44, and the MOA. Documents provided by WVDEP generally include the permit application, the draft or proposed permit, and the rationale for decisions made during the permit development process. EPA generally reviews these documents and considers whether the draft or proposed permit conforms with the applicable requirements of the CWA and its implementing regulations, including but not limited to 40 CFR Parts 122 and 123 and applicable West Virginia Water Quality Standards.

Generally, EPA's review considers whether the permit includes appropriate effluent limitations (technology- and water quality-based), monitoring requirements, and special conditions, and whether the supporting fact sheet and/or rationale are adequate to support the decisions made by the permit writer. In addition, EPA generally reviews the water quality characteristics of the receiving water and effluent characteristics, including whether the receiving water body is identified as impaired and if a TMDL has been established. Various tools exist to guide the permit reviewer and writer through this process, including a checklist that has been used in EPA's Permit Quality Reviews (PQRs) across the country that can be found at http://www.epa.gov/npdes/pubs/npdes_pqr_assess.pdf.

Since EPA receives many draft permits for review, EPA prioritizes its review based on a variety of factors, including workload considerations. Region III also focuses its review on specific focus areas, which are selected based on Agency priorities, deficiencies identified in PQRs or previous permits, or issues raised by the public, such as those described in a recently filed petition to withdraw West Virginia's NPDES program. Priority is often given to review of new or expanded facilities. Over the last year, EPA has focused on areas such as TMDL implementation, appropriate use of compliance schedules, water quality-based effluent limitations (WQBELs) for pollutants such as aluminum and selenium, and the protection of narrative water quality criteria.

To what extent is conductivity or total dissolved solids part of the consideration?

All NPDES permits must include limits necessary to achieve applicable water quality standards. Such standards often include narrative criteria, which may preclude discharges that adversely impact the aquatic ecosystem. To ascertain whether a permit includes appropriate WQBELs, EPA generally reviews background information submitted with the permit application, including baseline water quality data and actual or predicted effluent characteristics. Scientific data have shown that high levels of conductivity, Total Dissolved Solids (TDS), or sulfates can result in biological impairment in receiving waters.

When the baseline water quality data submitted with a WVDEP permit includes samples indicating that effluent from the project when discharged to the stream produce conductivity, TDS, or sulfates at levels that are potentially associated with such biological impairment, EPA may request further documentation from WVDEP to inform EPA's review, pursuant to 40 CFR § 123.44(d). The information requested may include a permit rationale that contains a reasonable potential analysis to determine whether specific conductivity, TDS, or total sulfates in the proposed discharges have a potential to cause or contribute to downstream biological impairment and whether limits for TDS, conductivity, or sulfates should be developed and included in the permit pursuant to 40 CFR § 122.44(d)(1)(vi).

What communication is involved with the applicant, and with outside groups?

WVDEP generally retains primary responsibility for communicating with the applicant or outside groups on the details of a specific permit. EPA responds to specific requests for information from outside interests and occasionally joins the WVDEP in conference calls or meetings with permittees at the request of the WVDEP. In the case of West Virginia, a Petition to withdraw WVDEP's authorization to administer the NPDES program has been submitted by the Appalachian Center for the Economy and the Environment on behalf of several groups. From time to time, EPA provides updates to the petitioners on the status of EPA's efforts to address the Petition and, upon request, provides information on the actions that EPA has taken on specific permits that are relevant to the issues raised in the Petition.

How do the Region III office and EPA Headquarters interact during the review process?

Reviews of draft permits submitted by WVDEP are conducted by Region III staff who maintain direct and frequent communication with WVDEP permit writers and managers. EPA Region III consults periodically with EPA Headquarters and other EPA regions on technical concerns, litigation concerns, or issues of national or regional consistency.

Who directs the review?

EPA Region III retains primary responsibility for reviewing proposed or draft permits submitted by the state for review under the terms of the MOA established between WVDEP and EPA Region III as part of WVDEP's authorization to administer the NPDES Program. EPA Region III consults periodically with EPA Headquarters and other EPA Regions on technical concerns, litigation concerns, or issues of national or regional consistency. EPA oversight of State NPDES programs and permits occurs at the regional level in Region III's Water Protection Division. Periodic reviews to assure program integrity and permit quality are conducted by EPA Headquarters in cooperation with the Region, such as a 2007 PQR for the base NPDES program and a Mining PQR completed in 2010.

What authority does each office have to object to the decisions of the other?

EPA Region III is responsible for day-to-day oversight of state programs and permit reviews. From time to time, Region III will consult with EPA Headquarters on new and emerging issues and policy matters. The primary responsibility for objecting to state draft permits rests with EPA Region III's Water Protection Division.

How many objections (interim, general, and specific) has the EPA raised with Sec. 402 permits in West Virginia?

During Fiscal Year (FY) 2010, EPA received 276 permit documents from WVDEP for review, including two general permits, 40 municipal/industrial permits, and 234 mining permits. These submitted permit documents were for new facilities, reissuances, and amendments. Of the 234 mining permit documents received in FY 2010, 57 received comments, 36 received interim objections, 30 received general objections, and 19 received specific objections. Of the 36 interim objections, EPA has received responses on 10, 7 of which have been resolved and 3 are pending. The comments and objections have raised a variety of issues, including selenium limits, the appropriate use of compliance schedules, permitting requirements for bond forfeiture sites, and conductivity.

How many other 402 permits are likely to raise objections by EPA?

EPA Region III staff work closely with WVDEP staff to exchange information, discuss

regulatory requirements, and seek mutually acceptable solutions to permitting issues. An objection to a proposed permit is an outcome that neither WVDEP nor EPA prefers. Since each permit is unique, and because EPA and WVDEP are continually working to identify and resolve potential issues, it is not possible to predict future permitting outcomes.

What is the timeline for resolving these objections?

The process and timing for permit review and objections are laid out in the MOA and 40 CFR § 123.44. Once an interim or specific objection is issued, the state is responsible for providing information or revising the draft permit documents. EPA is committed to reviewing any new information as quickly as practicable. For interim objections, EPA has up to 90 days to review the draft permit once the necessary information is provided. For specific objections, EPA regulations at 40 CFR § 123.44 provide that the State has 90 days to submit a proposed permit that satisfies EPA's objection. Within 90 days of receipt of a specific objection, the state or any interested party may request that a hearing be held by the Regional Administrator. Following the public hearing, the Regional Administrator shall affirm the objection, modify the terms of the objection or withdraw the objection. Exclusive authority to issue the permit passes to EPA when the times set out in the regulation expire.

What arrangements might be established to expedite an application?

The timeframes associated with EPA Region III's review of permits are established by the MOA and EPA's regulations as described above. Occasionally, WVDEP has requested that EPA provide an expedited review and EPA has made every effort to do so as resources permit.

What arrangements might be established to expedite resolution of any dispute(s) over an application?

EPA Region III and WVDEP maintain a close working relationship, and EPA is always available to discuss any disputes that may arise. We encourage early discussions of permitting issues to resolve issues promptly and informally. EPA's regulations at 40 C.F.R. § 123.44 and the MOA establish specific timeframes for State permit submissions, EPA permit reviews, and (if appropriate) potential permit objections. EPA conducts its permit reviews consistent with these timelines and works to expedite decision-making wherever practicable. In order to avoid the need for an interim objection based on lack of information, EPA encourages WVDEP to ensure that permits submitted for EPA review include all appropriate data, as outlined above. This can help reduce the amount of time it takes EPA to conduct its review and can promote issue resolution early in the permitting process.

What are you doing to simplify and expedite the process?

EPA is working with West Virginia on ways to streamline EPA's review process to identify issues of concern early in the process and to eliminate the need for comment or objection to the maximum extent. The Mining PQR and EPA's oversight over the past year have

identified several opportunities to do so, such as ensuring that WVDEP provides better documentation on permit decisions to enable effective EPA review.

As an example of recent collaboration, EPA worked successfully with WVDEP to resolve previous concerns over State calculations of site-specific effluent limits for aluminum. In response to EPA identifying discrepancies in WVDEP's statistical analysis process, WVDEP revised its template and permit software to address the concerns, which now provides strong documentation for how decisions are made. EPA was frequently commenting on aluminum limits, but now that the revised process is in place, similar comments on future permits are highly unlikely.

What progress have you made?

EPA and WVDEP have made substantial progress in our mutual understanding of how permits are written and reviewed. For several areas of frequent EPA objection, including selenium limits, use of compliance schedules, and aluminum limits, EPA and WVDEP have agreed on a path forward and future objections are unlikely. EPA and WVDEP continue to discuss how to best implement narrative criteria and conductivity within NPDES permits. EPA expects to meet with WVDEP to discuss this further over the coming months.

Matthew Klasen/DC/USEPA/US
01/19/2011 09:55 AM

To: Christopher Hunter
cc: Stefania Shamet, Kevin Minoli, Karyn Wendelowski, Gregory Peck, Julia McCarthy, Palmer Hough, Brian Frazer, Brian Topping
bcc:
Subject: Spruce FR notice and hard copies in water docket (?)

Chris et al.:

Attached is the FR notice from today's Federal Register on Spruce.

In reviewing the notice again, the boilerplate includes discussion that the Spruce docket will be available in hard-copy form in the Water Docket on the 3rd floor of EPA West. Have we pulled together hard copy materials of everything? If not, can we do that today? (I expect folks like H&W could be stopping by very shortly to find copies of everything.)

I'm copying Julia, Palmer, Brian, and Brian, in case you guys know the status or could help pull everything together, given that I know Chris is out.

Thanks,
Matt

Spruce FR Notice - January 19.pdf

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

consider, under 34 CFR 75.253, the extent to which a grantee has made "substantial progress toward meeting the objectives in its approved application." This consideration includes the review of a grantee's progress in meeting the targets and projected outcomes in its approved application, and whether the grantee has expended funds in a manner that is consistent with its approved application and budget. In making a continuation grant, the Secretary also considers whether the grantee is operating in compliance with the assurances in its approved application, including those applicable to Federal civil rights laws that prohibit discrimination in programs or activities receiving Federal financial assistance from the Department (34 CFR 100.4, 104.5, 106.4, 108.8, and 110.23).

VII. Agency Contacts

FOR FURTHER INFORMATION CONTACT: Trini Torres, U.S. Department of Education, 400 Maryland Avenue, SW., room 5C145, Washington, DC 20202–6510. Telephone: (202) 401–1445, or by e-mail: *trinidad.torres-carrion@ed.gov* or Itzetht Testa-Sanchez, U.S. Department of Education, 400 Maryland Avenue, SW., room 5C151, Washington, DC 20202–6510. Telephone: (202) 401–1459, or by e-mail: *Itzetht.testa-sanchez@ed.gov*.

If you use a TDD, call the FRS, toll free, at 1–800–877–8339.

VIII. Other Information

Accessible Format: Individuals with disabilities can obtain this document and a copy of the application package in an accessible format (e.g., Braille, large print, audiotape, or computer diskette) on request to the program contact person listed under **FOR FURTHER INFORMATION CONTACT** in section VII of this notice.

Electronic Access to This Document: You can view this document, as well as all other documents of this Department published in the **Federal Register**, in text or Adobe Portable Document Format (PDF) on the Internet at the following site: *http://www.ed.gov/news/fedregister.* To use PDF you must have Adobe Acrobat Reader, which is available free at this site.

Note: The official version of this document is the document published in the **Federal Register.** Free Internet access to the official edition of the **Federal Register** and the Code of Federal Regulations is available on GPO Access at: *http://www.gpoaccess.gov/nara/index.html.*

Dated: January 13, 2011.

Rosalinda B. Barrera,

Assistant Deputy Secretary and Director, Office of English Language Acquisition, Language Enhancement, and Academic Achievement for Limited English Proficient Students.

[FR Doc. 2011–1041 Filed 1–19–11; 8:45 am]

BILLING CODE 4000–01–P

ENVIRONMENTAL PROTECTION AGENCY

[EPA–R03–OW–2009–0985; FRL–9254–8]

Final Determination of the Assistant Administrator for Water Pursuant to Section 404(c) of the Clean Water Act Concerning the Spruce No. 1 Mine, Logan County, WV

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: This is a notice of EPA's Final Determination pursuant to section 404(c) of the Clean Water Act to withdraw the specification of Pigeonroost Branch, Oldhouse Branch, and their tributaries, within Logan County, West Virginia, as a disposal site for dredged or fill material in connection with construction, operation, and reclamation of the Spruce No. 1 Surface Mine, as authorized by DA Permit No. 199800436–3 (Section 10: Coal River). This determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch, and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine. EPA's determination is based upon a finding that the discharge of dredged or fill material associated with the construction and operation of the Spruce No. 1 Mine would result in unacceptable adverse effects on wildlife.

DATES: *Effective Date:* The effective date of the Final Determination is January 13, 2011.

ADDRESSES: U.S. Environmental Protection Agency, Office of Water, Wetlands Division, Mail Code 4502T, 1200 Pennsylvania Ave., NW., Washington, DC 20460. EPA has established a docket for this action under Docket ID No. EPA–R03–OW–2009–0985. All documents in the docket are listed on the *http://www.regulations.gov* Web site. Although listed in the index, some information may not be publicly available, *e.g.,* CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically through *http://www.regulations.gov* or in hard copy at the Water Docket, EPA/DC, EPA West, Room 3334, 1301 Constitution Ave., NW., Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Water Docket is (202) 566–2426.

FOR FURTHER INFORMATION CONTACT: Mr. Chris Hunter, Office of Wetlands, Oceans, and Watersheds; U.S. Environmental Protection Agency, Mail Code 4502T, 1200 Pennsylvania Ave., NW., Washington, DC 20460. Additional information and copies of EPA's Final Determination are available at the following Web site: *http://www.epa.gov/404c/.*

SUPPLEMENTARY INFORMATION: Section 404(c) of the CWA, 33 U.S.C. 1344(c), authorizes EPA to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site. EPA is authorized to restrict or deny the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever it determines, after notice and opportunity for public hearing, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas.

EPA's regulations for implementing section 404(c) are set forth in 40 CFR part 231. Four major steps in the process are: (1) The Regional Administrator's notice to the U.S. Army Corps of Engineers (the Corps), the applicant or permittee, the property owner, and the State, as appropriate, of the intention to initiate the section 404(c) process; (2) the Regional Administrator's publication of a Proposed Determination to withdraw, deny, restrict, or prohibit the use of the site, soliciting public comment and offering an opportunity for a public hearing; (3) the Regional Administrator's recommendation to the Assistant Administrator for Water at EPA Headquarters to withdraw, deny, restrict, or prohibit the use of the site (Recommended Determination); and, (4) the Assistant Administrator for Water's

Final Determination to affirm, modify, or rescind the Regional recommendation.

As a result of significant new scientific information confirming and strengthening EPA's concerns regarding the environmental effects of mountaintop mining operations, and in particular those operations on the scope and scale of the Spruce No. 1 Mine, EPA Region III initiated the Clean Water Act § 404(c) process for the Spruce No. 1 Mine on October 16, 2009. The Spruce No. 1 Mine, as authorized in 2007 by Department of the Army (DA) Permit No. 199800436–3 (Section 10: Coal River), is one of the largest mountaintop mining projects ever authorized in West Virginia. The DA Permit authorizes the Mingo Logan Coal Company to construct six valley fills, associated sedimentation structures, and other discharges of fill material to the Right Fork of Seng Camp Creek, Pigeonroost Branch, Oldhouse Branch, and their tributaries. If fully constructed, the project will disturb approximately 2,278 acres (about 3.5 square miles) and bury approximately 7.48 miles of streams beneath 110 million cubic yards of excess spoil.[1]

Following initiation of the Section 404(c) process, EPA Region III communicated with representatives of Mingo Logan (a subsidiary of Arch Coal, Inc.) and the Corps both in person and by telephone and electronic mail on several occasions to determine whether corrective action would be taken to address EPA Region III's concerns. However, corrective action was not taken to resolve EPA's concerns. On April 2, 2010, EPA Region III published in the **Federal Register** a Proposed Determination to prohibit, restrict, or deny the specification or the use for specification (including withdrawal of specification) of certain waters at the project site as disposal sites for the discharge of dredged or fill material for the construction of the Spruce No. 1 Surface Mine. EPA Region III took this step because it believed that discharges authorized by DA Permit No. 199800436–3 (Section 10: Coal River) would result in a significant loss of wildlife habitat and also cause significant degradation of downstream aquatic ecosystems and therefore could have unacceptable adverse effects on wildlife. A public hearing regarding the Proposed Determination was conducted on May 18, 2010. EPA Region III received more than 100 oral comments and more than 50,000 written comments both supporting and opposing its Proposed Determination.

On September 24, 2010, EPA Region III submitted to EPA Headquarters its Recommended Determination that the specification embodied in DA Permit No. 199800436–3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged or fill material for construction of the Spruce No. 1 Surface Mine be withdrawn. EPA Region III based this recommendation upon a conclusion that the discharges of dredged or fill material to Pigeonroost Branch and Oldhouse Branch for the purpose of constructing the Spruce No. 1 Surface Mine as authorized would likely have unacceptable adverse effects on wildlife.

The U.S. Fish and Wildlife Service (USFWS), in its comments on both the Proposed and Recommended Determinations, concurred with EPA Region III's conclusion that the project, as authorized, would result in unacceptable adverse effects on wildlife and that this conclusion is supported by the available scientific information. USFWS also noted that it has consistently expressed concerns regarding the loss of headwater streams and adjacent riparian and terrestrial habitats associated with the Spruce No. 1 Mine, as well as its likely impacts on downstream water quality, aquatic organisms, and terrestrial and aquatic wildlife that depend on those resources.

Following receipt of the Recommended Determination, and consistent with EPA's Section 404(c) regulations, EPA Headquarters provided an opportunity for the project's proponents to propose corrective actions intended to prevent the unacceptable adverse environmental impacts presented in the Recommended Determination. On November 16, 2010, a consultation meeting was held at EPA Headquarters in Washington, DC to discuss the Region III Recommended Determination and potential corrective actions that could be undertaken to avoid the unacceptable adverse impacts that were of concern to EPA. Participants at the meeting included the EPA Assistant Administrator for Water; the EPA Region III Regional Administrator; other EPA staff; representatives from Arch Coal, Inc. (parent company of Mingo Logan) and their legal counsel; the United Company (a mineral rights owner) and their legal counsel; the West Virginia Department of Environmental Protection, and the District Engineer of the Corps' Huntington District. At that meeting, and in subsequent communications, Arch Coal did not provide EPA with corrective actions that would meaningfully address the likely unacceptable adverse effects outlined in Region III's Recommended Determination.

Following review of the public comments received, existing and recently developed scientific data, and EPA Region III's Recommended Determination, EPA has concluded that the discharge of dredged or fill material to Pigeonroost Branch and Oldhouse Branch, in connection with the construction of valley fills and sedimentation ponds, as authorized by DA Permit No. 199800436–3 (Section 10: Coal River), will result in unacceptable adverse effects on wildlife. The administrative record developed in this case fully supports the conclusion that the Spruce No. 1 Surface Mine will have unacceptable adverse effects to wildlife, due to the filling of Pigeonroost Branch, Oldhouse Branch, and their tributaries. In addition, the administrative record demonstrates that the Spruce No. 1 Surface Mine will have unacceptable adverse effects on wildlife downstream of the project site as a result of increased pollution that the project will contribute to downstream waters.

EPA has determined that unacceptable adverse impacts to Pigeonroost Branch, Oldhouse Branch, and their tributaries will occur through the direct burial of 6.6 miles of high-quality stream habitat, including all wildlife in this watershed that utilize these streams for all or part of their life cycles (*e.g.,* macroinvertebrate, salamander, fish, and water-dependent bird populations). Pigeonroost Branch, Oldhouse Branch, and their tributaries contain diverse and high-quality wildlife communities that are consistent with the ecological richness of high-quality Appalachian headwater stream systems. With their adjacent riparian areas, these streams provide important habitat for 84 taxa of macroinvertebrates, up to 46 species of amphibians and reptiles, 4 species of crayfish, and 5 species of fish, as well as birds, bats, and other mammals. As some of the last remaining high quality,

[1] EPA's Final Determination addresses only the 6.6 miles of fill authorized in Pigeonroost Branch, Oldhouse Branch, and their tributaries. While the permit also authorizes construction of valley fills and other discharges to the Right Fork of Seng Camp Creek and its tributaries, EPA is not withdrawing specification of those waters, in part because some of those discharges have already occurred and because the stream resources in Right Fork of Seng Camp Creek were subject to a higher level of historic and ongoing human disturbance than those found in Pigeonroost Branch or Oldhouse Branch. Due to litigation and an agreement with environmental groups, represented by Ohio Valley Environmental Coalition, operations following the issuance of this DA Permit have been limited to the Seng Camp Creek watershed, and as part of that agreement one valley fill is partially constructed.

least-disturbed headwater stream habitat within the sub-basin, these streams not only support resident wildlife, but also provide ecosystem functions for downstream waters, serve as refugia for aquatic life and potential sources for recolonizing nearby waters, and ultimately serve to maintain the aquatic ecosystem integrity in the sub-basin and the rich animal diversity in the ecoregion.

Burial of Pigeonroost Branch, Oldhouse Branch, and their tributaries will also result in unacceptable adverse effects on wildlife downstream through the removal of functions performed by the buried streams and by transformation of the buried areas into pollution sources that will contribute contaminants to downstream waters. Based on recent peer-reviewed literature, as well as available data from adjacent mine sites and from the active portion of the Spruce No. 1 Mine, EPA has concluded that the full construction of the Spruce No. 1 Mine will transform these headwater streams from high-quality habitat into sources of pollutants (particularly total dissolved solids and selenium) that will travel downstream and adversely impact the wildlife communities that utilize these downstream waters. Increased pollutant levels will lead to loss of macroinvertebrate communities and population shifts to more pollution-tolerant taxa, specifically the extirpation of ecologically important macroinvertebrates. Through the loss of stream macroinvertebrate communities, there will be, in turn, substantial effects on fish, amphibian, and bird populations that rely on these communities as a food source.

Furthermore, the increased loading of pollutants to downstream receiving waters will increase the potential for harmful golden algal blooms, while increased selenium exposure will result in impaired salamander populations and adverse effects to the reproduction of fish and bird species, thus harming the ability of these local populations to rebound. The loss of macroinvertebrate prey populations, increased risk of harmful golden algal blooms, and additional exposure to selenium will have an unacceptable adverse effect on the 26 fish species found in Spruce Fork (the receiving stream for Pigeonroost Branch and Oldhouse Branch), and will also have an unacceptable adverse effect on amphibians, reptiles, crayfish, and bird species that depend on downstream waters for food or habitat.

Furthermore, these adverse impacts do not comply with the requirements of the Clean Water Act (CWA) and EPA's implementing regulations under section 404(b)(1). EPA has determined that the Spruce No. 1 Surface Mine fails to adequately evaluate less environmentally damaging alternatives, will cause or contribute to significant degradation of waters of the United States (especially when considered in the context of the significant cumulative losses and impairment of streams across the Central Appalachian ecoregion), and lacks compensatory mitigation to adequately offset the impacts to Pigeonroost Branch and Oldhouse Branch. These failures to comply with the Guidelines serve to strengthen EPA's judgment about the unacceptability of the significant adverse impacts that will occur.

Based on these findings and pursuant to section 404(c) of the CWA, EPA's Final Determination withdraws the specification of Pigeonroost Branch, Oldhouse Branch, and their tributaries, as described in DA Permit No. 199800436–3 (Section 10: Coal River), as a disposal site for the discharge of dredged or fill material for the purpose of construction, operation, and reclamation of the Spruce No. 1 Surface Mine. This Final Determination also prohibits the specification of the defined area constituting Pigeonroost Branch, Oldhouse Branch, and their tributaries for use as a disposal site associated with future surface coal mining that would be expected to result in a nature and scale of adverse chemical, physical, and biological effects similar to the Spruce No. 1 mine. This Final Determination does not affect discharges to Seng Camp Creek as authorized in DA Permit No. 19980043603 (Section 10: Coal River) associated with the Spruce No.1 Surface Mine.

EPA continues to work effectively with the Corps, the mining industry, and the public to evaluate proposed Appalachian surface coal mining projects and to enable permitting of environmentally responsible mining projects that authorize continued coal production while preventing unacceptable adverse effects on wildlife.

Dated: January 13, 2011.

Peter S. Silva,

Assistant Administrator, Office of Water.

[FR Doc. 2011–1013 Filed 1–18–11; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[FRL–9254–2]

Intent to Grant Patent License

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of Intent to Grant Co-Exclusive Patent License.

SUMMARY: Pursuant to 35 U.S.C. 207 (Patents) and 37 CFR part 404 (U.S. Government patent licensing regulations), EPA hereby gives notice of its intent to grant a co-exclusive, royalty-bearing, revocable license to practice the inventions described and claimed in the U.S. patents and patent applications listed at the end of this message, and all corresponding patents issued throughout the world, and all reexamined patents and reissued patents granted in connection with such patent applications, to Oakland Technology, LLC of Farmington Hills, Michigan.

The inventions pertain to hybrid vehicle technology, particularly hydraulic hybrid drive systems, methods, and components. The proposed license will contain appropriate terms, limitations, and conditions negotiated in accordance with 35 U.S.C. 209 and 37 CFR 404.5 and 404.7 of the U.S. Government patent licensing regulations. EPA will finalize terms and conditions and grant the license unless, within 15 days from the date of this notice, EPA receives, at the address below, written objections to the grant, together with supporting documentation. The documentation from objecting parties having an interest in practicing the inventions listed in the patents and patent applications below should include an application for a nonexclusive license with the information set forth in 37 CFR 404.8. The EPA Patent Attorney and other EPA officials will review all written responses and then make recommendations on a final decision to the Director or Deputy Director of the Office of Transportation and Air Quality, who have been delegated the authority to issue patent licenses under EPA Delegation 1–55.

The proposed license will apply to the following patents and patent applications:

Method or Vehicle Licensed Inventions

Patent No.	Title	Date issued
5,495,912	Hybrid Powertrain Vehicle	March 5, 1996.

Matthew Klasen/DC/USEPA/US
01/19/2011 10:20 AM

To Rose Kwok
cc Travis Loop, Gregory Peck, Brian Frazer, Christopher Hunter, Gregg Serenbetz
bcc
Subject Need to post updated Qs&As / fact sheet on Spruce -- thanks!

Hi Rose,

Since Chris is off in Philadelphia, can you help post updated versions of Spruce Qs&As and the two-page fact sheet to the 404(c) page? Chris has been in the loop on this process -- basically we've deleted a bullet from each document with respect to cumulative impacts. We need this updated as soon as you get a chance this morning.

The attached files have the same file names as those already on the site, for ease of uploading.

Main page with the files: http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/404c_index.cfm
Summary that needs updating is at
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/upload/FINAL_Spruce_Factsheet_011311.pdf
Qs&As that need updating are at
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/upload/FINAL_Spruce_404c_QA_011311.pdf

Let me know if you have any questions. (I'm copying Gregg as well, whom Chris suggested could also help if necessary.)

Thanks,
Matt

FINAL_Spruce_Factsheet_011311.pdf FINAL_Spruce_404c_QA_011311.pdf

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Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

EPA Action Halts Disposal of Mining Waste in Streams at Spruce No. 1 Mine to Protect Environment, Water Quality, and Appalachian Communities

EPA's Decision: Using authority provided under the Clean Water Act (CWA), the U.S. Environmental Protection Agency (EPA) completed its 15-month comprehensive review of impacts on water quality and wildlife from the Spruce No. 1 mountaintop coal mine in Logan County, West Virginia. EPA concluded, based on a substantial body of new scientific work completed since 2007, that the mine would result in significant environmental impacts from burying over 6.6 miles of ecologically valuable streams under mining waste and would also cause unacceptable adverse environmental effects to wildlife in downstream waters. As a result, EPA is acting under the CWA to protect wildlife, water quality, and Appalachian communities, who rely upon healthy streams, by prohibiting the Mingo Logan Coal Company from disposing of 110 million cubic yards of mining waste into waterways as part of proposed mountaintop coal mining at the Spruce No. 1 Mine. The Spruce No. 1 Mine, among the largest mountaintop coal mines ever proposed in Appalachia, would disturb approximately 2,278 acres (about 3.5 square miles) of forestlands in southern West Virginia and bury over six miles of streams under waste rock and mining debris. Two of these streams, Pigeonroost Branch and Oldhouse Branch, are two of the last-remaining high-quality streams in the watershed and are protected by EPA's action.

Summary of EPA Findings: EPA's decision to stop mining waste discharges to high-quality streams at the Spruce No. 1 mine is based on several major environmental, water quality, and wildlife concerns:

- Burying more than 35,000 feet (more than 6 miles) of high-quality streams under mining waste, which will eliminate all fish, invertebrates, salamanders, and other wildlife that live in them;
- Polluting downstream waters as a result of burying these streams, which will lead to unhealthy levels of salinity and toxic levels of selenium;
- Causing downstream watershed degradation that will kill aquatic wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms; and
- Inadequately mitigating for the mine's environmental impacts to high-quality streams, by using mining ditches, for example, to offset the functions provided by these natural streams.

In addition, EPA is concerned that the Spruce No. 1 Mine will expose Appalachian communities to additional mining related sources of pollution in a watershed already highly impacted by mining activity.

Key Background: Under CWA section 404(c), Congress authorized EPA to prohibit or restrict activities involving the placement of pollutants in the nation's waterways where the Agency determines that these pollutants will cause unacceptable adverse effects to municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. EPA has used its Section 404(c) authority sparingly, prohibiting just 13 projects, including the Spruce mine, since 1972. In this case, EPA is taking this action because a substantial body of new scientific studies and work completed since the mine was permitted in 2007 demonstrate that the burial of Pigeonroost Branch, Oldhouse Branch and their tributaries will have direct, unacceptable adverse effects on wildlife, including fish, salamanders, and waterfowl; and will contribute to downstream water quality degradation and associated adverse impacts to wildlife.

Mountain streams within the Central Appalachian ecoregion have some of the richest aquatic animal diversity of any area in North America, including one of the highest concentrations of salamanders in the world, as well as many rare species of mayflies, stoneflies and caddisflies, which are ecologically important aquatic insects that form the foundation of stream food webs. The project will bury 6.6 miles of some of the last remaining high quality streams and riverbank areas within the Coal River watershed. These streams contain important wildlife communities and habitat and they rank extremely high in comparison to other streams in West Virginia and in Central Appalachia. Including their riverbank areas, the streams within the Spruce No. 1 Mine area provide important habitat for over 40 species of amphibians and reptiles, 4 species of crayfish, and 5 species of fish, as well as numerous birds, bats, and

other mammals. The Spruce No. 1 Mine will eliminate the entire suite of important physical, chemical and biological functions provided by these streams and will result in the loss of salamander, fish, and other wildlife populations that depend on that habitat for survival.

Burial of Pigeonroost Branch and Oldhouse Branch will also result in unacceptable adverse effects on wildlife by increasing levels of pollution to downstream waters, where over 25 different species of fish are found. Full construction of the Spruce No. 1 Mine will bury streams on site beneath tons of broken mining waste rock that will leach pollutants, particularly total dissolved solids and selenium, into downstream waters and adversely impact the wildlife communities that live in or utilize these streams. The loss of food sources caused by these increased pollution levels, as well as additional exposure to selenium will cause adverse effects to fish species found in Spruce Fork as well as amphibians, reptiles, crayfish, and bird species that depend on downstream waters for food or habitat.

Section 404(c) Review Process: Key steps in EPA's CWA review of the Spruce No. 1 Mine:

- October 2009: EPA begins coordinating with Mingo Logan Coal Company and Corps of Engineers to identify potential corrective actions that reduce mining impacts and would eliminate need for further CWA review. Company does not agree to alternative mine configuration to avoid impacts.
- March 26, 2010: EPA Region III publishes comprehensive Proposed Determination outlining the project's environmental effects and requests public comments.
- May 18, 2010: EPA conducts Public Hearing in Charleston, West Virginia to discuss anticipated mine impacts and provide opportunity for public input. EPA receives over 50,000 public comments – most in support of EPA's review of the Spruce No. 1 Mine.
- September 24, 2010: EPA Region III prepares Recommended Determination for EPA Headquarters concluding that discharges associated with the Spruce No. 1 Mine would be likely to lead to significant adverse environmental effects. Region III developed its Recommended Determination in consideration of the Corps permit record, 50,000 public comments, and extensive scientific information relevant to the Spruce No. 1 project.
- October 2010: EPA Office of Water initiates second consultation process with Corps, Mingo Logan Company, State, and landowner to identify potential corrective actions that might eliminate need for EPA action. Company expresses unwillingness to improve its mining operation.
- January 13, 2011: EPA Office of Water completes Section 404(c) review of the Spruce No. 1 Mine and publishes Final Determination concluding that the project, as currently designed, would cause unacceptable environmental impacts, including water quality impacts, to waterways at the Spruce site and prohibits disposal of mining waste in streams.

A copy of the Final Determination is available at
http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/404c_index.cfm

Questions & Answers – Spruce Mine Final Determination

1. What were EPA's conclusions after its § 404(c) review of the Spruce No. 1 Mine?

EPA concluded that the Spruce No. 1 surface coal mine will have unacceptable adverse effects on water quality and the environment. EPA's decision to stop mining waste discharges to high quality streams at the Spruce No. 1 Mine was based on several major environmental and water quality concerns. The proposed mine would have:

- Disposed of 110 million cubic yards of coal mine waste into streams.
- Buried more than six miles of high-quality streams in Logan County, West Virginia with millions of tons of mining waste from the dynamiting of over 2,200 acres of mountains and forestlands.
- Buried more than 35,000 feet of high-quality streams under mining waste, which will eliminate all fish, small invertebrates, salamanders, and other wildlife that live in them.
- Polluted downstream waters as a result of burying these streams, which will lead to unhealthy levels of salinity and toxic levels of selenium that turn fresh water into salty water. The resulting waste that then fills valleys and streams can significantly compromise water quality, often causing permanent damage to ecosystems and rendering streams unfit for swimming, fishing and drinking.
- Caused downstream watershed degradation that will kill wildlife, impact birdlife, reduce habitat value, and increase susceptibility to toxic algal blooms.
- Inadequately mitigated for the mine's environmental impacts by not replacing streams being buried, and attempting to use stormwater ditches as compensation for natural stream losses

Finally, EPA's decision prohibits five proposed valley fills in two streams, Pigeonroost Branch, and Oldhouse Branch, and their tributaries. Mining activities at the Spruce site are underway in Seng Camp Creek as a result of a prior agreement reached in the active litigation with the Mingo Logan Coal Company. EPA's Final Determination does not affect current mining in Seng Camp Creek.

EPA also identified concerns that the permit does not comply with the environmental review criteria under § 404(b)(1) of the Clean Water Act, such as the availability of alternatives, prevention of significant degradation, and adequacy of compensatory mitigation, which further confirm the unacceptability of these impacts.

2. What is the result of EPA's § 404(c) action on the Spruce No. 1 Mine?

EPA's § 404(c) action prohibits the burial of two high-quality streams on the Spruce No. 1 project site, Pigeonroost Branch and Oldhouse Branch. EPA's action prevents the Spruce No. 1 project from disposing of mining waste in these two streams. EPA's action also prevents other mining waste disposal activities in these two streams that would have

impacts of a similar scope and scale as the Spruce No. 1 Mine. However, EPA's action does not prohibit mining activities that are currently being conducted at the Spruce No. 1 Mine in Seng Camp Creek, a third stream that has already been impacted by mining activities.

3. What are the environmental benefits of EPA's decision?

EPA is acting under the law and using the best science to protect water quality, wildlife and Appalachian communities, who rely on clean waters for drinking, fishing and swimming. These streams contain vibrant wildlife communities and play a critical role in sustaining the quality of downstream waters. These six miles of streams are among the last remaining high-quality streams within a watershed that has been fundamentally altered by prior and ongoing surface coal mining activities. By preventing these streams from being permanently buried, EPA's action protects these streams and the wildlife that live within them, including fish, amphibians, macroinvertebrates, and water-dependent birds. EPA's action also ensures that these streams will continue to sustain the aquatic wildlife communities downstream of the project site, which would have been significantly affected by pollution from the Spruce No. 1 Mine.

4. Why are these discharges harmful to wildlife?

Discharges associated with the Spruce No. 1 mine will have unacceptable effects on wildlife in two ways. First, dumping millions of tons of mining waste into six miles of streams will completely destroy these streams and kill all wildlife that live within them, including fish, amphibians, and macroinvertebrates. Second, as a result of burying these streams, downstream waters will be irreversibly polluted by potentially toxic levels of total dissolved solids and selenium, which will kill or injure wildlife such as fish, amphibians, water-dependent birds, and macroinvertebrates.

5. Why did EPA review and veto the Spruce mine but not others?

The Spruce No. 1 mine is one of the largest surface coal mines ever proposed in central Appalachia. EPA has consistently raised concerns regarding the environmental impacts that the project would cause. Since issuance of the Spruce No. 1 permit in 2007, significant new information has arisen to confirm and further inform EPA's earlier concerns and to emphasize the value of the environmental resources that would be affected by the Spruce No. 1 mine. Additionally, litigation associated with the environmental impacts of the Spruce No. 1 Mine has delayed the start of mining activities on the site, meaning that unacceptable adverse effects have not yet occurred.

EPA takes its § 404(c) responsibility seriously, and recognizes that EPA's use of 404(c) should meet a high standard. EPA has only completed 13 Final Determinations in the Agency's 40-year history, emphasizing the careful consideration EPA gives to its Section

404(c) responsibilities and the seriousness with which EPA views the impacts from the Spruce No. 1 Mine. EPA also recognizes that action in the context of a previously issued permit should only occur under exceptional circumstances.

6. What does this decision mean for the future of other previously permitted coal mines in Appalachia?

EPA's determination on the Spruce mine is extremely rare. EPA has used this Clean Water Act authority in just 12 circumstances since 1972 and reserves this authority for only unacceptable cases.

The determination on the proposed Spruce No. 1 Mine is limited to the particular circumstances of this mine. Because of the unique combination of scale of impacts and the nature of the impacted resources both in and of themselves and within the larger context of the watershed, EPA's concerns with the Spruce No. 1 Mine are unlikely to be repeated for other Appalachian surface coal mining projects for which permits have previously been issued.

EPA applied rigorous scientific research to the particular facts of the Spruce No. 1 Mine and determined that the environmental impacts would be unacceptable.

Despite EPA's willingness to consider alternatives, the company did not offer any new proposed mining configurations in response to EPA's concerns based on science and the law.

7. Is EPA considering vetoing other surface coal mining projects with existing permits?

At this time, EPA is not currently reviewing any other previously permitted Appalachian surface coal mining projects pursuant to § 404(c).

Betsy Behl /DC/USEPA/US
01/19/2011 08:16 PM

To Matthew Klasen
cc
bcc
Subject Re: Summary of SAB call today on ORD MTM reports

Thanks very much for thiS Matt. It will be helpful for development of conductivity criteri
to ----------\Sent by EPA Wireless E-Mail Services.
Matthew Klasen

----- Original Message -----
From: Matthew Klasen
Sent: 01/19/2011 06:08 PM EST
To: Gregory Peck; Denise Keehner; Bob Sussman; Nancy Stoner; Peter Silva; Karyn Wendelowski; Kevin Minoli; MichaelG Lee; Sharmin Syed; Tom Laverty; Marcus Zobrist; Brian Frazer; Christopher Hunter; Brian Topping; Timothy Landers; David Evans; Tanya Code; Js Wilson; Colleen Forestieri; Margaret Passmore; John Pomponio; Jon Capacasa; Jim Giattina; Tinka Hyde; Ephraim King; Betsy Behl
Cc: Michael Slimak; Susan Cormier; Glenn Suter; Susan Norton; Joe Beaman; Lisa Huff; Joe Beaman; Rachael Novak
Subject: Summary of SAB call today on ORD MTM reports

Hi everyone,

Given the broad interest in the SAB's review of ORD's draft MTM reports, I thought I'd send around a summary of the discussion. (This represents my unofficial summary only.)

Background: Today's teleconference was a "quality review" by the full SAB of the SAB Panel's draft reports. Today's call, run by the Chair of the SAB, consisted of public comments, a summary of each report from the Panel, a set of oral comments provided by a set of SAB reviewers, and a vote by the SAB on how to proceed with each report.

Summary of Discussion : In general, the SAB was supportive of the content of the Panel's draft reports, and offered suggested improvements (largely to encourage the Panel to take a second look at specific issues or to clarify its recommendations). The Panel spent more time discussing the MTM/VF impacts report than the conductivity report, and the call finished well ahead of schedule. A more detailed summary of the issues that were discussed is attached.

NMA Comments: NMA provided public comments at the outset of the meeting, criticizing the SAB process for its "disappointing" draft reports and its inadequate consideration of NMA's public comments and scientific analyses.

Next Steps: At the conclusion of the discussion, the Board approved each report pending revisions by the Panel and a re-review by a subset of SAB members. So the full SAB will not meet again to consider these reports and will defer to a subset of the group for final approval. The SAB staff office expects final SAB reports to be sent to the Administrator within 30 days.

Attached is a more detailed summary of what was discussed.

Finally, in terms of responding to any press inquiries that come in regarding NMA's strong process comments on today's call, it's worth pointing out that while the SAB does not pull together a formal response to public comments, ORD is pulling together a response to all public comments as it works to revise both reports.

Let me know if you have any questions.

Thanks,
Matt

[attachment "2011-01-19 MTM SAB Quality Review Telecon Summary.docx" deleted by Betsy Behl/DC/USEPA/US]

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Rachael Novak/DC/USEPA/US

To

cc

bcc

Subject SAB call- see Matt's 12/28 email

Meeting

Date 01/19/2011
Time 12:00:00 PM to 03:00:00 PM
Chair Rachael Novak
Invitees
Required
Optional
FYI
Location

The full SAB will be holding a quality review teleconference on Wednesday, January 19 from noon to 3 pm to discuss these draft reports, in preparation for forwarding the SAB's final reports to the Administrator early next year.

ORD let us know a few minutes ago that the SAB has posted updated draft reports on both of the ORD MTM reports (the MTM/VF impacts report, and the conductivity benchmark report).

The SAB drafts are available at http://yosemite.epa.gov/sab/SABPRODUCT.NSF/MeetingCal/ED55AF1742315D34852577EC0059AADC?OpenDocument (definitely not the most straightforward URL). Reports are at the bottom of the page.

Jim Pendergast/DC/USEPA/US
01/20/2011 03:56 PM

To Brian Frazer
cc "Julia McCarthy"
bcc
Subject Re: Fw: Spruce

Looks good. No edits. I just forwarded it.

Brian Frazer	Jim - I'm not going to have a chance to review thi...	01/20/2011 03:45:24 PM

From: Brian Frazer/DC/USEPA/US
To: "Jim Pendergast" <Pendergast.Jim@epamail.epa.gov>
Cc: "Julia McCarthy" <McCarthy.Julia@epamail.epa.gov>
Date: 01/20/2011 03:45 PM
Subject: Fw: Spruce

Jim - I'm not going to have a chance to review this until later this evening. I asked Julia to draft a Spruce Q&A for SEPW hearing.

Can you review and let Julia know if you have any comments. Thx

Julia - Thanks you for drafting the Q&A.

bf

Brian Frazer
Chief, Wetlands & Aquatic Resources Regulatory Branch
O:202-566-1652
[redacted]

Sent from my BlackBerry Wireless Handheld

Julia McCarthy

----- Original Message -----
From: Julia McCarthy
Sent: 01/20/2011 10:40 AM MST
To: Brian Frazer
Subject: Re: Spruce

Hey Brian,
Here's what I put together. Let me know if there's any changes or additions you need. Also, I put you and Chris as the contacts.
Cheers,
Julia

Spruce No1 Mine 1-20-11 Admin fact book.docx

Julia McCarthy
on detail to USEPA Headquarters
Office of Wetlands, Oceans and Watersheds
(202) 566-1660
mccarthy.julia@epa.gov

A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a connection of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal.

Conservation is our effort to understand and preserve this capacity. ~Aldo Leopold

Brian Frazer	Julia - Here is an example of the WUS fact sheet...	01/20/2011 11:22:33 AM

From: Brian Frazer/DC/USEPA/US
To: Julia McCarthy/R8/USEPA/US@EPA
Date: 01/20/2011 11:22 AM
Subject: Spruce

Julia - Here is an example of the WUS fact sheet. Can you pull together one on the Spruce mine.

[attachment "Waters of the US - 1-14-11 Admin fact book .docx" deleted by Julia McCarthy/R8/USEPA/US]

Thanks,

bf

Here is the question we were given.

MTM: What is the status of EPA's veto of the Spruce No. 1 Mine permit?

****

Brian M. Frazer, Chief
Wetlands & Aquatic Resources Regulatory Branch
Office of Wetlands, Oceans and Watersheds
U.S. EPA
1200 Pennsylvania Avenue, NW (MC 4502T)
Washington, DC 20460
202-566-1652

SPRUCE NO. 1 MINE VETO

QUESTION: What is the status of EPA's veto of the Spruce No. 1 Mine permit?

ANSWER:

- On January 13, 2011, the Final Determination concerning the Spruce No. 1 Mine in Logan Co., West Virginia was signed by Peter Silva, Assistant Administrator of Water.
- The Federal Register Notice of Final Determination was published on January 19, 2011.
- Using authority provided under the Clean Water Act § 404(c), EPA completed its 15-month comprehensive review of impacts on water quality and wildlife from the Spruce No. 1 mountaintop coal mine. EPA concluded, after considering a substantial body of new scientific work completed since 2007 as well as over 50,000 public comments, that the mine would result in significant environmental impacts from burying over 6.6 miles of ecologically valuable streams under mining waste and would cause unacceptable adverse environmental effects to wildlife in the project area and downstream waters.

BACKGROUND:

- The Spruce No. 1 Mine is among the largest mountaintop coal mines ever proposed in Appalachia and would disturb approximately 2,278 acres (about 3.5 mi^2) of forestlands in southern West Virginia and bury over six miles of headwater streams under waste rock and mining debris. Two of these streams, Pigeonroost Branch and Oldhouse Branch, are some of the last-remaining high-quality streams in the watershed.
- EPA's § 404(c) action prohibits five proposed valley fills in Pigeonroost Branch and Oldhouse Branch and their tributaries. EPA's action prevents the Spruce No. 1 project from disposing of mining waste in these streams and also prevents other mining waste disposal activities in these streams that would have impacts of a similar scope and scale as the Spruce No. 1 Mine. However, EPA's action does not affect current mining activities under the same permit in Seng Camp Creek.
- Discharges associated with the Spruce No. 1 mine will have unacceptable effects on wildlife in two ways. First, disposal of 110 million cubic yards of coal mine waste into over six miles of streams will bury these streams and kill all wildlife that live within them, including fish, amphibians, and macroinvertebrates. Second, as a result of burying these streams, downstream waters will be polluted by potentially toxic levels of total dissolved solids and selenium, which will adversely affect wildlife such as fish, amphibians, water-dependent birds, and macroinvertebrates.
- Since issuance of the Spruce No. 1 permit in 2007, significant new information has arisen to confirm and further inform EPA's earlier concerns and to emphasize the value of the environmental resources that would be affected by the Spruce No. 1 mine. Additionally, litigation associated with the environmental impacts of the Spruce No. 1 Mine has delayed the start of mining activities on the site, meaning that unacceptable adverse effects have not yet occurred.
- EPA has only completed 13 Final Determinations in the Agency's 40-year history, emphasizing the careful consideration EPA gives to its § 404(c) responsibilities and the seriousness with which EPA views the impacts from the Spruce No. 1 Mine. EPA also recognizes that action in the context of a previously issued permit should only occur under exceptional circumstances. At this time, EPA is not currently reviewing any other previously permitted Appalachian surface coal mining projects pursuant to § 404(c).

Chris Hunter (202) 566-1454
Brian Frazer (202) 566-1652

DRAFT

Kevin Minoli/DC/USEPA/US
01/21/2011 05:27 PM

To Christopher Hunter
cc Gautam Srinivasan
bcc
Subject Fw: Rescheduled: Revisions to Surface Coal Mining Guidance (Jan 26 10:00 AM EST in 6300D-Kenai/DC-CCW-OW-WEST@EPA)

Hey Chris- Can you please add Gautam as an optional invitee to this meeting? Thanks!
----- Forwarded by Kevin Minoli/DC/USEPA/US on 01/21/2011 05:27 PM -----

Rescheduled: Revisions to Surface Coal Mining Guidance

Wed 01/26/2011 10:00 AM - 11:00 AM

Attendance is **required** for Kevin Minoli

Chair: **Christopher Hunter/DC/USEPA/US**

Location: TBD Rooms: 6300D-Kenai/DC-CCW-OW-WEST@EPA

This reschedule notice has been applied to the meeting.

Required:	Cliff Rader/DC/USEPA/US@EPA, Karyn Wendelowski/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA, klasen.matthew@epa.gov, Marcus Zobrist/DC/USEPA/US@EPA, Tom Laverty/DC/USEPA/US@EPA
Optional:	Brian Frazer/DC/USEPA/US@EPA, Gregory Peck/DC/USEPA/US@EPA

Description

Now that the new year is here, attention has turned to the April 2010 Guidance and our commitment to finalize that guidance by April 1, 2011. Senior leadership will be meeting shortly to discuss what directions they would like the revised guidance to take, and while that is going on, we wanted to get a staff discussion going about timing and resources needed to accomplish this task. Since it will have to go back through interagency review before being finalized, Bob Sussman has indicated he would like to have a draft ready by the first week in March, which leaves us about 5 weeks to get it done. If anyone in EPA could find a room large enough for this meeting, we can have it over there since I'm the only one in West.

Attached are also the draft summaries of comments received from the comment docket, split out by issue area. We're still waiting on 2 issue areas, which I will pass along when I have them.

101231_11_Overall_Comments-summary (draft)_10058.pdf 101231_2_Fed_Auth-summary (draft)_10058.pdf
101231_3_Science (draft)_10058.pdf 101231_4_Conductivity-summary (draft)_10058.pdf 101231_5_NPDES (draft)_10058.pdf

101231_6_CWA Section 404 (draft)_10058.pdf 101231_7_CWA Section 401 (draft)_10058.pdf 101231_8_NEPA (draft)_10058.pdf

101231_10_EconomicConsiderations-summary (draft)_10058.pdf

XI. Overall Comments

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The Overall Comments issue includes those comments, recommendations, and opinions submitted by stakeholders in general support or opposition to the Guidance, and/or to mountaintop mining in general.

There were a total of 104 unique tallied comments posted by the docket as of December 1, 2010. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 11-1 on the next page presents the total comment letters that made an overall comment by commenter category.

Most comments from private citizens and the mass mailing campaigns are in general agreement with the Guidance and commend EPA for issuing it; and are generally opposed to mountaintop mining in general. They argue that mountaintop mining activities are destructive of wildlife, forests, and streams, and have negative health impacts; and that the Guidance is based on sound science. The few private citizens in opposition to the Guidance express economic concerns. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. Industry commenters contend that the Guidance is legally flawed, will have negative economic impacts, and relies on insufficient scientific data and peer review. Congressional delegates argue that the Guidance was issued prematurely, will cost many jobs, and undermines the authority, role, and responsibility of State agencies in reviewing and issuing permits. The Sierra Club argues that the Guidance is based on sound scientific evidence and commends EPA for issuing it. The Kentucky Energy and Environment Cabinet highlights EPA's challenge of implementing existing requirements while protecting other interests, including the economy and energy supply.

Below are summaries of the overall comments, presented by commenter category. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline)

and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

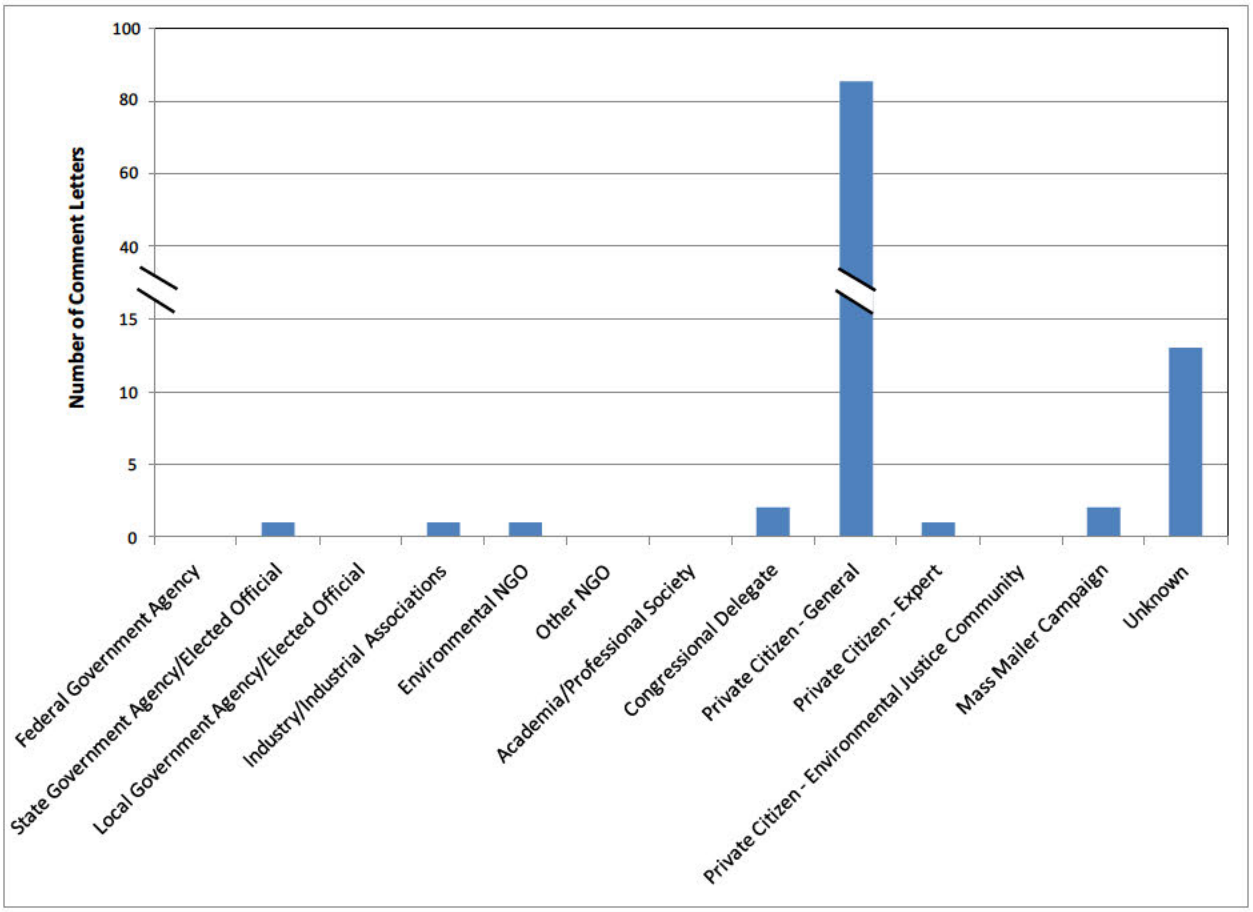

Figure 11-1. Overall Comments, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations.

a. General Support for the Guidance

The Kentucky Energy and Environment Cabinet agrees with EPA's commitment to developing environmentally effective, scientifically sound, and economically responsible approaches for

meeting existing requirements while not compromising the Appalachian region and depriving the entire nation of the benefits coal provides, both for the economy and energy supply.

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance.

b. General Opposition for the Guidance

Frost Brown Todd argue that the Guidelines "impose insurmountable technical and economic burdens on the coal mining industry, effectively shutting down surface coal mining (and possibly significant underground coal mining) throughout much of Central Appalachia" (p. 2)and request the Guidelines be immediately withdrawn. The following several arguments are provided to support their request:

- "The Guidance Memorandum is legally flawed and imposes inappropriate requirements on the regulated community without following proper procedures" (p. 3);
- "EPA's implementation of the Guidance threatens to effect unconstitutional taking of the property of mineral owners" (p. 6);
- "The April 1 Guidance Memorandum will create unnecessary confusion and uncertainty and treats the states, regions, and industries inequitably" (p. 7); and
- "The April 1 Guidance Memorandum relies on limited, questionable, and unproven scientific 'data' and analyses" (p. 8).

They further request EPA to "instruct the states, EPA regions, and other federal agencies not to implement or enforce any of the requirements contained therein" (p. 9).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, one letter was submitted from an Environmental NGO commenting on

EPA's Guidance. The Sierra Club (Doc. #0225.1) strongly supports the Guidance and commends EPA for issuing it.

a. General Support for the Guidance

The Sierra Club is of the opinion that the EPA was justified in implementing the Guidance immediately. They agree that the most recent, peer-reviewed scientific evidence was used as the basis for the Guidance and further state the Guidance is "necessary to protect water quality from the effects of mountaintop removal mining" (p. 2).

6. Other NGOs

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

8. Congressional Delegates

Two comment letters posted by the docket as of December 1, 2010 were submitted by congressional delegates. Both letters are signed by several members of Congress and disagree with the Guidance. The first letter (Doc. #0011) is signed by three congressional delegates representing the States of Virginia and West Virginia. The second letter (Doc. #0015) is signed by 23 congressional delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming.

b. General Opposition for the Guidance

Both letters argue the Guidance was issued prematurely and urge EPA to withdraw it. Some congressional delegates (Doc. #0011) agree that regulations are necessary but suggest EPA "continue to work with the affected States, the involved federal agencies, and all stakeholders to develop guidelines that truly provide a balanced process for energy development and environmental protection" (p. 2).

9. Private Citizen - General

Eighty two comment letters, typically one page in length, were received from members of the general public. Two letters from private citizens (Doc. #0019, and Doc. #0249) disagree with EPA's Guidance. The remaining private citizen commenters either support the Guidance or are opposed to mountaintop mining in general.

a. General Support for the Guidance

The majority of the general public is in support of the Guidance and commends EPA for issuing it. Several commenters point out that mountaintop mining destroys wildlife, forests, and streams and are of the belief that the Guidance will help protect people and the environment from negative impacts of mountaintop mining. Many agree the Guidance has been based on the best available science and thank EPA for enforcing the CWA.

One commenter (Doc. #0009) sums up the feelings of the overall general public by saying, "I applaud the Environmental Protection Agency for setting a tough new policy that should protect waterways and communities from the destruction caused by mountaintop removal. The new policy represents the most significant administrative action ever taken to address mountaintop removal coal mining and reaffirms the administration's commitment to science and environmental justice for the communities and natural areas of Appalachia."

b. General Opposition for the Guidance

Both commenters in general opposition to the Guidance are concerned that mines will be closed, small towns will be devastated, additional poverty will be created, and residents will be forced to relocate. One comment letter states, "My family and many others like us will have to leave our state to find work (Doc. #0019)."

c. Opposed to Mining in General

Many in the general public are opposed to mining in general. Commenters argue it destroys natural resources and causes health problems. One commenter (Doc. #0020) states: "Please help bring an end to Mountaintop Removal. I just can't believe this ever happened in the first place" (p. 2). Another commenter (Doc. #0025) points out that the profits earned by coal companies do not justify the negative impacts to people's health and the environment and writes: "several billion dollars of income are earned by the coal companies but the costs to West Virginia alone amount to tens of billions of dollars in health costs and perhaps even larger amounts to the degradation of WV's environment."

10. Private Citizen – Expert

As of December 1, 2010, one letter (Doc. #0112) was submitted from a private citizen - expert commenting on the issue of federal authority to regulate these activities in EPA's Guidance. The commenter is a biologist, with a Masters degree in biology, and is currently a teacher teaching Wildlife Management and Environmental Earth Science, with more than three decades of experience in the public school system.

a. General Support for the Guidance

The commenter is in general agreement with the Guidance, concurring that there is unequivocal scientific evidence to supports the Guidance. The commenter is of the opinion that: "it is our duty as the most powerful species to exist on this planet to use our might to protect the integrity

of our life support systems for the benefit of all living things" (p. 1).

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group had not been posted by the docket. Any comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

a. General Support for the Guidance

Both campaigns are in support of EPA's Guidance and suggest that the Guidance should be strengthened and finalized. They agree the most recent, peer-reviewed scientific information documents that mountaintop mining negatively impacts water quality.

13. Unknown

Thirteen comment letters, typically one page in length, were received from unknown or unidentified commenters. One commenter is in general disagreement with EPA's Guidance; the others are in general agreement.

a. General Support for the Guidance

The majority of the commenters in general agreement with the Guidance feel it will help protect public health and water quality from the impacts of mountaintop mining. Many commenters also urge EPA to strengthen and finalize the Guidance.

b. General Opposition for the Guidance

The commenter in general disagreement with the Guidance argues it is based on "scientific studies that are limited in scope and analysis (Doc. #0010)." The commenter feels the individual states should be able to administer their own water quality programs and define what constitutes stream degradation. The commenter claims the Guidance is a violation of states' rights.

X. Economic Considerations

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The issue area of Economic Considerations includes those comments, recommendations, and opinions submitted by stakeholders regarding lost jobs or income, impacts to the national, state, or local/county economy, and general economic considerations.

There were a total of 12 tallied comments submitted to the docket as of December 1, 2010, discussing the economy. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, congressional delegates, and the general public. Most comments were received from private citizens or anonymous commenters. Figure 10-1 on the next page presents the total comment letters that address the economy by commenter category.

Private citizen (including anonymous stakeholders) comments are both in support with and in opposition to the Guidance. Those in support of the Guidance express the view that natural resources and the public health should outweigh economic considerations, including jobs. Those in opposition to the Guidance associate it with negative economic impacts both locally (i.e., at the individual level) and at a larger scale.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) is in general support of the Guidance but seeks clarification on Guidance implementation through a series of questions. Both groups contend that the Guidance may render mountaintop mining activities economically unfeasible, negatively impacting local economies and the industry and resulting in potential closures of mountaintop mining activities. They also make note of the Guidance's limited applicability to six states, which they contend will result in economic disparities. Questions from the Kentucky Energy and Environment Cabinet relate to economic concerns associated with lost job opportunities, geographic inequity of the Guidance applicability, and environmental justice for low-income, high-unemployment areas.

Below are summaries, presented by commenter category, on economic considerations. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

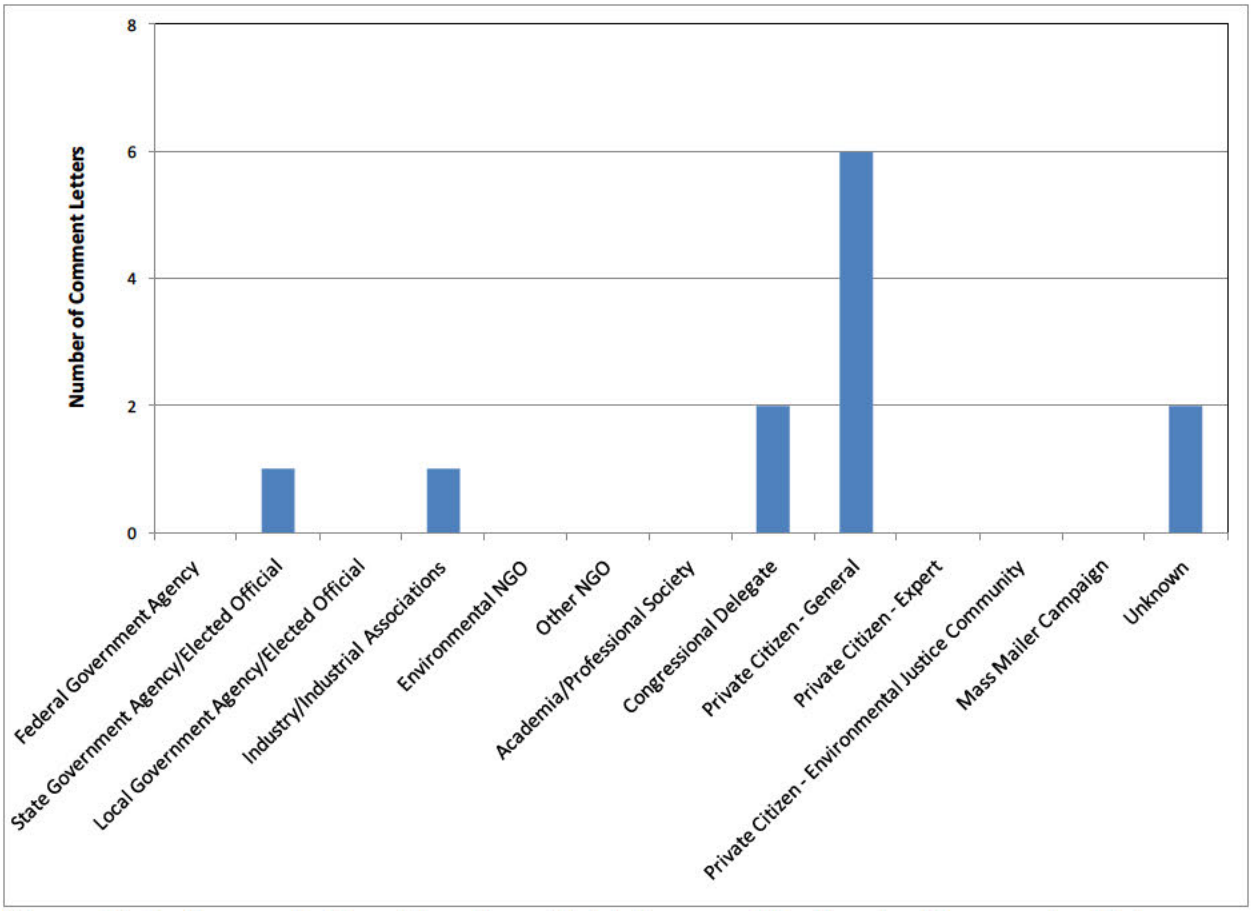

Figure 10-1. Economic Considerations, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

The Kentucky Energy and Environment Cabinet (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations. They express concern that the Guidance is premature and may unnecessarily impact the economy.

a. Jobs Lost/Lost Income

The Kentucky Energy and Environment Cabinet is concerned that the Guidance may be premature and has the potential to cause more economic harm than good. They ask: "is there not

a potential for permit requirements to be imposed by U.S. EPA in the interim that are more restrictive or potentially more cost prohibitive than in the final guidance, resulting in job loss and economic hardship that could be avoided by waiting until the guidance is finalized. (p. 3)?"

c. Impacts to State Economy

The Kentucky Energy and Environment Cabinet points out that only six states (Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia) are subject to the Guidance and speculate that the Guidance may be creating "economic inequity and a competitive disadvantage between the six targeted states and other coal producing states (p. 3)?"

e. General Economic Considerations

The Kentucky Energy and Environment Cabinet raises the issue of economic impacts to low-income areas of Appalachia. They acknowledge that "each Federal agency shall make achieving environmental justice (EJ) part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (p. 4), and ask: "How does the potential elimination of high wage jobs for citizens living in low-income, high unemployment areas of Appalachia, factor into the EJ decision-making process?" (p. 4).

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the economy. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance and argue that it will have negative economic impacts on the industry, resulting in potential closures of mountaintop mining activities.

a. Jobs Lost/Lost Income

Frost Brown Todd claim that the strict standards in the Guidance "will make most mining activities practically and economically infeasible" (p. 6). They further argue the Guidance focuses too much attention on community water supplies while ignoring "the potential severe harmful socio-economic effects that would be inflicted on low-income communities throughout Appalachia through the loss of employment" (p. 5).

b. Impacts to National Economy

Frost Brown Todd foresee impacts to the national economy, including loss of profits and resulting lawsuits against the federal government by the coal industry and property owners. They view the coal mining industry as "an essential part of our nation's economic vitality and a key to our short- and long-term economic and energy security" (p. 9). They suggest the Guidance will cause significant loss of profits and lead to lawsuits filed by companies in the coal business and property owners to recover hundreds of billions of dollars of lost profits. They claim the Federal Government will be required to provide compensation for these lawsuits and "at such a tenuous financial time, this would have disastrous, wide-spread effects on our nation" (p. 7).

c. Impacts to State Economy

Frost Brown Todd point out that the Guidance focuses on eliminating a specific type of mining in only six states (Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia) and argue: "This disparity creates dramatic economic inequities and puts these states and this industry at a crippling competitive disadvantage with industries in other states and regions. The result will be nothing less than catastrophic" (p. 8).

e. General Economic Considerations

Frost Brown Todd argue that the Guidelines "impose insurmountable technical and economic burdens on the coal mining industry, effectively shutting down surface coal mining (and possibly significant underground coal mining) throughout much of Central Appalachia" (p. 2).
They further contend that EPA's adaptive remedial action provision will "impose economically impracticable and technically unachievable mitigation requirements on them in perpetuity" (p. 8).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

6. Other NGOs

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. Congressional Delegates

Two comment letters posted by the docket as of December 1, 2010 were submitted by congressional delegates. Both letters are signed by several members of Congress, are in general opposition to the Guidance, and discuss economic considerations. The first letter (Doc. #0011) is signed by three congressional delegates representing the States of Virginia and West Virginia. The second letter (Doc. #0015) is signed by 23 congressional delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming.

a. Jobs Lost/Lost Income

Both letters express concern that the Guidance will jeopardize a significant number of jobs. For example, on letter states: "Permits issues under the Clean Water Act affect nearly 80,000 direct coal mining jobs in Appalachia" (Doc. #0015, p. 1).

b. Impacts to National Economy

The Guidance is specific to surface coal mining in Appalachia, and congressional delegates feel it "sorely fails to address the equally noble goal of economic fairness. The Appalachian states know all too well the challenges of economic inequity and any actions that would serve to further undermine the fragile economy of this region ought to be met with a robust federal effort to shore up and improve the economy" (Doc. #0011, p. 1).

d. Impacts to Local / County Economy

One letter argues that the Guidance will have a negative impact to the local economy and that "EPA has jeopardized the future of mining operations [and] the sustenance of local communities" (Doc. 0015, p. 1).

e. General Economic Considerations

Commenters express concern that the Guidance will have economic impacts to communities that have not had opportunity to provide input, as stated "with the country's economy still

floundering and unemployment hovering near 10%, the potential economic impact of these policies validate our request that affected communities be given the opportunity to voice their concerns in the decision-making process" (Doc. #0015, p. 1).

9. PRIVATE CITIZEN - GENERAL

Seven comment letters, typically one page in length, submitted by members of the general public discuss economics. Two letters (Doc. #0019, and Doc. #0249) disagree with EPA's Guidance, while the remaining general private citizen letters either support the Guidance or are opposed to mountaintop mining in general.

a. Jobs Lost/Lost Income

Commenters, both in support of and in disagreement with EPA's Guidance, recognize it could impact the workforce. One commenter in disagreement with EPA's Guidance is concerned "my daughter will not be able to attend college if my husband loses his job in mining" (Doc. #0019). Another commenter in general agreement with the Guidance states "I'm all for creating more jobs, and allowing people to use their land as they see fit. But I'm not going to let them trash what isn't theirs –the water and air—in the process" (Doc. #0006, p. 1).

d. Impacts to Local / County Economy

One commenter in general opposition to the Guidance, is concerned that mines will be closed, small towns will be devastated, and residents will be forced to relocate: "my family and many others like us will have to leave our state to find work" (Doc, #0019).

e. General Economic Considerations

Many in the general public support the Guidance and hope it will be a "change to business as usual that places private profit above public resources" (Doc. #0088). Several commenters feel the protection of public health and waterways should outweigh economic concerns.

10. PRIVATE CITIZEN – EXPERT

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

11. ENVIRONMENTAL JUSTICE AND/OR TRADITIONALLY DISADVANTAGED COMMUNITY

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

As of December 1, 2010, comments from this category group discussing the economy had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

13. Unknown

Two comment letters, both one page in length, received from unknown or unidentified commenters discuss the economy. One commenter is in general agreement with EPA's Guidance; the other is in general disagreement.

a. Jobs Lost/Lost Income

The commenter in general disagreement with the Guidance feels it has had a negative impact on the economy stating "our families were forced to leave to find work" (Doc. #0010). The same commenter further suggests the "true endangered species … is the American worker."

d. Impacts to Local / County Economy

The commenter in support of the Guidance suggests people are being pushed from their homes by mining and argues that "property rapidly devalues due to mining activities nearby leaving poor people with few options" (Doc. #0183).

e. General Economic Considerations

The commenter opposed to EPA's Guidance feels it is a violation of states' rights and suggests "this administration does not care about the people of Appalachia and the industry that so many of us depend on to provide for our families" (Doc. 0010). This commenter feels individual states should be allowed to regulate water quality programs.

VIII. National Environmental Policy Act

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The NEPA issue includes comments and opinions submitted by stakeholders regarding cumulative impact analyses under NEPA, the need to prepare Environmental Impact Statements (EISs), and any recommended changes to the Guidance specifically relating to NEPA.

Three tallied comments submitted to and posted by the docket as of December 1, 2010, discussed NEPA. These comments were submitted by the following commenter categories: industry representatives, the general public, and an anonymous commenter. The general private citizen and the anonymous commenter are generally supportive of the issuance of the Guidance and encourage EPA to further its environmental protections when reviewing mountaintop mining projects. Industry commenters focus their comments on the need for preparing an EIS, citing a lack of sufficient information to support EPA's conclusion that an EIS should be required categorically for certain mountaintop mining projects affecting more than one mile of jurisdictional streams. They recommend that the Guidance be immediately withdrawn.

Below are summaries, presented by commenter category, on the NEPA issue. Under each commenter category all sub-issues commented on are listed by letter (based on the issue outline) and discussed.

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. INDUSTRY OR INDUSTRIAL ASSOCIATIONS

Five comment letters were received from industry representatives regarding NEPA. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance, and disagree on the requirement to prepare an EIS under NEPA for specific types of mining activities.

b. Need to Prepare Environmental Impact Statements

Frost Brown Todd contend that "EPA has prematurely, and without sufficient specific information, concluded that an environmental impact statement ('EIS') will be required under the National Environmental Policy Act ('NEPA') for any proposed mining activity that will affect more than one mile of jurisdictional 'streams' (…) Again, EPA has provided no information to support a general conclusion that all such actions will have a 'significant effect' on the human environment" (p. 6).

The commenters further argue that "Moreover, EPA has not subjected that conclusion to notice and comment, as would be required for any general determination to require an EIS for a whole category of activities (as is the case here)" (p. 6).

While not specifically providing recommendations for changes in the guidance relating to NEPA, the commenters conclude with a request that EPA "immediately withdraw the April 1 Guidance in its entirety" (p. 9).

5. ENVIRONMENTAL NON-GOVERNMENTAL ORGANIZATIONS (NGOS)

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

6. OTHER NON-GOVERNMENTAL ORGANIZATIONS (NGOS)

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. ACADEMIA/ PROFESSIONAL SOCIETIES

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. CONGRESSIONAL DELEGATES

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

9. PRIVATE CITIZEN – GENERAL

Only one comment letter from a private citizen had been posted by the docket as of December 1, 2010. This individual, while not specifically referencing the NEPA process, encourages the EPA to "write specific steps in the permitting process which address the collection and analysis of data about the public health impacts (Doc. # 0186, p. 1)" of mountaintop removal coal mining.

10. PRIVATE CITIZEN – EXPERT

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

11. ENVIRONMENTAL JUSTICE AND/OR TRADITIONALLY DISADVANTAGED COMMUNITY

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. FORM LETTERS AND MASS MAILER CAMPAIGNS

As of December 1, 2010, comments from this category group discussing NEPA had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

13. UNKNOWN

One letter (Doc. #0183) posted to the docket as of December 1, 2010, from unknown sources commented on NEPA. The commenter appears to be generally supportive of the Guidance, and encourages the EPA to "Enforce water quality requirements of CWA" and "incorporate WQBELs into permit requirements" again presumably referring to the information necessary for submittal within an EIS.

VII. Clean Water Act Section 401

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The Clean Water Act Section 401 issue includes comments and opinions submitted by stakeholders regarding recommended changes to the Guidance specifically relating to Section 401 of the CWA.

There were a total of three tallied comments submitted to and posted by the docket as of December 1, 2010, discussing Section 401 of the CWA. These comments were all submitted by private citizens, one of whom is a citizen of Appalachia. Commenters express gratitude for the issuance of the Guidance and urge further protection under the CWA, citing the destructive nature of mountaintop mining practices to date.

Below are summaries, presented by commenter category, of the comments received on Section 401 of the CWA.

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

2. State Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

4. Industry or Industrial Associations

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will

be addressed in the final summary.

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

6. Other Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

7. Academia/ Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

8. Congressional Delegates

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

9. Private Citizen – General

Three comment letters posted by the docket as of December 1, 2010, and submitted by members of the general public commented on Section 401 of the CWA either directly or by reference to water quality issues. Additional comments received subsequently will be addressed in the final summary. The comments generally support the issuance of the Guidance, and recommend further measures. For example, one commenter recommends that EPA "further increase protections for our streams and our communities. Stream protections must be more permanent via rule-making. I urge the EPA to assure that state and federal agencies do not issue permits that are contrary to the clear science and legal requirements discussed in the guidance (Doc. #0247)."

10. Private Citizen – Expert

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

13. Unknown

As of December 1, 2010, comments from this category group discussing the issue area of Section 401 of the CWA had not been posted by the docket. Any comments received subsequently will be addressed in the final summary.

VI. Clean Water Act Section 404

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The CWA Section 404 issue area includes those comments, recommendations, and opinions submitted by stakeholders regarding the following sub-issues:

a. Federal Roles of EPA, the Unites States Army Corps of Engineers (Corps), and the Office of Surface Mining Reclamation and Enforcement (OSM) in Evaluating CWA 404 Applications;
b. Independent Evaluation of Water Quality under CWA 404;
c. Mine Design;
d. Relationship of Water Quality to Significant Degradation under 230.10(c);
e. Compensatory Mitigation under CWA 404;
f. Monitoring and Reporting Requirements;
g. Cumulative Impact Analysis under CWA 404; and
h. Recommended Changes in Guidance Relating to CWA 404.

A total of 69 comments posted by the docket as of December 1, 2010 discussed the CWA Section 404. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 6-1 on the next page presents the total comment letters that address the CWA Section 404 issue, by commenter category.

Most comments from private citizens and the mass mailing campaigns are in general agreement with the Guidance and support EPA's implementation of the CWA requirements and identify EPA and the Corps as responsible for the prevention of water quality degradation. These comments are not supportive of valley fills, viewed as destructive, or of stream creation, qualified as insufficient mitigation for stream loss. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. Industry

commenters contend that the Guidance oversteps established authorities and regulatory structures, is incorrectly reflective of the so-called Hobet 45 mine case outcomes which they view as not necessarily applicable to all surface coal mining operations, and imposes unrealistic and unpredictable monitoring requirements. Congressional delegates urge EPA to withdraw the Guidance because it represents substantial changes that exceed the intent of the CWA, and undermines the authority, role, and responsibility of State agencies in reviewing and issuing permits. The Sierra Club disagrees with the sequencing of valley fills and compensatory mitigation, particularly for headwater streams, and urges EPA to further strengthen the Guidance requirements and ensure its prompt implementation in Appalachia. The Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions, some of which relate to mitigation.

Below are summaries, presented by commenter category, on the issue of the CWA Section 404. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

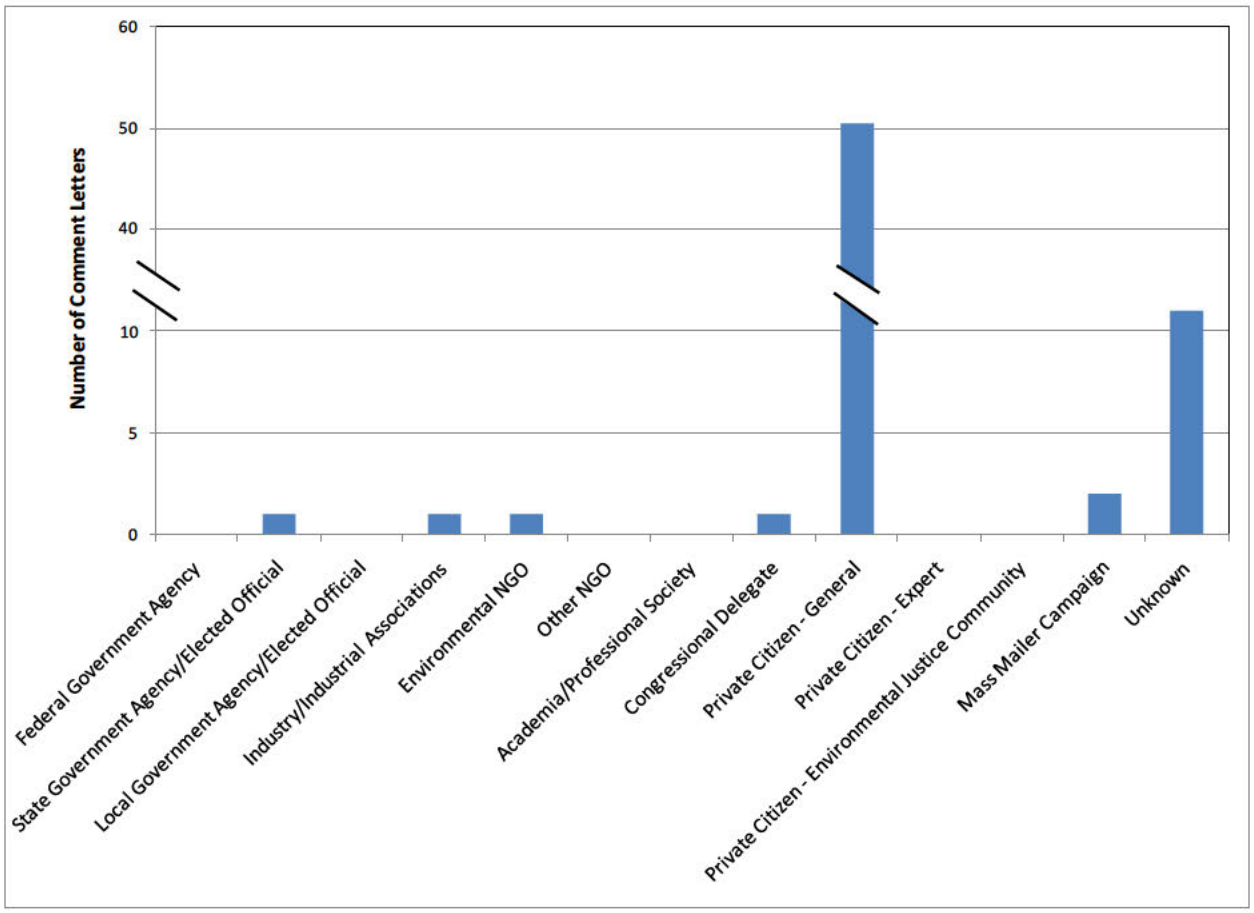

Figure 6-1. Clean Water Act Section 404, Total Comment Letters by Commenter Category

1. FEDERAL GOVERNMENT AGENCIES

As of December 1, 2010, comments from this category group discussing the issue area of the CWA Section 404 had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. STATE GOVERNMENT AGENCIES AND ELECTED OFFICIALS

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations, specifically on the roles of federal agencies in evaluating Section 404 applications.

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

The Kentucky Energy and Environment Cabinet seeks confirmation of whether a Section 404 permit may be issued if a surface coal mining operation "complies with the suggested alternative mining practices in this guidance," and whether "such alternative mining practices will sufficiently mitigate for a reasonable potential to violate for the parameters identified at the bottom of page 22 for a CWA § 402 permit" (p. 5). Seeking further clarification on the roles of federal agencies, Kentucky inquires as to whether the Corps may issue a CWA § 404 permit "in advance of issuance of a CWA § 402 permit" (p. 5).

3. LOCAL GOVERNMENT AGENCIES AND ELECTED OFFICIALS

As of December 1, 2010, no comments from this category group discussing the issue area of Section 404 of the CWA had been posted by the docket. Any comments received subsequently will be addressed in the final summary.

4. INDUSTRY OR INDUSTRIAL ASSOCIATIONS

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. In general, the comments do not support the Guidance. Their CWA Section 404 comments focus

on the roles of government agencies, independent evaluations of water quality under CWA Section 404, sequencing of valley fills, and monitoring and reporting requirements.

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

Frost Brown Todd imply that EPA is overstepping its legal and regulatory boundaries under the 404(b)(1) program: "EPA has clearly directed its regional offices to enforce these requirements, which are set forth in detail in the Guidance, through various means, including objecting to proposed NPDES permits; ignoring state water quality certifications under Section 401 of the CWA; and forcing state and federal agencies to 'correct' NPDES permit deficiencies through other permitting programs, such as the U.S. Army Corps of Engineers' ("Corps") program under CWA Section 404" (p. 3).

They further contend that the Guidance "ignores the careful federal-state balance established by Congress, and imposes numerous requirements on coal mining permitting that are not authorized under the Clean Water Act and related statutes" (p. 4). Frost Brown Todd finally conclude on this subject with the following statement. "These heavy-handed requirements not only contradict the long-established regulatory standards, authorities, and programs under the CWA, SMCRA, and related statutes – they threaten to establish precedents that would undermine the consistent and fair application of those statutes to activities and industries throughout the United States."

b. Independent Evaluation of Water Quality under CWA 404

Frost Brown Todd also assert that the Guidance "effectively precludes the use of whole effluent testing ("WET") and/or best management practices, as allowed under 40 CFR § 122.44, to implement narrative water quality standards," and that the EPA has effectively done so "without notice and comment or appropriate regulatory action" (p. 5).

c. Mine Design with Respect to Sequencing Valley Fills

Referencing the so-called Hobet 45 mine case, Frost Brown Todd argue that the Guidance is reflective of the outcome of that specific case, qualified as "one of the first permits to be addressed through the so-called Enhanced Coordination Procedures adopted by EPA and the Corps in mid-2009" (p. 3). They further imply that the outcome of the negotiations between the EPA, the Corps, and Hobet Mining, LLC, is not necessarily applicable to all surface coal mining operations.

> "This includes the imposition of strict conductivity limits that may not be attainable, dramatic reductions in the percentage of coal to be recovered, requirements for mitigation monitoring and 'adaptive management plans,' and significant revisions to valley fill design. These measures were clearly the 'price to be paid' in order to eliminate EPA's objections to the permits required for the Hobet 45 mine, and EPA has made it patently clear in the April 1 Guidance Memorandum and all of its recent actions that it intends to make these measures mandatory for all future mine permits in Central Appalachia" (p. 3).

f. Monitoring and Reporting Requirements

Echoing the opinion expressed above, Frost Brown Todd further assert that the Guidance imposes unnecessary and costly monitoring requirements for permittees.

> "to include provisions for 'adaptive remedial action" [that] threatens to require every permittee to write an open-ended blank check for further, unlimited mitigation demands by EPA and other resource agencies – without any clear standards or expectations in advance. This threatens to force permittees to attempt to hit constantly moving targets for mitigation and to impose economically impracticable and technically unachievable mitigation requirements on them in perpetuity" (p. 8)

They argue that these monitoring requirements are "arbitrary and capricious and well beyond EPA's statutory authority," and contend that "EPA and other permitting agencies must provide clear, predictable, and attainable standards in advance" (p. 8).

5. ENVIRONMENTAL NON-GOVERNMENTAL ORGANIZATIONS (NGOS)

As of December 1, 2010, one letter was submitted from an Environmental NGO commenting on the issue of the CWA Section 404. Overall, the Sierra Club (Doc. #0225) is supportive of the Guidance, yet encourages the implementation of additional measures to protect the environment from the "environmentally destructive activities taking place" in Appalachia (p. 1). Sierra Club comments upon the sequencing of valley fills and the ability of mitigation measures imposed under Section 404 to mitigate for water quality impacts, and provides recommendations for changes to the Guidance relating to Section 404 of the CWA.

c. Mine Design with Respect to Sequencing Valley Fills

While generally supportive of the Guidance, Sierra Club disagrees "with the policy of sequencing approval of valley fills" (p. 2). Citing that valley fills "cause irreparable damage to streams," the commenter notes that "high conductivity levels cause the loss of streams' ecological services" (p. 2) as demonstrated by the scientific information on which EPA's Guidance is based. The commenter goes on to remind the EPA and the Corps of their "responsibility to prevent water pollution, not simply monitor it after it occurs" (p. 2).

e. Compensatory Mitigation under CWA 404 and the Ability of Mitigation to Compensate for Water Quality Impacts

The Sierra Club disagrees with compensatory mitigation by asserting that "Mitigating for the loss of headwater streams should not be permitted because it is not possible to re-create the ecological functions of these streams." The Sierra Club also wishes for EPA to "recognize that mitigation for these streams is not a viable option" (p. 2).

h. Recommended Changes in Guidance Relating to CWA 404

Sierra Club commends EPA for issuing the Guidance, but urges EPA to further strengthen its requirements with respect to Guidance implementation under the CWA Section 404. "While Sierra Club supports the guidance as an important initial step, we believe that EPA must strengthen it in several aspects" (p. 2). Sierra Club concludes with the statements, "We urge EPA to ensure that the guidance is faithfully carried out in its regional offices and in the Appalachian states. In addition, we ask EPA to strengthen the guidance by recognizing the failure of stream mitigation effort and to abandon its policy of sequencing valley fills" (p. 2).

6. OTHER NON-GOVERNMENTAL ORGANIZATIONS (NGOS)

As of December 1, 2010, no comments from this category group discussing the issue area of Section 404 of the CWA had been posted by the docket. Any comments received subsequently will be addressed in the final summary.

7. ACADEMIA/ PROFESSIONAL SOCIETIES

As of December 1, 2010, comments from this category group discussing the issue area of the CWA Section 404 had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. CONGRESSIONAL DELEGATES

One comment letter (Doc. #0011) submitted by congressional delegates discusses Section 404 of the CWA. The letter is signed by three members of Congress representing the States of Virginia and West Virginia, is in general disagreement with the Guidance, and expresses concerns on many of its aspects.

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

The congressional delegates focus their comments on the Guidance around the "far-reaching implications of the policies it espouses" (p. 1). Specific to the roles of federal agencies in evaluating CWA 404 applications, they assert that "Essentially, EPA is seeking to bootstrap conductivity as a section 402 effluent limitation standard through the section 404 process … [and] only in Appalachia, and only with respect to surface coal mining operations" (p. 1). The commenters contend that "not only is there no precedent for such an action, but [that] it is also patently a wrong approach to implementing the Clean Water Act."

The congressional delegates conclude by urging EPA to withdraw the Guidance and to "continue to work with the affected States, the involved federal agencies, and all stakeholders to develop guidelines that truly provide a balanced process for energy development and environmental protection" (p. 2).

9. PRIVATE CITIZEN – GENERAL

Fifty-one comment letters posted by the docket as of December 1, 2010, from members of the general public commented on the issue area of the CWA Section 404. Several identical comments are expressed by many of the commenters, and many of these comment letters appear to be modified versions of the mass mailing campaigns (e.g., Doc. #0022 from Earthjustice, and Doc. # 0103 from Sierra Club).

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

Many of the private citizen letters comment upon the roles of federal agencies in evaluating CWA 404 applications, with most expressing gratitude that the Guidance will strengthen this process and "ensure that regional staff will finally following Clean Water Act Requirements calling for an end to one of the devastating impacts of mountaintop removal coal mining" (e.g., Doc. # 0179). Others are thankful that "EPA has recognized the role of the Clean Water Act to support this scientific research and protect the people of Appalachia" (e.g., Doc. # 0180), and that "both EPA and the Army Corps have the duty up front to prevent significant degradation of waters from happening before any permit is issued" (e.g., Doc. # 0222.1)

One commenter (Doc. #0053) summarizes the general sentiment by writing: "I urge the EPA to apply the Clean Water Act to permit applications for mountain top removal mines. I understand that this type of mining has continued despite its violation of law due to carious waivers and loopholes based on false information. I urge the EPA to base their decisions in fact and enforce laws passed to protect air and water quality".

c. Mine Design and Sequencing of Valley Fills

More than half of the private citizen commenters express concern over the practice of sequencing valley fills, imploring that "EPA must also not establish a policy of sequencing its approval of valley fills, because there is no scientific evidence that sequential construction of valley fills avoids the devastating long-term and downstream pollution caused by valley fills" (e.g., Doc. # 0032).

One Tennessee resident (Doc. #0074, p. 1) expresses the strong opinion that: "there is no mitigation value or other benefit to any policy of 'sequencing' valley fills. Such a policy would only lengthen the period of time over which the same absolute ecological genocide occurs. There is, to date, no actual restoration of Appalachian forest following the removal of its topsoil yet demonstrated, let alone practiced by mining companies. Without such restoration, 'sequencing' would only delay the inevitable destruction. Environmental laws are meant to prevent ecological destruction, not merely delay it."

c. Mine Design and Material Handling and Upland Disposal

Among the commenters who discuss the material handling and upland disposal of sediments, most focus upon valley fills, and express skepticism of the practice. For instance, one commenter writes: "Scientific research suggests that one valley fill is too many, because the

unique headwater streams filled are lost forever, along with all of the ecological services they provide to the ecosystem. On top of that, every valley fill becomes a source of pollution that contaminates the watershed downstream" (Doc. #0222.1, p. 3).

Another commenter states that "Scientific research suggests that one valley fill is too many, because the unique headwater streams filled are lost forever, along with all of the ecological services they provide. On top of that, every valley fill becomes a source of pollution that contaminates the watershed downstream" (Doc. #0245).

d. Relationship of Water Quality to Significant Degradation under 230.10(c)

Several comments (sometimes with identical sections) express that "both EPA and the Army Corps have the duty up front to prevent significant degradation of waters from happening before any permit is issued" and that "After-the-fact monitoring is not a legal or effective substitute for preventing significant harm and loss of waters in the first place" (e.g., Doc. #0222.1, p. 3).

A Tennessee resident expresses a slightly different, and more strongly worded opinion (Doc. #0074): "This outrage will stop when EPA enforces the Clean Water Act and other environmental laws as they were intended. 'Undue degradation' of waterways necessarily includes their complete obliteration, and the latter is therefore illegal. The Corps of Engineers' determination in 2002 that the complete burial of streams could constitute 'fill,' permissible under the CWA, was driven by political directives from the former administration, not science or a plain reading of the law. The EPA must not further indulge this violence to environmental law and the resulting violence to the Appalachians."

e. Compensatory Mitigation under CWA 404 and Suitability of Stream Creation

More than half of the private citizen letters discuss the suitability of stream creation as compensatory mitigation under Section 404, with many expressing the identical comment that "there is no scientific evidence to support claims of 'stream creation,' and it is never a viable option to mitigate for stream loss, especially for headwater streams" (e.g., Doc. #0032).

Several commenters also make the identical statement that: "EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams. Similarly, EPA must not allow sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation of downstream waters" (e.g., Doc. #0088).

One commenter furthers the general opinion expressed by many by stating: "The proposed guidance policy is only a first step toward compliance with the Clean Water Act. In particular, there is no scientific evidence that 'stream creation' is a sufficient means of mitigation, as no replication of an intact, functioning Appalachian forest stream has ever been attained" (Doc. #0074, p. 1).

e. Compensatory Mitigation under CWA 404 and the Ability of Mitigation to Compensate for Water Quality Impacts

Only a small handful of commenters from the private citizen – general category reference the ability of proposed mitigation under CWA 404 to compensate for water quality impacts, primarily referring indirectly to this sub-issue by referencing the ecological functions of streams. They state that "EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams" (Doc. #s 0217, 0218, and 0219). Another commenter (Doc. #0254) points out that "stream creation does not mitigate for stream loss, especially for headwater streams."

f. Monitoring and Reporting Requirements

The docket contains several letters from private citizens commenting on the monitoring and reporting requirements, although only in passing. These commenters make the identical statement that "After-the-fact monitoring is not a legal or effective substitute for preventing significant harm and loss of waters in the first place" (e.g., Doc. #0222.1, p. 3).

g. Cumulative Impact Analysis under CWA 404

Several letters from private citizens address the concept of cumulative impacts under Section 404 of the CWA, commenting that "EPA also deserves credit for finally recognizing in the policy that the Clean Water Act does not permit the massive, cumulative impacts that result from mountaintop removal mining. Appalachia cannot afford to continue to bury its streams and pollute entire watersheds" (Doc. #s 0088, 0089, 0090, 0091, and 0222.1, p. 2).

h. Recommended Changes in Guidance Relating to CWA 404

Most private citizen comments provide recommendations to EPA that they feel will strengthen the environmental protections of the Guidance. A quote found repeatedly among this commenter category is as follows: "Finally, EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams. Similarly, EPA must not allow sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation of downstream waters" (e.g., Doc. 0213.1).

The opinion expressed by many of the general private citizen letters is that "the proposed guidance policy is only a first step toward compliance with the Clean Water Act," (Doc. # 0074), recommending that EPA strengthen its Guidance document by reconsidering several aspects of the Guidance. These aspects include the practice of sequencing valley fills and relying upon stream creation as suitable mitigation for impacts under CWA 404. One commenter (Doc. #0230) is particularly adamant regarding valley fills stating that "Valley fills should be completely banned anywhere in the USA forever!"

Several commenters (Doc. #s 0244, 0245, and 0253) cite that "More than 2,000 miles of streams have already been destroyed, and we cannot afford to lose more, especially unique and vital headwater streams. Because of this, I strongly urge the EPA to strengthen this guidance."

One letter recommends the use of rule-making: "The EPA now must further increase protections for streams and communities. Please use rule-making to make stream protections permanent" (Doc. #0264), a recommendation echoed by other commenters.

Doc. #0088 calls for "a change to business as usual that places private profit above public resources by upholding the Clean Water Act in the mining practice in Appalachia and live up to the name The Environmental Protection Agency." Another comment (Doc. #0075) simply states: "NO MORE MOUNTAIN REMOVAL MINING".

A West Virginia commenter (Doc. #0251) implores: "Please don't back down on the rules you have started to create; move forward with confidence and courage knowing that the vast majority of Americans are rooting for you to curb the out-of-control greed and rapacious practices of what we call BIG COAL."

10. PRIVATE CITIZEN – EXPERT

As of December 1, 2010, one letter was submitted by a private citizen - expert commenting the CWA Section 404. The commenter is a biologist with a Masters degree in biology and more than 30 years in the Appalachian region public school system, and is currently teaching wildlife management and environmental earth science (Doc. #0112). The comment echoes most of the Earthjustice mass mailing campaign (Doc. #0022), with some personal insight to his experience living in this region. He comments upon the sequencing of valley fills and the suitability of stream creation to provide compensatory mitigation under Section 404 of the CWA, and provides recommended changes in the Guidance relating to CWA Section 404.

c. Mine Design and Sequencing of Valley Fills

As with others who are against the practice of sequencing valley fills, the commenter expresses that "EPA must also not establish a policy of sequencing its approval of valley fills, because there is no scientific evidence that sequential construction of valley fills avoids the devastating long-term and downstream pollution caused by valley fills."

e. Compensatory Mitigation under CWA 404 and Suitability of Stream Creation

The comment letter, inclusive of content from the Earthjustice mass mailing campaign repeats the statement that "There is no scientific evidence to support claims of 'stream creation,' and it is never a viable option to mitigate for stream loss, especially for headwater streams."

h. Recommended Changes in Guidance Relating to CWA 404

As with many other supporters of the Guidance, the commenter supports EPA in its efforts to finalize the Guidance with even further environmental protections. "After years of neglect by

EPA, Appalachia deserves better than another failed experiment that allows for the damage to start before the impact of the permit is appropriately assessed, in permits that put a local community in limbo while decisions about the future of their waters get made behind closed doors" (p. 2).

11. ENVIRONMENTAL JUSTICE AND/OR TRADITIONALLY DISADVANTAGED COMMUNITY

As of December 1, 2010, no comments from this category group discussing the issue area of the CWA Section 404 had been posted by the docket. Any subsequent comments received from this commenter category will be addressed in the final summary.

12. FORM LETTERS AND MASS MAILER CAMPAIGNS

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns are in support of EPA's Guidance and focus on the sequencing of valley fills, the suitability of stream creation, and the ability of mitigation to compensate for impacts to water quality. Both mass mailing letters advocate for strengthening the Guidance.

c. Mine Design and Sequencing Valley Fills

Despite overall agreement with the issuance of the Guidance, neither mass mailing campaign supports the practice of sequencing valley fills. "Additionally, EPA must also not establish a policy of sequencing its approval of valley fills, because there is no scientific evidence that sequential construction of valley fills avoids the devastating long-term and downstream pollution caused by valley fills." This sentiment is echoed by the Sierra Club mass mailing campaign.

e. Compensatory Mitigation under CWA 404 and Suitability of Stream Creation

The Earthjustice campaign comments generally on the ability of stream creation to provide suitable mitigation under the CWA by stating, "There is no scientific evidence to support claims of 'stream creation,' and it is never a viable option to mitigate for stream loss, especially for headwater streams." The Sierra Club campaign furthers this reaction by stating that "…EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams."

e. Compensatory Mitigation under CWA 404 and the Ability of Mitigation to Compensate for Water Quality Impacts

While not commenting directly on the ability of the mitigation practices to compensate for water quality impacts, the Earthjustice supporters urge EPA to carefully assess the impact of a permit before it is issued, stating "both EPA and the Army Corps have the duty up front to prevent significant degradation of waters from happening before any permit is issued."

h. Recommended Changes in Guidance Relating to CWA 404

The Earthjustice campaign concludes with a plea for EPA to further the environmental protections within the Guidance: "Finally, I strongly urge you, Administrator Jackson, to strengthen this guidance." Sierra Club supporters echo this sentiment.

13. UNKNOWN

Eleven letters from unknown or anonymous sources comment on the CWA Section 404. All comments support the Guidance. These letters comment upon aspects of Section 404 of the CWA, the roles of federal agencies, sequencing of valley fills, the relationship of water quality to significant degradation, the suitability of stream creation as mitigation, the ability of mitigation to compensate for water quality impacts, and cumulative impacts. About half of these comment letters also provide recommended changes, mostly related to strengthening the Guidance.

a. Federal Roles of EPA, Corps, and OSM in Evaluating CWA 404 Applications

One commenter (Doc. #0216) expressed gratitude that "EPA has recognized the role of the Clean Water Act to support this scientific research and protect the people of Appalachia. The streams in coal country must not be destroyed by mining impacts."

c. Mine Design and Sequencing Valley Fills

Most letters from unknown sources disapprove of the practice of sequencing valley fills, "as there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation of downstream waters" (e.g., Doc. #0187) and that "scientific research suggests that one valley fill is one too many, because the unique headwater streams filled are lost forever, along with all of the ecological services they provide to the ecosystem" (e.g., Doc. # 0209).

d. Relationship of Water Quality to Significant Degradation under 230.10(c)

Two of the unidentified commenters (Doc. #s 0185 and 0214.1) reference the relationship of water quality to significant degradation, noting that "the EPA and the Army Corps have the duty up front to prevent significant degradation of waters from happening before any permit is issued."

e. Compensatory Mitigation under CWA 404 and Suitability of Stream Creation

The majority of the commenters from this category remark on the suitability of stream creation, by stating that "Science shows that current mitigation strategies are ineffective and that we can not replace buried streams. This needs to be recognized as part of permitting process" (Doc. #0183). Many expressed the identical sentiment that "EPA should strengthen the policy by refusing to permit mitigation as an option for the loss of streams because it is not possible to re-create the ecological functions of streams" (e.g., Doc. #0210).

e. Compensatory Mitigation under CWA 404 and the Ability of Mitigation to Compensate for Water Quality Impacts

A few commenters from this category make a passing reference to the ability of mitigation to compensate for water quality impacts, most of them expressing skepticism. One commenter advises EPA to "recognize that current mitigation strategies do not work" (Doc. #0183), while another "oppose[s] the use of permit mitigation for damage created by surface mining. Once the damage occurs it is irreparable. No amount of mitigation can off-set this type of injury to our land, water, and citizens" (Doc. #0226).

h. Recommended Changes in Guidance Relating to CWA 404

About half of the comment letters provide recommendations for changes to the Guidance relating to Section 404 of the CWA, with many encouraging EPA to strengthen the guidance "by refusing to permit mitigation as an option for the loss of streams" (Doc. #s 0187, 0209, and 0211). "EPA must further increase protections for our streams and our communities; too many streams have been lost, and no more valley fills should be permitted. While these initial steps are important, stream protections must be made more permanent via rule-making" (Doc. #s 0184 and 0214.1).

Multiple commenters also express appreciation for "EPA's commitment to finally enforce the Clean Water Act to protect Appalachia," and encourage EPA to "Finalize your guidance to improve review of Appalachian surface coal mining (Doc. #s 0209 and 0216).

V. NPDES Oversight and Review

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The issue area of NPDES oversight and review includes those comments, recommendations, and opinions submitted by stakeholders regarding the following sub-issues:

a. Federal authority to regulate these activities under 402;
b. Application of reasonable potential analysis;
c. Incorporation of numeric standards in NPDES permit;
d. Monitoring and reporting requirements;
e. Compliance schedules;
f. Narrative standards;
g. Antidegradation; and
h. Recommended changes in guidance relating to CWA 402.

There were a total of 34 tallied comments submitted to the docket as of December 1, 2010, discussing NPDES oversight and review. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 5-1 on the next page presents the total comment letters that address the issue of NPDES oversight and review, by commenter category.

All comments received from private citizens and the mass mailing campaigns either support the Guidance or are opposed to mountaintop mining activities in general, and recommend that water quality criteria for conductivity be set and adopted throughout Appalachia. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. Industry commenters view the Guidance as flawed in imposing new requirements on NPDES permits solely for mountaintop mining activities, and request that the Guidance be withdrawn. Congressional delegates disagree that EPA's emphasis on conductivity for NPDES permits

related to mountaintop activities. The Sierra Club urges EPA to set water quality criteria for conductivity throughout Appalachia and to encourage states to implement them. The Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions, including data collection, water quality standards, baseline monitoring, and compliance schedules.

Below are summaries, presented by commenter category, on the issue of NPDES oversight and review. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

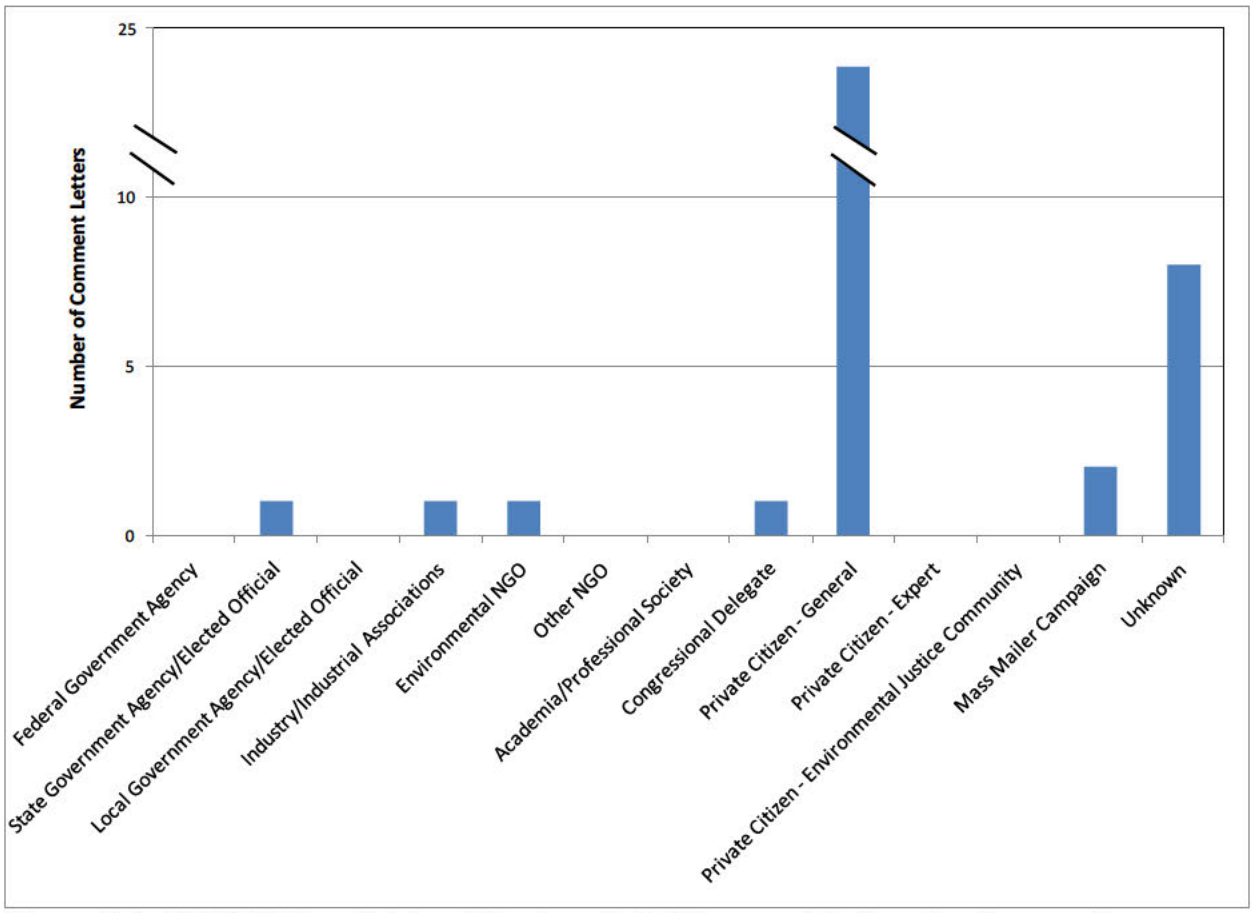

Figure 5-1. NPDES Oversight and Review, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. STATE GOVERNMENT AGENCIES AND ELECTED OFFICIALS

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations.

b. Application of Reasonable Potential Analysis

The Kentucky Energy and Environment Cabinet requests clarification regarding the issue of a permit conditional on the collection of data during the permit term, and the status of States not listed in the Guidance. Their questions are as follows:

- "Is it U.S. EPA's determination that the issuance of a CWA § 402 permit may not be conditioned on collection of data during the permit term appropriate for performance of a reasonable potential analysis, with the requirement in the permit that it be re-opened or conditioned to include appropriate requirements once reasonable potential is determined?" (p. 4); and
- "Will States other than those specified in the Guidance also be "subject to reasonable potential analysis of non-coal mining activities?" (p. 5).

c. Incorporation of Numeric Standards in NPDES Permit

The Kentucky Energy and Environment Cabinet questions the relevance of numeric standards, and asks if other water quality standards (including narrative standards) could be used. Question 15 (p. 2) asks: "Is it U.S. EPA's determination that a delegated state cannot in some or all cases use the available approaches outlined in 40 CFR 122.44 for implementing a narrative water quality standard, including whole effluent testing (WET) or best management practices (BMPs) in lieu of a numeric limit for a narrative water quality standard?"

d. Monitoring and Reporting Requirements

The Guidance requires baseline monitoring data for biological condition, conductivity, total dissolved solids, sulfates, bicarbonate, chloride, magnesium, potassium, calcium, sodium, pH, and selenium. The commenter wonders if EPA is concerned with other parameters or if the concern is limited specifically to this list. The comment letter also asks (question 25, p.5): "What is U.S. EPA's position as it relates to the use of water quality variances with respect to this new final interim guidance?"

e. Compliance Standards

The Kentucky Energy and Environment Cabinet questions EPA's position on compliance schedules in the new Guidance.

f. Narrative Standards

The Guidance states that a top priority of the Administration is to reduce and minimize impacts of surface coal mining. The Kentucky Energy and Environment Cabinet requests an explanation of EPA's "perspective of reducing and minimizing impacts of surface coal mining as it relates to the goals and objectives of the CWA § 402 program (p. 4)." As stated above (under c. Incorporation of Numeric Standards in NPDES Permit), the Kentucky Energy and Environment Cabinet references 40 CFR 122.44 to recommend the use of narrative standards (question 15 p. 2).

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance.

a. Federal Authority to Regulate These Activities Under 402

Frost Brown Todd claim the Guidance is a legally binding rule that has been adopted without public notice and comment, making it legally flawed, and request it be withdrawn immediately. They state "EPA has made clear its intent to impose specific new requirements on NPDES permits (and other related environmental permits) associated with surface mining activities in Appalachia, and to use its full authority and influence to compel the states and other federal agencies to enforce these requirements" (p. 3).

Frost Brown Todd is of the opinion that the permit requirements and environmental standards have not been subject to a full scientific review and feel the Guidance was issued prematurely. For example, the Guidance does not allow coal mining activities to be authorized under the NPDES general permit. Frost Brown Todd argues that EPA has not provided enough information to justify this requirement. They further claim EPA "improperly seeks to 'correct'

NPDES permits that have already been issued by states by seeking to force the Corps to address those alleged deficiencies through the Section 404 permitting program" (p. 5).

c. Incorporation of Numeric Standards in NPDES Permit

The Guidance sets a specific, numeric standard for states to enforce through the NPDES permitting process and requires specific documentation to support NPDES permitting decisions. Frost Brown Todd again make the argument that the Guidance is legally flawed and request it be withdrawn.

f. Narrative Standards

Frost Brown Todd disagrees with the Guidance's position on narrative standards and contend that "the Guidance effectively precludes the use of whole effluent testing ("WET") and/or best management practices, as allowed under 40 CFR § 122.44, to implement narrative water quality standards. Through this approach, EPA has effectively written these methods out of the regulation without notice and comment or appropriate regulatory action" (p. 5).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, one letter was submitted from an Environmental NGO commenting on the issue of NPDES oversight and review. The Sierra Club (Doc. #0225) strongly supports the Guidance and commends EPA for issuing it.

c. Incorporation of Numeric Standards in NPDES Permit

The Sierra Club feels the Guidance is necessary to protect water quality from negative impacts of mountaintop removal mining. They further urge EPA to "set water quality criteria for conductivity for central Appalachia and require states to adopt these criteria as soon as possible (p. 1)." Given the number of pending mining permits, they agree with EPA's immediate implementation of the Guidance.

6. Other NGOs

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. Congressional Delegates

One comment letter (Doc. #0011) posted by the docket as of December 1, 2010 was submitted by congressional delegates. It is signed by three members of Congress representing the States of Virginia and West Virginia, and is in general disagreement with the Guidance and federal authority to regulate mountaintop mining activities under 402.

a. Federal Authority to Regulate These Activities Under 402

The members of Congress are in general disagreement with the Guidance and are of the opinion that "EPA is seeking to bootstrap conductivity as a section 402 effluent limitation standard through the section 404 process" (p. 1) for surface coal mining in Appalachia. They argue there is no precedent to justify this action and it is a "wrong approach to implementing the Clean Water Act. This is a national law and should be applied evenly and equally throughout the country as has been done in the past, and there is simply no justification for departing from that practice" (p. 1).

9. Private Citizen - General

Twenty three comment letters, typically one page in length, submitted by members of the general public comment on the issue of NPDES oversight and review. All of the private citizen commenters either support the Guidance or are opposed to mountaintop mining in general.

a. Federal Authority to Regulate These Activities Under 402

Commenters support EPA's decision to implement the Guidance immediately. One commenter (Doc. # 0222.1) states: "I also strongly encourage the EPA to promptly follow the science discussed in this guidance by setting a National Recommended Water Quality Criterion for conductivity for Central Appalachia and requiring states to adopt the criterion" (p. 2).

c. Incorporation of Numeric Standards in NPDES Permit

Most commenters express concern with the impacts of mining to water quality. Many feel EPA should set water quality criteria for conductivity for Central Appalachia and require these standards be adopted by states as soon as possible.

h. Recommended Changes in Guidance Relating to CWA 402

As stated above, the majority of commenters are concerned with the impacts of mining to water quality. Many feel EPA should set water quality criteria for conductivity for Central Appalachia and require these standards be adopted by states as soon as possible. Several commenters further suggest that EPA "prohibit issuance of permits that are contrary to the guidance (Doc. #0215)."

10. Private Citizen – Expert

As of December 1, 2010, one letter was submitted from a private citizen - expert commenting on the issue of NPDES oversight and review. The commenter is a biologist, with a Masters degree in biology, and is currently a teacher teaching Wildlife Management and Environmental Earth Science (Doc. #0112).

c. Incorporation of Numeric Standards in NPDES Permit

The commenter shares concern for water quality with commenters from several other commenter categories and reiterates the request for EPA to "follow the science discussed in this guidance by setting a National Recommended Water Quality Criterion for conductivity for Central Appalachia" (p. 2).

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of NPDES oversight and review had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns are in support of EPA's Guidance and suggest that the Guidance should be strengthened and finalized.

c. Incorporation of Numeric Standards in NPDES Permit

Both campaigns share concern for water quality with commenters from several other commenter categories and reiterate the request for EPA to "follow up the policy by setting water quality criteria for conductivity for central Appalachia and require states to adopt these criteria as soon as possible (Doc. #0103)."

13. Unknown

Eight comment letters received from unknown or unidentified commenters discuss NPDES oversight and review. All commenters are in general agreement with EPA's Guidance.

c. Incorporation of Numeric Standards in NPDES Permit

The majority of commenters "strongly encourage EPA to promptly follow the science discussed in this guidance by setting a National Recommended Water Quality Criterion for conductivity for Central Appalachia and requiring states to adopt the criterion (Doc. #0214.1, p. 1)."

h. Recommended Changes in Guidance Relating to CWA 402

Many commenters appreciate EPA's commitment to protect Appalachia by enforcing the CWA and urge EPA to "strengthen and finalize your guidance to improve review of Appalachian surface coal mining (Doc. #0192)."

IV. Conductivity

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The issue area of conductivity includes those comments, recommendations, and opinions submitted by stakeholders regarding the suitability of specific conductance as a benchmark, the use of constituent ions instead of conductivity, and the use of pollutants other than conductivity or constituent ions as a benchmark for water quality.

There were a total of 35 tallied comments submitted to the docket as of December 1, 2010, discussing conductivity. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 4-1 on the next page presents the total comment letters that address conductivity issue by commenter category.

Most comments from private citizens and mass mailing campaigns are in general agreement with the Guidance and support the use of conductivity as a benchmark. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, arguing that specific conductance is not an adequate benchmark for water quality downstream of mountaintop mining activities, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. The Sierra Club argues that scientific research has demonstrated that mountaintop mining activities are responsible for downstream high levels of conductivity because these cannot be attributed to residential development or agriculture, and recommends a stricter conductivity benchmark. The Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions, some of which are related to water quality measures and benchmarks.

Below are summaries, presented by commenter category, on the issue of conductivity as it relates to the Guidance. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

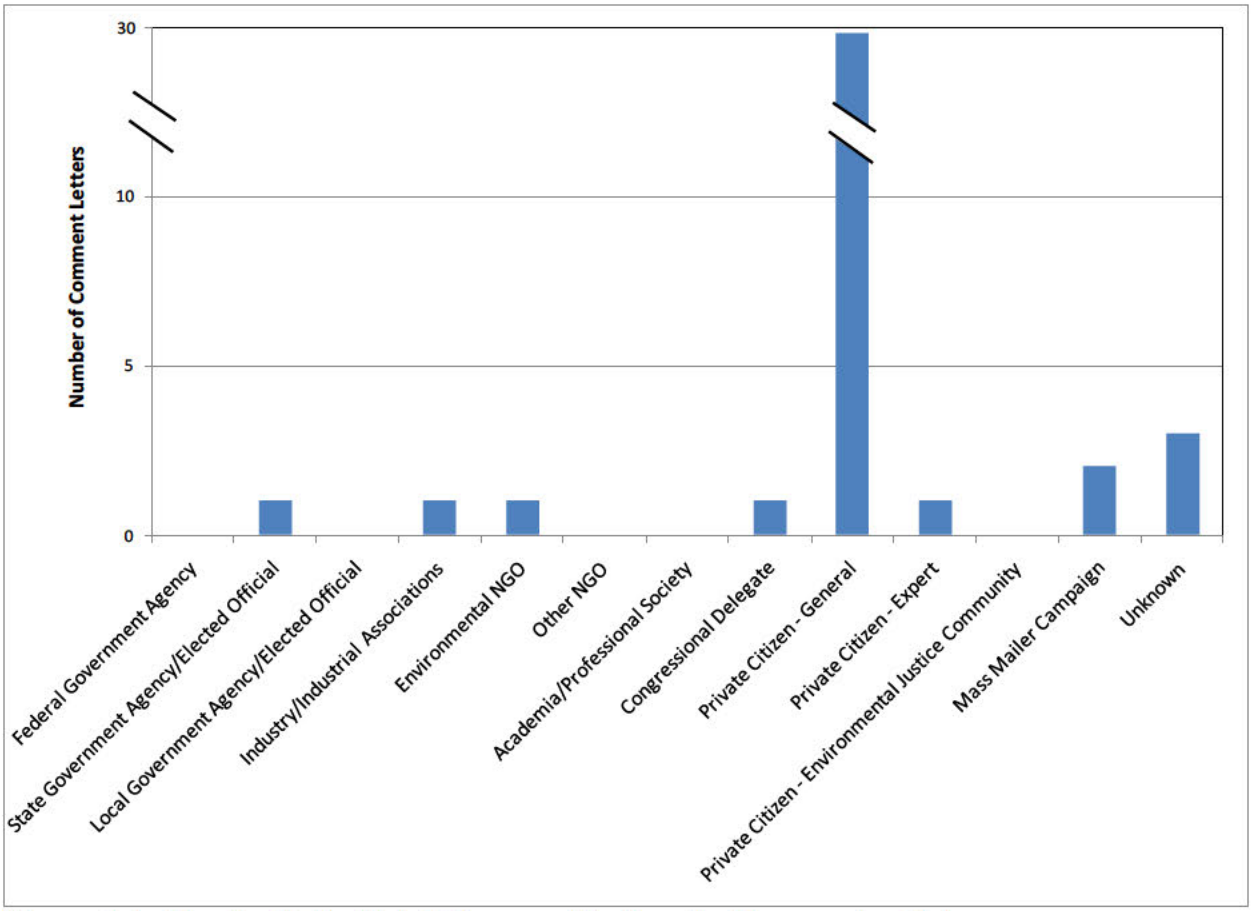

Figure 4-1. Conductivity, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations. Some of their questions relate to the Guidance's proposed water quality benchmarks.

b. Use of Constituent Ions Instead of Conductivity

The Kentucky Energy and Environment Cabinet refers to footnote 21 in the Guidance and a study "that narrows the applicability of this guidance to waters dominated by salts of SO_4^{2-} and

HCO_3^- at circum-neutral pH and low levels of chloride (q. A.16)" to request that EPA describe how this determination will be made when processing CWA Section 402 permits. They further ask "what delegated states should do when waters are not so dominated (q. A.16)."

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance, and to conductivity measures that they feel cannot be upheld.

a. Suitability of Specific Conductance as a Benchmark

With respect to conductivity, Frost Brown Todd states that the Guidance "includes the impositions of strict conductivity limits that may not be attainable" (p. 3).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, one letter was submitted by an environmental NGO commenting on the issue of conductivity in EPA's Guidance. The Sierra Club (Doc. #0225) strongly supports the Guidance, commends EPA for issuing it, and supports the suitability of conductivity as a benchmark for water quality.

a. Suitability of Specific Conductance as a Benchmark

The Sierra Club argues that ample scientific research has demonstrated that high levels of conductance are seen downstream of mountaintop removal mines in Appalachia. They also argue that EPA's research has shown that other sources, such as soil disturbances from residential development and agriculture are not responsible for high conductance levels. They therefore make the point that the use of specific conductance is a suitable benchmark for determining water quality.

They are requesting the implementation of a higher conductivity benchmark in the Guidance "to prevent damage to headwater streams as well as the larger, downstream aquatic system" (p. 2). Furthermore, they reference the peer review conducted by the Science Advisory Board that confirms the validity of the conductivity study and the numeric benchmark and argue that the "levels that EPA identified for the benchmark may not be sufficiently protective of water quality" (p. 2).

6. Other NGOs

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. Congressional Delegates

One comment letter received from congressional delegates (Doc. #0011) addresses conductivity. The letter is signed by three Congressional Delegates representing the States of Virginia and West Virginia. It is in general disagreement with the Guidance and the use of conductivity as a benchmark.

a. Suitability of Specific Conductance as a Benchmark

The congressional delegates argue that the Guidance is "premature largely" and contend that full consideration has not been given to the "far-reaching implications of the policies it espouses, especially as it relates to conductivity" (p. 1).

9. Private Citizen - General

Twenty four comment letters, typically one page in length, received from members of the general public comment on conductivity. All letters are in agreement with the Guidance and the suitability of specific conductance as a benchmark.

a. Suitability of Specific Conductance as a Benchmark

Commenters argue that specific conductance is suitable as a benchmark, with all letters except one (Doc. #0006) stating at least one of the following three reasons:

- "Because conductivity is elevated downstream from mountaintop removal mines;"

- "Best available science has shown that stream conductivity level is a reliable indicator of stream health and function;" or
- "Based on the research showing a strong relationship between conductivity of at least 300 – 500 µs/cm and harm to aquatic life."

About half of all the commenters encouraged EPA to "promptly follow the science discussed in this guidance by setting a National Recommended Water Quality Criterion for conductivity for Central Appalachia and requiring states to adopt the criterion." It should be noted that this language is also found in the mass mailing campaign sponsored by Earthjustice (Doc. #0022)

One commenter (Doc. #0006) applauds and supports the new conductance tests for streams and "supports the limits of conductance, on dissolved solids and small particulates" (p. 1).

10. Private Citizen – Expert

As of December 1, 2010, one letter submitted by a private citizen - expert comments on conductivity. The commenter is a biologist, with a Masters degree in biology, and is currently a teacher teaching Wildlife Management and Environmental Earth Science (Doc. #0112). The commenter strongly supports the Guidance and of the use of specific conductance as a benchmark.

a. Suitability of Specific Conductance as a Benchmark

This commenter is in support of specific conductance suitability as a benchmark and further states that "available science shows that stream's conductivity level is a reliable indicator of stream health and function" and that "best available science shows a strong relationship between conductivity of at least 300 – 500 µs/cm and harm to aquatic life."

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of conductivity had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns are in support of EPA's Guidance, and of the use of specific conductance as a benchmark.

a. Suitability of Specific Conductance as a Benchmark

Both Earthjustice and the Sierra Club support the suitability of specific conductance as a benchmark. They argue that research has shown a strong correlation between conductivity levels exceeding 300 – 500 µs/cm and "harm to aquatic life." The Sierra Club (Doc. #0103) further recommends that EPA "follow up the policy by setting water quality criteria for conductivity for central Appalachia and requires states to adopt these criteria as soon as possible."

13. UNKNOWN

Three comment letters received from unknown or unidentified commenters discuss conductivity. They are all in support of the guidance.

a. Suitability of Specific Conductance as a Benchmark

Similar to the mass mailing campaign sponsored by Earthjustice, two comment letters (Doc. #0184 and #0214) support the suitability of specific conductance as a benchmark because "conductivity is elevated downstream form mountaintop removal mines."

Similar to the other mass mailing campaign sponsored by The Sierra Club, two comment letters (Doc. #0185 and #0214) encourage EPA to set a "National Recommended Water Quality Criterion for conductivity for Central Appalachia and requiring states to adopt the criterion."

III. Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia issue includes those comments, recommendations, and opinions submitted from stakeholders regarding the scientific validity of material referenced in the Guidance, scientific materials not reviewed or referenced in the Guidance, the suitability of ecoregion use in the Guidance, scientific and technical recommendations for project review and monitoring, and the issue of insufficient scientific evidence or peer review in the Guidance.

There were a total of 45 tallied comments submitted to and posted by the docket as of December 1, 2010, discussing the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. These were submitted by different types of commenters, including a State agency, representatives of the mining industry, Congressional Delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 3-1 on the next page presents the total comment letters posted to the docket as of December 1, 2010, that addressed the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia issue by commenter category.

Most comments from private citizens and mass mailing campaigns support the validity of the scientific material referenced in the Guidance, and some argue for additional scientific research to further develop an understanding of the adverse impacts of valley fills. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) is in general support of the Guidance. Congressional delegates and industry comments focus on the aspect of scientific peer review with regard to the issuance of the Guidance, generally stating that there was not sufficient scientific peer review in the process, and thereby challenging the overall validity of the Guidance. The Commonwealth of Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions regarding the scientific validity of reports referenced in the Guidance, and whether there is sufficient scientific

evidence to support the Guidance, particularly requesting scientific evidence related to Kentucky.

Below are summaries, by commenter category, on the issue of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. Under each commenter category all sub-issues commented on are listed by letter (based on the issue outline) and discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

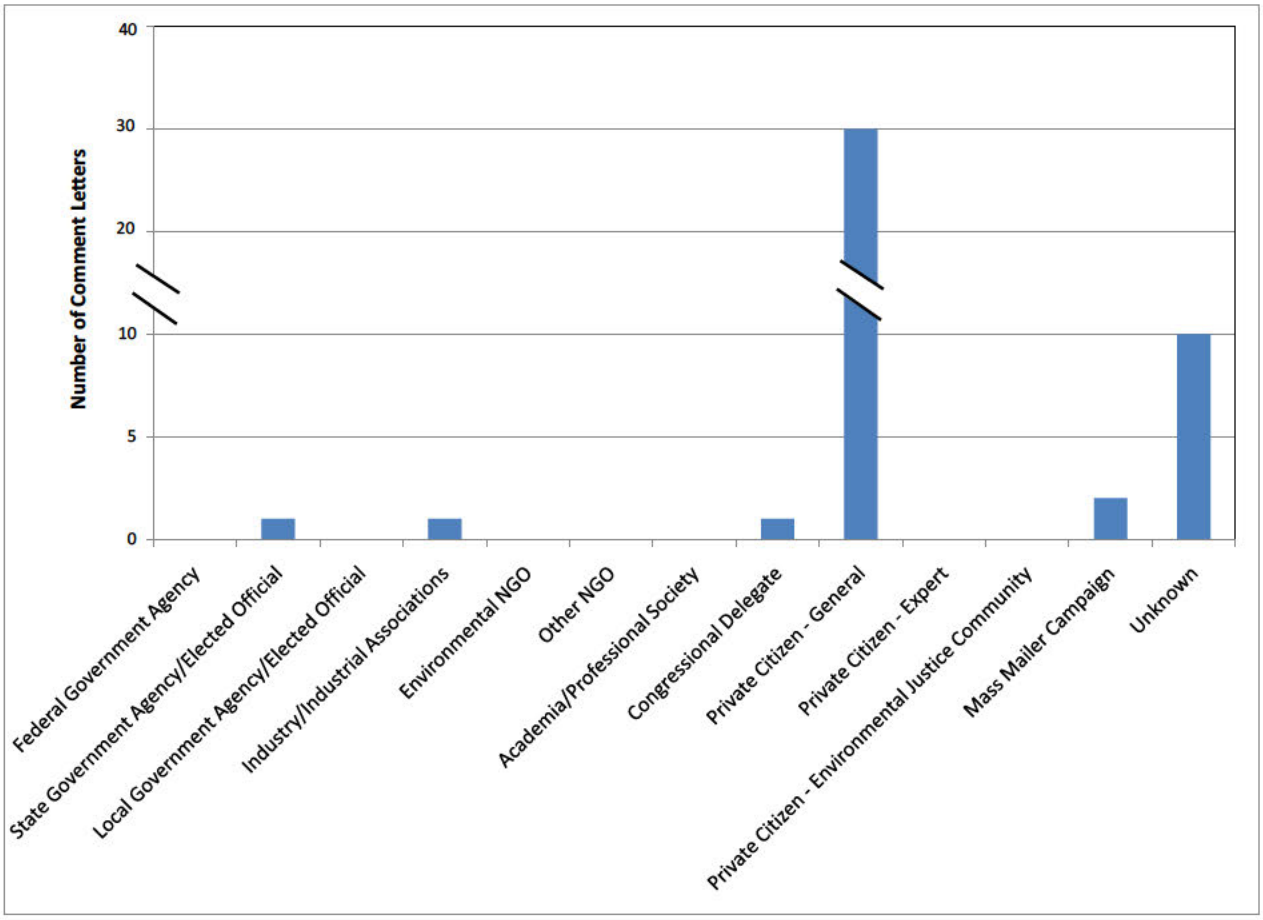

Figure 3-1. Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

2. STATE GOVERNMENT AGENCIES AND ELECTED OFFICIALS

The Commonwealth of Kentucky Energy and Environment Cabinet (Doc. #0012) was the only comment received from a state government agency or elected official commenting on the issue of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. The agency appears to be generally in support of the Guidance, but questions the scientific validity of reports referenced in the Guidance, and whether there is sufficient scientific evidence to support the Guidance. In particular the agency expresses interest in receiving documentation of scientific studies performed in Kentucky, as well as more details on its implementation: "I request that these inquiries be responded to expeditiously in writing given the CWA § 402 surface coal mining permit applications pending before the Commonwealth, and those that we continue to receive daily" (p. 1).

a. Scientific Validity of Material Referenced in Guidance

The Kentucky Energy and Environment Cabinet poses the following questions regarding the issue of Scientific Validity of Material Referenced in the Guidance:

- "10. At the top of page 3 [of the Guidance] it is stated that impairments related to surface coal mining have been 'linked to contamination of surface water supplies and resulting health concerns.' Does U.S. EPA have documentation and data specific to Kentucky that supports this statement? If so, what is that documentation and data?" (p. 3); and
- "23. In the middle of page 30, the guidance makes the statement that 'it is EPA's experience that projects that involve more than one mile of stream loss or more than one valley fill are likely to result in significant adverse impact.' What documentation with respect to Kentucky did EPA rely upon in making this statement?" (p. 5).

e. Insufficient Scientific Evidence/ Insufficient Peer Review

The Kentucky Energy and Environment Cabinet asks many questions regarding statements made in the Guidance and the sources of the supporting scientific evidence. In general, the comments and questions in this letter suggest that insufficient scientific evidence has been referenced in the Guidance to support claims of adverse environmental impacts from surface coal mining in Kentucky.

The comment letter questions the scientific data referenced in the Guidance regarding impaired stream life downstream from surface mining, citing discrepancies between the scientific data utilized in the Guidance, and that used for a different draft EPA document. The commenter writes: "EPA's assertion appears to be refuted in U.S. EPA's draft document 'The effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystem of the Central Appalachian Coalfields' on page 55 'there is little evidence in the peer-reviewed literature of cumulative impacts of mining on downstream ecology. Fulk et al. (2003) found no evidence of additive effects of multiple mines on the fish. In another MTM-VF [Mountaintop Mining-Valley Fill] study, Pond, et al. (2008) reported no evidence of a significant relationship between the number of valley fills and macro invertebrate indices" (p. 4).

The letter also requests clarification of the noted discrepancy and documentation of scientific data specific to Kentucky to support comments made in the Guidance. In addition, the commenter requests identification of scientific data and reports to support comments made in the Guidance by asking the following questions:

- "5. Please identify the recent scientific reports … and the list of other pollutants and pollutant parameters demonstrated by these recent scientific reports in Kentucky to cause or contribute to significant water quality impacts below surface mining operations other than conductivity and total dissolved solids" (p. 5); and
- "7. At the bottom of Page 11, the Q & A indicates that 'to date, there is no evidence that the streams that have been restored have returned to their normal ecological functions after the mining is completed,' what documentation with respect to Kentucky did U.S. EPA rely upon in making this statement?" (p. 6).

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

4. Industry

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below:

- Gorman Company, LLC (Doc. #0013.1);
- Kentucky Union Company (Doc. #0014.1);
- Black Gold Sales, Inc. (Doc. #0016.1);
- Hazard Coal Corporation (Doc. #0017.1); and
- Kycoga Company, LLC (Doc. #0018.1).

In general, the comments do not support the Guidance, and discuss the validity and adequacy of material referenced in the Guidance, the suitability of eco-region use, and scientific review.

a. Scientific Validity of Material Referenced in Guidance

Frost Brown Todd disagree that the Guidance is based on valid scientific evidence and express concern that the standards set by the Guidance will change once they have been subjected to peer review and "scientific scrutiny."

They recommend that EPA "engage in rigorous, scientifically valid, and peer reviewed analysis of relevant and available scientific data before attempting to impose any additional specific requirements on permits for coal mining activities" (p. 1). They contend that it is not sound science to set new standards based on scientific studies that have not been thoroughly peer reviewed and state that "It is unclear why EPA believes that it constitutes (…) sound science to

begin implementing a strict numeric limit when the science behind that limit has not even been 'truthed' out" (p. 9).

Frost Brown Todd suggest that the conductivity standard in the Guidance is based on limited scientific data, "Despite numerous statements in EPA's documents about 'extensive' data supporting its analysis, EPA's conclusions about the effects of surface coal mining on conductivity and the effects of conductivity on aquatic ecosystems in the region appear to be based largely on a single study – the so-called Pond-Passmore study – conducted in 2008" (p. 9).

Frost Brown Todd also argue that any changes may greatly impact projects permitted under the current Guidance: "… these detailed stringent requirements … are based on scientific data and conclusions that have not been subjected to peer review or scientific scrutiny. This clearly is a case of putting the policy 'cart' before the scientific 'horse" (p. 4).

c. Suitability of Ecoregion Use in Guidance

Frost Brown Todd question the applicability of the Guidance solely to Central Appalachia and argue that the suitability of ecoregion use in the Guidance is not science-based but rather a way to specifically target the coal mining industry in Appalachia through the use of policy. They question why the guidance is not applicable to other regions of the country with mining activities: "EPA has not articulated any reasonable or clear basis for the scope of these new rules – whether based on geography or industry" (p. 7). In addition they state: "It is also unclear why EPA has sought to limit the applicability of this conductivity limit to 'Central Appalachian streams containing the types of soil found in those streams.' Why is this information not relevant to other streams, regions, or industries? EPA's conductivity benchmark in fact appears to be an artificial limited and manipulated standard designed to target a specific industry in a specific region, with the sole purpose of making the continued practice of that industry a practical impossibility" (p. 9).

d. Scientific Review and Technical Recommendations for Project Review and Monitoring

Frost Brown Todd recommend that the Guidance not be implemented immediately on permits for coal mining activity. They contend that prior to implementation of the Guidance on permit and project review the scientific data referenced should be subjected to scientific peer review: "EPA also should engage in a rigorous, scientifically valid, and peer reviewed analysis of relevant and available scientific data before attempting to impose any additional specific requirements on permits for coal mining activities" (p. 2).

Frost Brown Todd convey their opinion that once the scientific data has been reviewed the Guidance may change. which will negatively impact projects that are permitted under the current Guidance, as they are subject to different requirements: "Those permits are likely to be based upon requirements in the 'interim' Guidance that may prove unnecessarily stringent, scientifically invalid, or otherwise legally unnecessary" (p. 4).

e. Insufficient Scientific Evidence and Insufficient Peer Review

Overall, the comment letter by Frost Brown Todd states their opinion that the Guidance is based on insufficient scientific evidence that has not been adequately peer reviewed or proven. They express their concern that the Guidance will have a detrimental impact on the coal mining industry in Appalachia and that insufficient scientific data and evidence have been referenced to support its requirements: "This hardly appears to be the kind of extensive data that EPA purports to rely upon, nor does it appear to be the kind of extensive data on which such a far- reaching and potential devastating limit should be based. Yet this is what EPA has done" (p. 9).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

6. Other Non-Governmental Organizations (NGOs)

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

7. Academia/ Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

8. Congressional Delegates

One letter (Doc. #0015) received from congressional delegates comments on the issue of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. This letter is signed by 23 Congressional Delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming. In general the comment letter is not supportive of the Guidance, and is critical of the peer review process used by EPA for reviewing the scientific data prior to issuance of the Guidance.

a. Scientific Validity of Material Referenced in Guidance

The congressional delegates express their opinion that the scientific data referenced in the Guidance should be subject to outside peer review prior to implementation: "We believe these proposals should be subject to public comment, as well as outside peer review for any draft scientific data, prior to implementation, so as to strike a better balance between environmental protections and responsible governance" (p. 1).

9. PRIVATE CITIZEN – GENERAL

Of the 84 comment letters posted by the docket as of December 1, 2010 by members of the general public, 30 letters commented on the issue area of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. All letters but one (Doc. #0249) generally approve of the Guidance and its supporting materials.

a. Scientific Validity of Material Referenced in Guidance

A majority of the commenters support the scientific validity of materials referenced by the Guidance. Multiple comment letters state that "… there is unequivocal evidence from numerous studies both within the EPA and by independent scientists documenting that conductivity is elevated in waterways downstream from mountaintop removal mines in central Appalachia." It should be noted that this language is also found in the mass mailing campaign sponsored by Sierra Club (Doc. #0103).

Other commenters express support for the scientific material referenced in the Guidance with the following common statement: "The most recent, peer – reviewed scientific information documents the harm that mountaintop removal causes to water quality. Based on research showing a strong relationship between conductivity of at least 300 – 500 µS/cm and harm to aquatic life, the policy will help ensure clean water." It should be noted that this language is also found in the mass mailing campaign sponsored by Earthjustice (Doc. #0022).

b. Scientific Materials Not Reviewed/ Referenced by Guidance

Several commenter letters included the following common statement referencing a supplemental 2010 scientific article by Margaret Palmer that supports scientific materials referenced by the Guidance, "A recent peer-reviewed scientific article details the harm that mountaintop removal causes to water quality (Doc. #0180)." A reference to this scientific article is also mentioned by another commenter (Doc. #0222.1) quoting from the article the following statement regarding science and regulation: "The best available science clearly demonstrates that the impacts of mountaintop removal are 'pervasive and irreversible' and that 'current attempts to regulate mountaintop removal practices are inadequate" (p. 1).

e. Insufficient Scientific Evidence/ Insufficient Peer Review

Many of the commenters in support of the Guidance and the referenced scientific reports share the common opinion that the mining practice of valley fills should not be allowed. Some commenters suggest that additional research should be funded by EPA for the study of the impacts of valley fills. One commenter writes (Doc. #0186): "The EPA must fund comprehensive research aimed at increasing your understanding of the impacts of valley fills"(p. 2).

Multiple letters identify their objections to mitigation through stream creation and provide the following statement related to insufficient scientific evidence: "EPA should strengthen the policy by refusing to permit mitigation (…) it is not possible to re-create the ecological functions of

streams. Similarly, EPA must not allow for the sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation downstream (Doc. #0189)."

In general, most comment letters support the scientific reports referenced by the Guidance. However, in addition to the referenced scientific evidence they suggest that funding for additional research will further develop an understanding of the adverse impacts of valley fills.

The commenter that opposes the Guidance (Doc. #0249) is of the opinion that there is insufficient scientific evidence to prove that mountaintop mining and the practice of valley fills affect the ecological services provided by streams: "Lobbyists will tell you that scientific research suggests that one valley fill is too many, because of the unique headwater streams lost along with the ecological serviced they provide this is not supported by facts."

10. Private Citizen – Expert

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of the Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia had not been posted by the docket. Any comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns commented on the issue area of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. These campaigns are supportive of the Guidance.

a. Scientific Validity of Material Referenced in Guidance

The comments in the letters from both the Earthjustice and Sierra Club campaigns support the scientific validity of material referenced in the Guidance. The Earth Justice campaign (Doc. #0022) states: "I support this Guidance because there is unequivocal evidence from numerous

studies both within the EPA and by Independent scientists documenting that conductivity is elevated in the waterways downstream from mountaintop removal mines in central Appalachia." The comment letter goes on to state: "The best available science shows strong relationships between conductivity of at least 300 – 500 µS/cm, and harm to aquatic life in the affected streams."

The Sierra Club campaign (Doc. #0103) argues that "The most recent, peer reviewed scientific information documents the harm that mountaintop removal causes to water quality." Comments in the letter include the support of scientific research documenting the relationship between higher levels of conductivity and water quality referenced in the Guidance.

e. Insufficient Scientific Evidence/ Insufficient Peer Review

The Sierra Club letter (Doc. #0103) expresses opposition to the Guidance allowing for the sequencing of valley fills due to insufficient scientific evidence. They convey their opinion that "EPA must not allow sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation of downstream waters."

13. UNKNOWN

Ten letters posted by the docket as of December 1, 2010 from unknown sources commented on the issue area of Science Regarding Environmental Impacts from Surface Coal Mining in Appalachia. Of the ten comment letters, all but one letter (Doc. #0010) are in support of the Guidance.

a. Scientific Validity of Material Referenced in Guidance

Several of the comment letters identify scientific research referenced in the Guidance demonstrating the loss of 2,000 miles of streams and headwaters due to mountaintop removal and express their appreciation that EPA is supporting this scientific research: "I am also pleased that EPA has recognized the role of the Clean Water Act to support this scientific research and protect the people of Appalachia (Doc. #0192)."

One comment (Doc. #0010) opposes the science referenced, including the research from the Pond study by stating that the "Guidance is based on scientific studies that are limited in scope and analysis."

b. Scientific Validity of Material Referenced in Guidance

Several comment letters include the following statement referencing a supplemental 2010 Science article by Margaret Palmer that supports scientific materials referenced by the Guidance: "A recent peer-reviewed scientific article details the harm that mountaintop removal causes to water quality (Doc. #0187)."

e. Insufficient Scientific Evidence/ Insufficient Peer Review

Many of the commenters who support the Guidance and the referenced scientific reports share the common opinion that the practice of valley fills when mining should not be allowed. Some commenters suggest that additional research should be funded by EPA for the study of the impacts of valley fills. Multiple commenters state: "The EPA must fund comprehensive research aimed at increasing your understanding of the impacts of valley fills." Many of these comment letters also include the following statement of opposition to the valley fill practice citing insufficient scientific evidence: "EPA must not allow for the sequencing of valley fills; there is no scientific evidence demonstrating that sequential construction of stream burial sites avoids the devastation downstream waters (Doc. #0211)."

II. Federal Authority to Regulate these Activities (Generally)

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency Region III (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that prevent harmful public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from those affected communities are taken into consideration.

The issue area of Federal Authority to Regulate these Activities includes those comments, recommendations, and opinions submitted by stakeholders regarding the relationship of the CWA, NEPA, and the Executive Order on Environmental Justice to the Surface Mine Coal Reclamation Act (SMCRA); as well as the authority, roles, and responsibility of federal and state agencies.

There were a total of 45 tallied comments submitted to the docket as of December 1, 2010, discussing federal authority to regulate these activities. These were submitted by different types of commenters, including a state agency, representatives of the mining industry, an environmental non-governmental organization (NGO), congressional delegates, the general public, and mass mailing campaigns. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 2-1 on the next page presents the total comment letters that address the federal authority to regulate these activities issue by commenter category.

Most comments from private citizens and the mass mailing campaigns are in general agreement with the Guidance and support EPA's regulatory authority. It should be noted that some of the comment letters received from private citizens may be modified mass mailers, as they use language similar, if not identical to mass mailing campaigns identified by the docket. These comment letters were summarized with other unique letters because they raise issues beyond what was raised by the mass mailing campaign letters.

Industry commenters and congressional delegates are in general opposition to the Guidance, while the environmental NGO (The Sierra Club) and the state agency (the Commonwealth of Kentucky Energy and Environment Cabinet) are in general support of the Guidance. Industry commenters contend that the Guidance contradicts established authorities and regulatory structures, could create unfair precedents, and should be withdrawn. Congressional delegates argue that the Guidance represents substantial changes that exceed the intent of the "Acts" (i.e., CWA, NEPA, and SMCRA), and undermines the authority, role, and responsibility of State agencies in reviewing and issuing permits. The Sierra Club urges EPA to ensure prompt implementation of the Guidance at the state and federal levels. The Kentucky Energy and Environment Cabinet seeks clarification on Guidance implementation through a series of questions, some of which are related to Federal and State authorities.

Below are summaries, presented by commenter category, on the issue of federal authority to regulate these activities as it relates to the Guidance. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore not all sub-issues are listed under each commenter category.

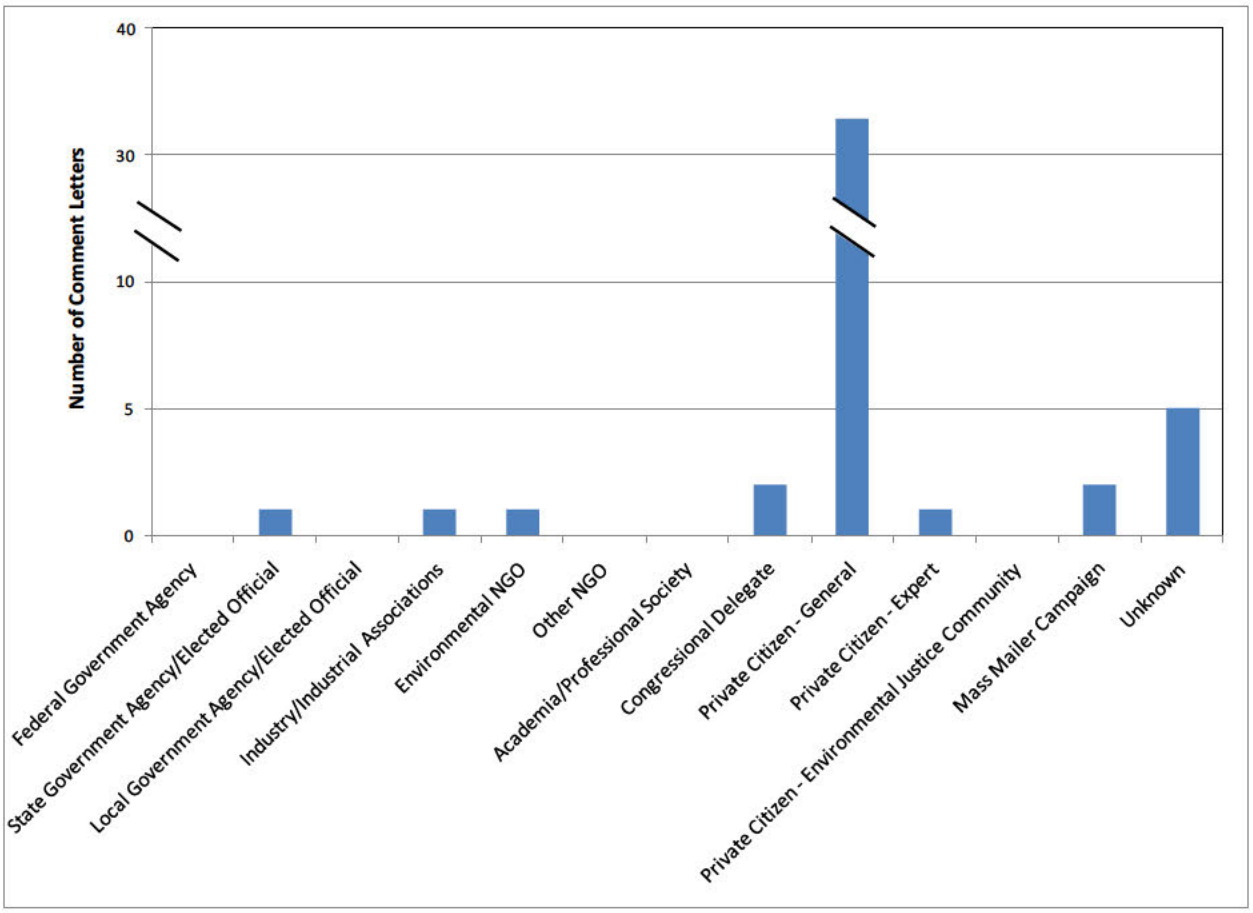

Figure 2-1. Federal Authority, Total Comment Letters by Commenter Category

1. Federal Government Agencies

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

2. State Government Agencies and Elected Officials

The Kentucky Energy and Environment Cabinet letter (Doc. #0012) was the only comment received from a state government agency or elected official. The Cabinet generally supports the Guidance but is unclear about its application in certain instances. Their comment letter presents a series of questions to EPA, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations.

a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to SMCRA

The Kentucky Energy and Environment Cabinet would like a clarification on the term "mountain top mining" in the context of the SMRCA, which they state is different from surface coal mining operations in general (q. A.1). They ask if the Guidance is for mountaintop mining or for surface mining operations as a whole (q. B.8). Furthermore, they would also like to know if it is correct to assume that the Guidance does not apply to coal mining operations (q. A.2).

b. Authority, Role, and Responsibility of Federal and State Agencies

The Kentucky Energy and Environment Cabinet referenced the detailed Guidance – footnote 3 to state that it "does not impose legally binding requirements on EPA, the U.S. Army Corps of Engineers (Corps), the States, or the regulated community, and may not apply to a particular situation depending upon the circumstances." They ask for clarification on the legal authority of the April 1, 2010 announcement and its associated references, with respect to delegated states' implementation, and EPA oversight of state delegated CWA Section 402 permitting programs (q. A.6). They would also like to know if the interim final Guidance represents the final EPA determination subject to judicial review (q. A.7).

In addition, they are also asking if EPA will proactively continue to provide technical support in the future and if EPA will commit to providing additional CWA 106 funding to the Commonwealth, to address limited staff resources for permit reviews (q. A.19 and B.6).

Finally, they ask if the Guidance is limited to certain states and Appalachian eco-regions, and if so, to clarify the basis for applying the Guidance only to certain states (q. A.8 and A.17).

3. Local Government Agencies and Elected Officials

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

4. Industry or Industrial Associations

Five comment letters were received from industry representatives regarding the federal authority to regulate these activities. The letters were all submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients, listed below.

- Gorman Company, LLC (Doc. #0013);
- Kentucky Union Company (Doc. #0014);
- Black Gold Sales, Inc. (Doc. #0016);
- Hazard Coal Corporation (Doc. #0017); and
- Kycoga Company, LLC (Doc. #0018).

The bodies of all five letters are identical, except for the name of the represented client. The letters are generally in opposition to the Guidance.

a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to SMCRA

With respect to federal authority, Frost Brown Todd claim that the Guidance is in contradiction with established authorities and regulatory structures, and could create precedents that may result in unfair treatment of all applications. Specifically, they state that the "methods through which EPA has instructed to its regions to enforce those requirements, violate the carefully balanced federal-state regulatory structure established by Congress under the CWA, the SMCRA, and related environmental laws" (p. 4). Frost Brown Todd further describe the Guidance as "heavy-handed requirements [that] not only contradict the long-established regulatory standards, authorities, and programs under the CWA, SMRCA and related statutes – they threaten to establish precedents that would undermine the consistent and fair application of those statutes to activities and industries throughout the United States" (p. 5).

b. Authority, Role, and Responsibility of Federal and State Agencies

Frost Brown Todd request that EPA withdraw its Guidance which they see as unlawful and confusing, and superseding legitimate authority from other agencies to regulate these activities. They also request that EPA instruct relevant agencies not to implement or apply the Guidance as it currently stands.

Specifically, Frost Brown Todd states that the Guidance is "inconsistent with EPA's statutory authorities, and imposes an unconstitutional taking of property" (p. 2), and in violation of "the rights of the states and other federal agencies to exercise their own statutory authorities" (p. 6).

In addition, Frost Brown Todd would like EPA to "instruct all relevant state and federal agencies and EPA regions that the requirements of the Guidance are not to be implemented or applied under any circumstances until further notice; and not adopt any further requirements without the benefit of a full and fair public process, based upon input from all interested stakeholders, and in compliance with the requirements of notice-and-comment rulemaking" (p. 2).

Frost Brown Todd further claims that "EPA also seeks to supersede the Corps' authority in administering the Section 404 permitting program and working with the states under Section 401" (p. 5). They also state that the Guidance "improperly presumes that NPDES general permits may not be used to authorize activities associated with coal mining" (p. 5) and that the Guidance itself will "create unnecessary confusion and uncertainty, and treats the states, regions, and industries inequitably" (p. 7).

5. Environmental Non-Governmental Organizations (NGOs)

As of December 1, 2010, one letter was submitted from an Environmental NGO commenting on the issue of federal authority to regulate these activities in EPA's Guidance. The Sierra Club (Doc. #0225) strongly supports the Guidance and commends EPA for issuing it.

b. Authority, Role, and Responsibility of Federal and State Agencies

Although not stating it directly, the Sierra Club supports the EPA's authority to regulate these activities in urging "EPA to make sure that its regional offices and other federal and state agencies adhere to the guidance and do not issue permits that are contrary to the Guidance" (p. 1).

6. Other NGOs

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

7. Academia/Professional Societies

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

8. Congressional Delegates

Two comment letters posted by the docket as of December 1, 2010 were submitted by congressional delegates. Both letters are signed by several members of Congress, are in general opposition to the Guidance, and address the issue of federal authority. The first letter (Doc. #0011) is signed by three congressional delegates representing the States of Virginia and West Virginia. The second letter (Doc. #0015) is signed by 23 congressional delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming.

a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to Surface Mining Control and Reclamation Act (SMCRA)

The letter signed by 23 congressional delegates (Doc. #0015) argues that guidance is usually issued to clarify or further explain an agency's interpretation of a statute or regulation, but that the April 1, 2010 Guidance appears to make substantive changes and exceeds the original intent of the Acts. Specifically, they identify changes to "three sections of the CWA, along with various provisions of the NEPA and the SMCRA" (p. 1). They further argue that with its "sweeping regulatory action far exceeds the intent of Congress under these Acts" (p. 1) and that they are "troubled by federal efforts to undermine Congressional intent on primary state regulatory authority under SMCRA and the CWA" (p. 2).

b. Authority, Role, and Responsibility of Federal and State Agencies

Both comment letters are opposed to EPA's Guidance, and argue that it usurps certain authorities. The letter signed by congressional delegates from Virginia and West Virginia (Doc.

#0011) criticizes the Guidance's restricted applicability to Appalachia and to surface coal mining operations. They state that "Not only is there no precedent for such an action, but it is also patently a wrong approach to implementing the CWA" (p. 1). The letter signed by 23 congressional delegates representing 14 States (Doc. #0015) criticizes the Guidance because it undermines the authority, roles, and responsibility from state agencies when reviewing and issuing mining permits: "Such a determination threatens the cooperative federalism system Congress created in both SMRCA and CWA" (p. 2). They further argue that under the CWA, States have "the power to design state-specific conditions to federal permits" (p. 2) and this approach "recognizes that state regulators at the local level are better equipped to interpret water quality standards and apply them to site-specific permits because they have in-depth knowledge of local watersheds, their conditions and their long-term plans for improvement" (p. 2).

9. Private Citizen - General

Thirty two comment letters, typically one page in length, submitted by members of the general public comment on the issue of federal authority to regulate these activities. All of the letters are in support of the Guidance and most of them applaud or thank the EPA for recognizing the need to address this issue.

a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to Surface Mining Control and Reclamation Act (SMCRA)

Six of the commenters state that this Guidance is valuable "to ensure that regional staff will finally follow CWA requirements." It should be noted that this language is also found in the mass mailing campaign sponsored by Earthjustice (Doc. #0022).

b. Authority, Role, and Responsibility of Federal and State Agencies

Most commenters supported EPA's role in regulating these activities, and wished to encourage stronger authority. They urged EPA to "strengthen and finalize the guidance and make sure that its regional offices and other federal and state agencies adhere to the policy and do not issue permits that are contrary to the guidance." They also urged EPA to "assure state and federal agencies do not issue permits that are contrary to the clear science and legal requirements discussed in the guidance."

One commenter wishes to encourage federal agencies to "follow consistent and strict application of the rules and regulations that are otherwise turned over for enforcement by local/state EPA agencies (Doc. #0178)."

10. Private Citizen – Expert

As of December 1, 2010, one letter was submitted from a private citizen - expert commenting on the issue of federal authority to regulate these activities in EPA's Guidance. The commenter is a biologist, with a Masters degree in biology, and is currently a teacher teaching wildlife management and environmental earth science (Doc. #0112).

b. Authority, Role, and Responsibility of Federal and State Agencies

The commenter strongly supports the Guidance, commends EPA for issuing it, and urges EPA to "to ensure that regional staff will finally follow CWA requirements."

11. Environmental Justice and/or Traditionally Disadvantaged Community

As of December 1, 2010, comments from this category group discussing the issue area of the federal authority to regulate these activities had not been posted by the docket. Any subsequent comments received will be addressed in the final summary.

12. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "form mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. As of December 1, 2010, two distinct campaigns were identified by the docket as sponsored by the following NGOs (Document numbers identify the letter representative of the campaign, as indicated by the docket):

- Earthjustice (Doc. #0022); and
- The Sierra Club (Doc. #0103).

Both campaigns are in support of EPA's Guidance and suggest that the Guidance should be strengthened and finalized.

b. Authority, Role, and Responsibility of Federal and State Agencies

The Sierra Club urges EPA to "strengthen and finalize the guidance and make sure that its regional offices and other federal and state agencies adhere to the policy and do not issue permits that are contrary to the guidance (Doc. #0103)." This statement is echoed by many general private citizens in their comment letters.

Earthjustice urges regional staff to follow the CWA requirements and urges EPA to "assure state and federal agencies do not issue permits that are contrary to the clear science and legal requirements discussed in the guidance (Doc. #0022)." Another exact statement made by many general private citizens in their comment letters.

13. Unknown

Five comment letters received from unknown or unidentified commenters discuss federal authority to regulate these activities. Of the five comment letters, all but one letter (Doc. #0010) are in support of the Guidance.

b. Authority, Role, and Responsibility of Federal and State Agencies

Similar to the mass mailing campaign sponsored by Earthjustice, the four comment letters supporting the Guidance urge EPA not to issue permits that are "contrary to the guidance" or "contrary to the clear science and legal requirements discussed in the guidance."

The comment letter in general opposition to the Guidance states that "EPA has no right dictating to the states how to administer their water quality programs and it is the states who shall determine what criteria is to be met (Doc. #0010)."

Bette Conway/R3/USEPA/US
01/24/2011 08:54 AM

To Evelyn MacKnight, Francisco Cruz, David Rider, Jessica Martinsen, Jeffrey Lapp, Douglas Frankenthaler, Jaclyn McIlwain
cc
bcc
Subject Fw:WV 2011 Mine Drainage Syposium-Please forward to staff that would have interest in this

FYI, I have gone to this for the past 2 years; anyone want to join me?

Bette Conway
EPA Region III
Water Protection Division
NPDES Permits Branch
1650 Arch Street, (3WP41)
Philadelphia PA 19103
Ph: 215-814-5744
Fax: 215-814-2301
conway.bette@epa.gov
----- Forwarded by Bette Conway/R3/USEPA/US on 01/24/2011 08:52 AM -----

From: Jeff Skousen <jskousen@wvu.edu>
To: jskousen@wvu.edu
Date: 01/22/2011 02:10 PM
Subject: 2011 Mine Drainage Syposium

Please excuse me if you get this message more than once, since I'm sending it out to several email lists.

Well everyone: We finally have the program set and the web site is ready for on-line registrations.
I have attached a program (or you can get it on the web site). Please send to others who may be interested in the program and attending the symposium

http://www.wvmdtaskforce.com/

Please register and come!
Questions, call me or email back.

Jeff Sk.

2011 TaskForce Brochure.doc

WEST VIRGINIA MINE DRAINAGE TASK FORCE SYMPOSIUM

Ramada Inn, Morgantown, West Virginia
March 29 – 30, 2011

Tuesday, March 29, 2011
7:30 – 8:30 a.m. **Registration**

"Status of WV Mining and Reclamation"
Randy Huffman, WVDEP

"OSM Update on Mining, Recl. and AMD"
Joe Pizarchik, Director, OSM

"Total Dissolved Solids Control by Managed Discharge"
Paul Ziemkiewicz, WVU

"Mining Methods and Best Management Practices to Minimize TDS Evolution"
Richard Warner, UK

"Mine Spoil Weathering and TDS Dynamics"
Lee Daniels, Virginia Tech

"A Comparison of the Effects of Mining over a 10-Year Period on the Fisheries, Macro-invertebrates, and Water Chemistry within the Tributaries of East Fork Twelvepole Creek, WV"
Jonny Hart, Ed Kirk, REIC
Randy Maggard, Argus

12:00 - 1:30 p.m. **LUNCH**

"2010-11 Legislative Issues on Mining, Reclamation and Water Quality"
Jason Bostic, WVCA

"Analysis of Total Aluminum and Dissolved Aluminum"
Louis McDonald, Jeff Skousen, WVU

"New Policies and Procedures for Aluminum Translator Studies"
Jennie Henthorn, Henthorn Env.

"Comparing TDS, Conductivity and Major Ions as Aquatic Life Stressors in Streams"
Carl Zipper, Virginia Tech

"Selenium Impacts on Aquatic Life in the Mudd River"
Patricia Mazik, P. Ziemkiewicz, WVU

Tuesday Evening, 5:00 - 7:30 p.m.
RECEPTION AND EXHIBIT SESSION

Wednesday, March 30, 2011
7:45 – 8:00 a.m. **Registration**

"Marcellus Gas Development: Implications for the Coal Industry"
Paul Ziemkiewicz, WVU

"Using AMDTreat and PHREEQC Titration Module for Prediction of AMD Effluent Quality and Sludge Quantity"
Chuck Cravotta, USGS

"Semi-Passive Bioreactors and RCTS Lime Treatment at Remote Sites"
Tim Tsukamoto, TKT Consulting

"Air Jammer: Cutting AMD Costs at Warwick Mine on a Limited Budget"
Robert Marmo, Marmo & Assoc.
Charles Blankenship, Duquesne Light

"A Review of the Role of Phosphate Mining Waste: A Chemical or Biological Reagent for AMD Prevention?"
Margarete Kalin, CBoojum Research

"Aeration of Mine Water Using a TROMPE"
Bruce Leavitt, Hydrogeologist

"Sustained Treatment of AMD with Drainable Limestone Beds"
Bob Hedin and N. Wolfe, Hedin Env.

12:00 Noon ADJOURN

More Information and to Register Online:
http://www.wvmdtaskforce.com

Call Jeff Skousen at 304-293-2667
Email: jskousen@wvu.edu

Registration Fee: $125
Hotel: Ramada Inn: 304-296-3431

REGISTRATION FORM
West Virginia Mine Drainage Task Force
March 29-30, 2011

Name_____

Company or Agency
_____

Address_____

_____

Phone: _____

Email: _____

Register Online: **www.wvmdtaskforce.com**

For payment with credit card:
Card Number _____

Exp. Date _____

Card Type ___Visa ___MasterCard
___Discover ___American Express

Registration Fees:

Before March 11, 2011	$125
After March 11, 2011	$150
Students	$ 25

Check Payable to:
Mine Drainage Task Force

Return Form and Fees to:
Patty Bruce
1444 Wilkie Drive
Charleston, WV 25314
Ph. 304-344-8554
Email: pbruce@suddenlink.net

MEETING ANNOUNCEMENT
AND
REGISTRATION INFORMATION

WEST VIRGINIA MINE DRAINAGE TASK FORCE SYMPOSIUM

MARCH 29-30, 2011

RAMADA INN
MORGANTOWN, WV

Sponsored by

WEST VIRGINIA MINE DRAINAGE TASK FORCE

and

WV COAL ASSOCIATION

Joe Lovett
<jlovett@appalachian-center.org>
01/24/2011 12:01 PM

To Gregory Peck
cc
bcc
Subject FW: Brune OpEd on Spruce/MTR in Richmond Times-Dispatch

http://www2.timesdispatch.com/news/2011/jan/24/TDOPIN02-brune-saving-mountains-saves-lives-ar-793342/

Brune: Saving Mountains Saves Lives
By MICHAEL BRUNE
Published: January 24, 2011

"Determined effort, especially in the face of difficulty." That's how Webster's defines heroic, and that's not too strong a word for the final decision announced this month by Lisa Jackson and the Environmental Protection Agency to revoke the permit for Arch Coal's proposed Spruce No. 1 mine in Logan County, W.Va. By stopping what would have been one of the largest mountaintop-removal mines in all of Appalachia, the EPA has sent its strongest message yet that it will defend the health and safety of Americans in the face of strong opposition from corporate polluters and a hostile Congress.

The proposed Spruce Mine exemplified everything objectionable about mountaintop-removal mining — a practice so destructively short-sighted that it's both incredible and shameful that we've allowed it to go on this long. That it has is testimony to the power and influence of the coal industry both on Wall Street and in Washington, D.C. And nowhere in America does coal cast a longer shadow than in West Virginia.

But the truth about mountaintop-removal mining is so terrible that it could not be denied, especially with the courageous work of local activists in Appalachia like the late Judy Bonds, the coal miner's daughterwhose memorial service was just held in Beckley, W.Va. She and other activists refused to let America turn a blind eye to the destruction of entire communities and watersheds in some of the poorest areas of our country. It is a bitter irony that she did not live to see this decision.

The Spruce Mine would have blasted away more than 400 feet of Appalachian hilltops. Arch Coal would have cleared 2,200 acres of forestlands, and 110 million cubic yards of mining waste would then have buried more than 7 miles of high-quality headwater streams forever.

Appalachian headwater streams contain some of the greatest aquatic animal diversity of any area in North America.

Unfortunately, there are applications for additional mountaintop removal mines across Appalachia now pending before the Obama administrationthat, taken together, would cause

many times the damage of the Spruce Mine.When combined with the destruction caused by existing mines, the cumulativedamage from any additional mining would be devastating for the region.

The loss of irreplaceable mountains, forests and streams, though, is only part of the story. Massive surface-mining operations like Spruce also contaminate downstream waters with waste products like selenium, and the surface-mining operations fill the mountain air with toxic coal and rock dust. Although our reliance on burning coal for energy adversely affects the health of millions of Americans, nowhere have people suffered more dearly than in Appalachia. For too long, too many Americans — not just coal miners — have paid with their lives for our addiction to coal.

What enabled the EPA to stop the Spruce Mine — and what should stop all future mountaintop removal mining projects — are science and the rule of law. Science has proven that mountaintop-removal mining destroys — irrevocably — a precious natural resource: clean water. The Clean Water Act, which was passed to safeguard the health and safety of the American people, charges the EPA to review mining permits and to deny those that will, as the agency put it, result in "unacceptable adverse impacts."

Fortunately, the EPA exists to enforce the much-needed safeguards that can keep polluters from making us and our children sick. Stopping irresponsible coal mining has another huge benefit for all Americans, though — it moves us closer to a clean-energy economy that creates good jobs and can be the basis for a real, long-term prosperity that doesn't ask ordinary Americans to sacrifice their health to keep the lights on.

We are already hearing howls of protest from those who stand to gain financially by tearing apart Appalachia's mountains to get at the coal inside, as well as from the politicians who leap to their defense.

They say that coal mining creates jobs. They say that clean water, clean air and good health will hurt the economy. The reality, though, is that the coal industry has been cutting jobs and cutting cornersin Appalachia for years now. In contrast, clean energy and efficiency investments there could generate almost 80,000 jobs by 2030 and save consumers more than $25 billion in energy costs.

Lisa Jackson and the EPA deserve our gratitude for taking a bold stand on the Spruce Mine — one that puts people first — instead of chaining us to the dirty-energy past.

Michael Brune is executive director of the Sierra Club and the author of "Coming Clean Breaking America's Addiction to Oil and Coal." Contact him at Michael.Brune@sierraclub.org .

Gregory Peck/DC/USEPA/US
01/24/2011 12:23 PM

To Peter Silva, Nancy Stoner, Bob Sussman, Betsaida Alcantara, Arvin Ganesan, Shawn Garvin
cc Denise Keehner, Matthew Klasen, Karyn Wendelowski, Christopher Hunter, Kevin Minoli
bcc

Subject Michael Brune - Saving Mountains Saves Lives OP Ed on Spruce

"Heroic!!!"

Brune: **Saving Mountains Saves Lives**
By MICHAEL BRUNE
Published: January 24, 2011

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Michael Brune is executive director of the Sierra Club and the author of "Coming Clean Breaking America's Addiction to Oil and Coal." Contact him at Michael.Brune@sierraclub.org .

Gregory E. Peck
Chief of Staff
Office of Water
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

202-564-5778

Christopher Hunter/DC/USEPA/US 01/24/2011 03:38 PM	To	Marcel Tchaou, Julia McCarthy, Palmer Hough, Brian Frazer, Ross Geredien, David Evans
	cc	
	bcc	
	Subject	Fw: Michael Brune - Saving Mountains Saves Lives OP Ed on Spruce

Probably the highest praise I've seen from anyone on the Spruce decision, coming from executive director of Sierra Club, and published in the NY Times.

----- Forwarded by Christopher Hunter/DC/USEPA/US on 01/24/2011 03:36 PM -----

From:	Gregory Peck/DC/USEPA/US
To:	Peter Silva/DC/USEPA/US@EPA, Nancy Stoner/DC/USEPA/US@EPA, Bob Sussman/DC/USEPA/US@EPA, Betsaida Alcantara/DC/USEPA/US@EPA, Arvin Ganesan/DC/USEPA/US@EPA, Shawn Garvin/R3/USEPA/US@EPA
Cc:	Denise Keehner/DC/USEPA/US@EPA, Matthew Klasen/DC/USEPA/US@EPA, Karyn Wendelowski/DC/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA
Date:	01/24/2011 12:23 PM
Subject:	Michael Brune - Saving Mountains Saves Lives OP Ed on Spruce

"Heroic!!!"

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By MICHAEL BRUNE
Published: January 24, 2011

"Determined effort, especially in the face of difficulty." That's how Webster's defines heroic, and that's not too strong a word for the final decision announced this month by Lisa Jackson and the Environmental Protection Agency to revoke the permit for Arch Coal's proposed Spruce No. 1 mine in Logan County, W.Va. By stopping what would have been one of the largest mountaintop-removal mines in all of Appalachia, the EPA has sent its strongest message yet that it will defend the health and safety of Americans in the face of strong opposition from corporate polluters and a hostile Congress.

The proposed Spruce Mine exemplified everything objectionable about mountaintop-removal mining — a practice so destructively short-sighted that it's both incredible and shameful that we've allowed it to go on this long. That it has is testimony to the power and influence of the coal industry both on Wall Street and in Washington, D.C. And nowhere in America does coal cast a longer shadow than in West Virginia.

But the truth about mountaintop-removal mining is so terrible that it could not be denied, especially with the courageous work of local activists in Appalachia like the late Judy Bonds, the coal miner's daughterwhose memorial service was just held in Beckley, W.Va. She and other activists refused to let America turn a blind eye to the destruction of entire communities and watersheds in some of the poorest areas of our country. It is a bitter irony that she did not live to see this decision.

The Spruce Mine would have blasted away more than 400 feet of Appalachian hilltops. Arch

Coal would have cleared 2,200 acres of forestlands, and 110 million cubic yards of mining waste would then have buried more than 7 miles of high-quality headwater streams forever.

Appalachian headwater streams contain some of the greatest aquatic animal diversity of any area in North America.

Unfortunately, there are applications for additional mountaintop removal mines across Appalachia now pending before the Obama administrationthat, taken together, would cause many times the damage of the Spruce Mine.When combined with the destruction caused by existing mines, the cumulativedamage from any additional mining would be devastating for the region.

The loss of irreplaceable mountains, forests and streams, though, is only part of the story. Massive surface-mining operations like Spruce also contaminate downstream waters with waste products like selenium, and the surface-mining operations fill the mountain air with toxic coal and rock dust. Although our reliance on burning coal for energy adversely affects the health of millions of Americans, nowhere have people suffered more dearly than in Appalachia. For too long, too many Americans — not just coal miners — have paid with their lives for our addiction to coal.

What enabled the EPA to stop the Spruce Mine — and what should stop all future mountaintop removal mining projects — are science and the rule of law. Science has proven that mountaintop-removal mining destroys — irrevocably — a precious natural resource: clean water. The Clean Water Act, which was passed to safeguard the health and safety of the American people, charges the EPA to review mining permits and to deny those that will, as the agency put it, result in "unacceptable adverse impacts."

Fortunately, the EPA exists to enforce the much-needed safeguards that can keep polluters from making us and our children sick. Stopping irresponsible coal mining has another huge benefit for all Americans, though — it moves us closer to a clean-energy economy that creates good jobs and can be the basis for a real, long-term prosperity that doesn't ask ordinary Americans to sacrifice their health to keep the lights on.

We are already hearing howls of protest from those who stand to gain financially by tearing apart Appalachia's mountains to get at the coal inside, as well as from the politicians who leap to their defense.

They say that coal mining creates jobs. They say that clean water, clean air and good health will hurt the economy. The reality, though, is that the coal industry has been cutting jobs and cutting cornersin Appalachia for years now. In contrast, clean energy and efficiency investments there could generate almost 80,000 jobs by 2030 and save consumers more than $25 billion in energy costs.

Lisa Jackson and the EPA deserve our gratitude for taking a bold stand on the Spruce Mine — one that puts people first — instead of chaining us to the dirty-energy past.

Michael Brune is executive director of the Sierra Club and the author of "Coming Clean Breaking America's Addiction to Oil and Coal." Contact him at Michael.Brune@sierraclub.org .

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01/24/2011 05:22 PM

To Christopher Hunter
cc Thomas Noble, Mark Nelson, Amy Ball
bcc
Subject Summaries of issues I and IX and linked database

3 attachments

110124_9_EJ-summary (draft)_10058.pdf 110124_1_Background-summary (draft)_10058.pdf

_110124_DeliverableDatabase_10058.xlsx

Hi Chris:

Attached are the summaries for issue areas I and IX, as well as an updated database showing the issue areas addressed by unique comments. Please let me know if you would also like Word versions of these documents. You will notice that in the database, the document numbers have links to the actual PDF documents. For these to work, I would recommend that you save the Excel database directly from your email (not Excel) to the folder where you saved the comments (i.e., use “save as” from your email before opening the file in Excel). The attached database can replace the previous database that was submitted in the zip file with the comments. If this does not work, we can re-submit the zipped comments with the correct database through our ftp server.

Please let Tom or I know if you have any questions or comments regarding this deliverable or the project in general.
Best Regards,
Geraldine

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Letter Type	Commenter Category	Geographic Origin	Agency Name
Unique Letter	Private Citizen - General	PA	
Unique Letter	Private Citizen - General	Other State	
Duplicate Letter	Private Citizen - General	PA	
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Unknown	Unknown	
Unique Letter	Congressional Delegate	Other State	U.S. House of Representativ
Unique Letter	State Government Agency/E	KY	Office of the Secretary, Ene
Unique Letter	Industry/Industrial Associatio	KY	Gorman Company, LLC
Duplicate Letter	Industry/Industrial Associatio	KY	Kentucky Union Company
Unique Letter	Congressional Delegate	KY	U.S. House of Representativ
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Unique Letter	Private Citizen - General	Unknown	
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Modified Mass Mail	Mass Mailer Campaign	Unknown	Earthjustice
Mass Mailing Camp	Mass Mailer Campaign	Unknown	Earthjustice
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Modified Mass Mail	Mass Mailer Campaign	Unknown	Earthjustice
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Modified Mass Mail	Mass Mailer Campaign	Unknown	Earthjustice
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Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
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Unique Letter	Private Citizen - General	Other State	
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Modified Mass Mail	Mass Mailer Campaign	Unknown	Unknown 367
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Unique Letter	Unknown	Unknown	
Unique Letter	Industry/Industrial Associatio	Unknown	RGGS Land and Minerals L
Unique Letter	Private Citizen - Expert	WV	
Unique Letter	Industry/Industrial Associatio	WV	Logan Corporation
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Unique Letter	Environmental NGO	Unknown	American Rivers
Unique Letter	Environmental NGO	Unknown	Appalachian Voices
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Other NGO	PA	Eastern Abandoned Mine P
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Environmental NGO	Other State	Rainforest Action Network
Mass Mailing Camp	Mass Mailer Campaign	Unknown	Unknown 367
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Unique Letter	Private Citizen - General	KY	Certified Home Inspectors
Unique Letter	Private Citizen - General	Unknown	
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Unique Letter	Private Citizen - General	VA	
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Unique Letter	Private Citizen - General	Other State	Tri Cities Tea Party-912 Gr
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Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Unknown	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	PA	Earthjustice

Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Unknown	
Modified Mass Mail	Mass Mailer Campaign	WV	Unknown 367
Modified Mass Mail	Mass Mailer Campaign	Unknown	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	WV	Unknown 367
Modified Mass Mail	Mass Mailer Campaign	Other State	Unknown 367
Modified Mass Mail	Mass Mailer Campaign	Unknown	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Unknown	Unknown	
Unique Letter	Unknown	Unknown	
Modified Mass Mail	Mass Mailer Campaign	Unknown	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	TN	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Unique Letter	Private Citizen - General	WV	

Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	WV	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	WV	Earthjustice
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	PA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	PA	
Unique Letter	Private Citizen - General	KY	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	WV	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	TN	Sierra Club
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	TN	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Duplicate Letter	Environmental NGO	Other State	Rainforest Action Network
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice

Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Sierra Club
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	PA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	OH	
Modified Mass Mail	Mass Mailer Campaign	TN	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	PA	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	WV	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	PA	
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	OH	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Private Citizen - General	Unknown	
Modified Mass Mail	Mass Mailer Campaign	PA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	KY	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	

Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Unknown	Unknown 367
Modified Mass Mail	Mass Mailer Campaign	VA	Unknown 367
Unique Letter	Other NGO	VA	Alpha Natural Resources
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - Expert	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Mass Mailing Camp	Mass Mailer Campaign	WV	Unknown 599
Mass Mailing Camp	Mass Mailer Campaign	Other State	Unknown 600
Mass Mailing Camp	Mass Mailer Campaign	Unknown	Earthjustice
Mass Mailing Camp	Mass Mailer Campaign	Other State	Unknown 602
Mass Mailing Camp	Mass Mailer Campaign	Other State	Unknown 603
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	PA	Earthjustice
Unique Letter	Industry/Industrial Associatio	Other State	Federal Water Quality Coali
Unique Letter	Environmental NGO	Other State	Earthjustice et al.
Unique Letter	Industry/Industrial Associatio	Other State	National Mining Associatio
Unique Letter	Industry/Industrial Associatio	TN	Tennessee Valley Authority
Unique Letter	Private Citizen - Expert	Other State	Universities of Maryland, D
Unique Letter	State Government Agency/E	WV	West Virginia Department o
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	Carmichael's Bookstores
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	Unknown	
Modified Mass Mail	Mass Mailer Campaign	TN	Earthjustice
Unique Letter	Private Citizen - General	KY	
Modified Mass Mail	Mass Mailer Campaign	KY	Earthjustice

Unique Letter	Private Citizen - General	PA	
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Private Citizen - General	PA	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	KY	
Modified Mass Mail	Mass Mailer Campaign	WV	Earthjustice
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	OH	
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	WV	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Private Citizen - Expert	PA	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - Expert	TN	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	PA	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	PA	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	KY	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	OH	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	PA	Earthjustice
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	Other State	

Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Federal Government Agency	Other State	U.S. Department of the Inte
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	PA	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	OH	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	OH	
Modified Mass Mail	Mass Mailer Campaign	WV	Unknown 599
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	TN	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Local Government Agency/E	VA	Town Council, St Charles, V
Unique Letter	Private Citizen - Expert	TN	
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	PA	Unknown 599
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	Unknown	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice

Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Unique Letter	Private Citizen - General	VA	
Modified Mass Mail	Mass Mailer Campaign	OH	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	OH	
Unique Letter	Private Citizen - General	VA	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	WV	Earthjustice
Unique Letter	Private Citizen - Expert	KY	
Modified Mass Mail	Mass Mailer Campaign	OH	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	PA	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	WV	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	KY	Unknown 599
Unique Letter	Private Citizen - General	VA	
Unique Letter	Private Citizen - General	WV	
Unique Letter	Private Citizen - General	TN	
Modified Mass Mail	Mass Mailer Campaign	VA	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	TN	Sierra Club
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	VA	Unknown 600
Unique Letter	Private Citizen - General	Other State	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	PA	Unknown 599
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	KY	Earthjustice
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	WV	Earthjustice
Unique Letter	Federal Government Agency	Other State	U.S. Department of the Inte
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	Other State	
Modified Mass Mail	Mass Mailer Campaign	TN	Sierra Club
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	PA	
Unique Letter	Private Citizen - Expert	Other State	
Unique Letter	Private Citizen - General	KY	

Modified Mass Mail	Mass Mailer Campaign	Other State	Earthjustice
Modified Mass Mail	Mass Mailer Campaign	TN	Unknown 599
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	
Modified Mass Mail	Mass Mailer Campaign	KY	Earthjustice
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	KY	
Unique Letter	Private Citizen - General	Unknown	
Unique Letter	Private Citizen - General	KY	
Modified Mass Mail	Mass Mailer Campaign	KY	Unknown 599
Unique Letter	Private Citizen - General	KY	
Unique Letter	Other NGO	KY	Kentuckians For The Comm
Unique Letter	Private Citizen - General	Other State	
Mass Mailing Camp	Mass Mailer Campaign	Other State	Rainforest Action Network
Duplicate Letter	Federal Government Agency	Other State	U.S. Department of the Inte

Commenter Name	Doc. Number	I. Background/basis for Guidance	
		a. Environmental impact of Appalachian coal mining	
		i. Watershed/ ecosystems	ii. Appalachian wildlife
J.F. Sabl	0006		
J. R. McGhee and M. A.	0007	x	
J. F. Sabl	0008 (same as 0006)		
D. Auerbach	0009	x	
Anonymous	0010		
A. B. Mollohan, N. J. Rah	0011		
L. K. Peters	0012		
Paul E. Sullivan, Frost Br	0013		
Paul E. Sullivan, Frost Br	0014 (same as 0013)		
Congressman Harold Rog	0015		
Paul E. Sullivan, Attorney	0016 (same as 0013)		
Paul E. Sullivan, Attorney	0017 (same as 0013)		
Paul E. Sullivan, Attorney	0018 (same as 0013)		
V. Hager	0019		
Liz (no surname provided	0020		
M. Lickert	0021		
Mass Comment Campaig	0022	x	
Anonymous	0023		
Anonymous	0024		
F. Krueger	0025		
Anonymous	0026		
C. Mulligan	0027		
E. DeHuff	0028		
C. Johnston	0029		
A. Sheldon	0030		
M. Panetti	0031		
L. Thompson	0032		
M. Shimizu	0033		
D. Hartel	0034		
J. Shirazi	0035		
L. Kappes	0036	x	
L. Touchstone	0037		
A. Mink	0038		
J. Urbanas	0039		
B. Flowers	0040		
Dr. P. Silveston	0041		
C. O. Dietrich	0042		
P. Rizzo	0043		
K. Hartman	0044		
P. Crouser	0045		
J. Eakins	0046	x	
M. Fogg	0047		
P. Rustad	0048		

J. Niblack	0049		
B. Barrett	0050		
V. Cohen-Crumpton	0051		
P. Scheirer	0052		
N. Stevens	0053		
S. Perkins	0054		
R. Scott	0055		
A. J. Averett	0056		
J. Boone	0057		
J. Schor	0058		
J. Caldwell	0059		
J. T. Lang, Ph.D.	0060	x	x
R. Addessa	0061		
A. Leary	0062		
Wicce	0063		
Dr. S. Schade	0064		
P. Jones	0065		
P. Holmlund	0066		
B. Sabo	0067		
P. Tenney	0068		
M. Tolson	0069		
H. Whitfield	0070		
D. Payne	0071		
S. De Feudis	0072		
R. Philbrick	0073		
J. Steitz	0074	x	
J. Y. Edelstein	0075		
G. Crouse	0076		
N. Littlejohn	0077		
G. Casey	0078		
C. Nohl	0079		
S. McKee	0080		
R. Pollock	0081		
G. and F. Alderson	0082		
M. Bergman	0083		
C. R. Lord	0084		
K. B. Russell	0085		
P. Menyuk	0086		
R. LoBianco	0087		
M. Griffin	0088		
M. Genin	0089		
A. Hadad	0090		
P. Popple	0091		
M. Chevalier	0092		
C. Timko	0093		
N. Schlager	0094		
Dr. J. Hodges	0095		
R. Hawkes	0096		
R. Swennes	0097		

C. Stone	0098		
P. Kugler	0099		
K. Wolfe	0100		
J. Bess	0101		
R. Lernberg	0102		
Mass Comment Campaig	0103		
G. James	0104		
B. Rendar	0105		
C. Slayman	0106		
R. Horn	0107		
V. Hood	0108		
D. Devaul-Smylie	0109		
I. Brooke	0110		
N. Davlantes	0111		
R. A. Mertz	0112		
D. Engle	0113		
R. Callen	0114		
A. Gwartney	0115		
M. Kohn	0116		
B. M. Bean	0117		
E. Oberweiser	0118		
K. Anderson	0119		
L. Spalla	0120		
J. Durfee	0121		
D. Low	0122		
M. McCarthy	0123		
G. Weber	0124		
B. Neumeyer	0125		
R. Atwood	0126		
G. Collins	0127		
S. Ross	0128		
J. Burgess	0129		
E. Doss	0130		
N. Sather	0131		
C. Dildine	0132		
E. Johnson	0133		
G. Gabriel	0134		
J. Ferner	0135		
M. Shipley	0136		
A. Ravitz	0137		
A. Winger	0138		
M. Hart	0139		
J. Benefield	0140		
W. Steele	0141		
L. D. Zafar	0142		
D. Keller-Perry	0143		
S. Brass	0144		
W. Krakauer	0145		
S. Sameshima	0146		

M. Holm	0147		
L. Cassada Jr.	0148		
C. Barker	0149		
R. Tarr	0150		
M. A. Hawxhurst	0151		
R. Dankwort	0152		
M. Perkins	0153		
D. Robertson	0154		
J. & S. Waldroop	0155		
Nancy (no surname provi	0156		
E. H. Roth	0157		
J. M. Mitchem	0158		
D. Spare	0159		
T. Crossland	0160		
J. Clark	0161		
A. J. Dectis	0162		
S. Blanton	0163		
K. Haralson	0164		
L. and E. Zablow	0165		
J. Gambardella	0166		
D. Thompson	0167		
J. Auris	0168		
G. Casey	0169		
T. C. Keymah	0170		
J. Harrington	0171		
R. Bywater	0172		
S. B. Cowgill	0173		
M. Finerty	0174		
M. Lewellen	0175		
K. Embler	0176		
S. Peters	0177		
W. R. Scott	0178		
M. Lindsey	0179		
A. Janke	0180		
J. Cresseveur	0181		
B. Koval	0182		
Anonymous	0183		
Anonymous	0184		
Anonymous	0185		
B. A. Sabo	0186		
Anonymous	0187		
S. Keach	0188		
J. E. Embry	0189		
M. Gebhardt	0190		
M. Billmaier	0191	x	x
Anonymous	0192		
L. Alfson	0193		
K. Austin	0194		
W. and C. Thwaites	0195		

L. Mazzone	0196		
D. Harralson	0197		
D. Burg	0198		
G. Ritter	0199		
D. McAllister	0200		
M. Moorehead	0201		
S. D. Salisbury	0202		
R. Gipson	0203		
H. Reid	0204		
N. Johnson	0205		
J. Mcnaughton	0206		
H. Schulze	0207		
A. Cox	0208		
Anonymous	0209		
Anonymous	0210		
Anonymous	0211		
J. McMahon	0212	x	
J. Peacock	0213		
Anonymous	0214		
C. Herman	0215		
Anonymous	0216		
D. Katz	0217		
L. Garland	0218		
R. Cooper	0219		
P. Busacca	0220	x	
Liz Garland Associate Di	0221		
C. Lish	0222		
Anonymous	0223		
Anonymous	0224		
Ed Hopkins, Director, En	0225	x	
Anonymous	0226		
S. Ibarra	0227		
J. L. Keltner	0228		
M. Dance	0229		
J. Cunningham	0230		
T. Young	0231		
B. McElfish	0232		
J. Smarr	0233		
R. Moser	0234		
S. Futrell	0235		
S. Mehrotra	0236		
R. Rieve	0237		
R. Mooney	0238		
S. Bland	0239	x	
T. Buckingham	0240		
C. DeJaco	0241		
N. Bosken	0242	x	
D. Wallwork	0243		
J. Salzman	0244		

J. Matthews	0245		
G. Miller	0246	x	
S. Salsburg	0247		
M. Osborn	0248		
M. Martin	0249	x	
B. Sowder	0250		
T. Tucker	0251		
M. Simon	0252	x	x
C. K. Fischer	0253		
K. Nussbaum	0254		
J. Zamboni	0255		
A. C. Silverman	0256		
T. Brueggemann, Shore E	0257		
G. Hilgar	0258		
L. Hothem	0259	x	
S. Terwilliger	0260		
J. Thacker	0261		
G. and D. Peters	0262		
G. Lee	0263		
S. Lannin	0264		
M. Shipley	0265	x	
M. Burke-Hueffmeier	0266		x
N. Bellak	0267	x	
E. Koncsek	0268		
S. Slavova	0269		
A. Alston	0270		
D. Cohen	0271		
L. Tesmer	0272		
S. McGinnis	0273		
E. Peach	0274		
B. Hughes	0275		
A. Mink	0276		
G. Sferra	0277		
S. Hepler	0278		
S. Dvorsky	0279		
L. Lyford	0280		
Anonymous	0281		
D. Steadham	0282		
G. Maimone	0283		
A. Moody	0284		
G. Stover, Penn Virginia	0285		
G. Holden	0286		
E. Crane	0287		
B. Hall	0288		
S. Morris	0289		
C. Bonilla-Jones	0290		
S. Bortz	0291		
C. DeBerry	0292		
C. Mullin	0293		

D. McMillan	0294		
M. Matzorkis	0295		
R. Jacobi	0296		
A. Dutt	0297		
S. Weist, Oxbow Mining	0298		
Anonymous	0299		
Anonymous	0300		
L. R Wyatt Jr	0301		
J. Keogh	0302		
C. Barkow	0303		
J. Weir	0304		
H. Hisamoto	0305		
V. Burris	0306		
A. and A. Hansen	0307		
G. Ralph	0308		
L. MacAuley	0309		
T. Behrs	0310		
C. Scanlon	0311		
Pamela	0312		
S. Lewis	0313		
Roger B. Walker	0314		
J. Potter	0315		
T.Abraham	0316		
J.Anderssen	0317		
A.Woolford	0318		
W.R. Wilson	0319		
M. Foreman	0320		
J. O'Leary	0321		
B. Mink	0322		
F. Symanoskie	0323		
K. Breeden	0324		
J. Slusher	0325		
J. Roseberry	0326		
T. L. Woolwine	0327		
Anonymous	0328		
K. Lilly, Supervisor	0329		
D. Hales	0330		
D. Elkins	0331		
Anonymous	0332		
Anonymous	0333		
B. Lawrence	0334		
J. T. Popp	0335		
J. C. Nelson, President	0336		
B. Wayne Melton	0337		
W. McCune	0338		
C. Johnson	0339		
Anonymous	0340		
Anonymous	0341		
Anonymous	0342		

D. M. Drummond on beh	0343		
Sam Broach, President	0344	x	
M. Banyai	0345		
Thornton L. Newlon, Leg	0346		
D. M. Murray and G. B. F	0347	x	x
B. C. Lambert, Deputy Di	0348		
Anonymous	0349		
Anonymous	0350		
T. Silva	0351		
T. Jones	0352		
G. Chambers	0353		
Thomas Clay	0354		
S. Bush	0355		
S. T. Piasecki	0356		
J. B. Mullins	0357		
Anonymous	0358		
D. Cercone	0359		
Anonymous	0360		
L.G. Deardorff, Associate	0361	x	
M. Wasson	0362		
B. Emery	0363		
A. G. Wolfe, Director,	0364		
E. Greer	0365		
A. Starbuck, Global Finar	0366	x	x
Mass Comment Campaig	0367		
R. Powers	0368		
D. Haught	0369		
D. Powers	0370		
Anonymous	0371		
Mr.& Mrs. M. Green, Fed	0372		
T. Bigelow	0373		
W. Dent	0374		
D. Ellis	0375		
M. Stevens, Federation fo	0376		
D. White and K. White	0377		
T. Iarossi	0378		
D. Northcut	0379		
P. Danbury	0380		
T. McEachern	0381		
M. Perez	0382		
P. Doherty	0383		
R. Fox	0384		
S. Donnelly	0385		
R. Soper	0386		
S. Finkle	0387		
B. Winholtz	0388		
A. Gibbs	0389		
D. V. Nouhuys	0390		
S. Benson	0391		

S. Amy	0392		
D. Low	0393		
B. Rich	0394		
S. Chandler	0395		
S. Holme	0396		
R. Tice	0397		
M. Bailey	0398		
J. Jordan	0399		
D. Artley	0400		
P. Disney, PE	0401	x	
M. Kalos	0402		
Anonymous	0403		
Anonymous	0404		
P. Boggs, Mark V Mining	0405		
Anonymous	0406		
Anonymous	0407		
J. Kelley	0408		
J. Kiger, Oxbow Mining	0409		
Faces of Coal, Federation	0410		
R. E. Golkosky	0411		
Anonymous	0412		
Anonymous	0413		
J. O. Roan	0414		
M. Terlizzi	0415		
D. L. Watson	0416		
V. R. Miller	0417		
L. Stiles	0418		
D. H. Miller	0419		
Federation for American	0420		
Anonymous	0421		
Anonymous	0422		
Anonymous	0423		
Anonymous	0424		
Anonymous	0425		
D. Boleneus	0426		
Anonymous	0427		
G. W. Frame	0428		
E. Miller	0429		
S. Nelson	0430		
W. Lowe	0431	x	
G. Crouse	0432		
W. McNeely	0433		
C. Brumleve	0434	x	
H. Wheeler	0435		
B. Imam	0436		
R. Russo	0437		
A. Havighorst	0438		
Anonymous	0439		
M. M. Robinson	0440		

D. Paprocki	0441	x	
J. A. Bialas	0442		
J. Grossman	0443		
L. Landon	0444		
Anonymous	0445		
J. Blaustein	0446	x	x
L. Eatenson	0447		
B. Kobernuss	0448		
C. Rowan	0449		
M. Femia	0450		
K. Winchell	0451		
S. Bannister	0452		
R. Grover	0453		
M. Merryman	0454		
W. Falk	0455		
P. Feldman	0456		
A. Blaess	0457		
L. Lambeth	0458		
N. C. Mayes	0459		
T. Gaalaas	0460		
L. Herndon	0461		
B. Sibelman	0462		
A. Dodd	0463		
Anonymous	0464		
Anonymous	0465		
G. Gadd	0466		
E. Guise	0467		
B. Winholtz	0468		
C. Smith	0469		
W. Rorick	0470		
P. La Point	0471		
V. Bergstedt	0472		
T. Sanford	0473		
G. Janzen	0474		
J. Hodges	0475		
A. Journet	0476		
K. Kruger	0477		
T. Stimpfel	0478	x	
C. Weber-Kearney	0479		
B. Newell	0480		
L. M. Baer	0481		
J. Lowe	0482		
J. Broussard	0483		
K. Russell	0484		
L. Chamberlain	0485		
C. Rodriguez	0486		
D. Eagan	0487		
N. L. Trihey	0488		
J. King	0489		

D. Esopi	0490	x	
N. Walbourn	0491		
M. Meizner	0492		
T. Spaeth	0493		
E. Sweeney	0494		
J. Perlman	0495		
M. Staples	0496	x	x
S. Adams	0497		
W. Johnston	0498		
A. Reynolds	0499		
B. Frierson	0500		
K. Buttles	0501		
J. Feldish	0502		
G. King	0503		
M. Maloney	0504		
L. Zander	0505	x	
J. Thomas	0506		
D. and S. Wright	0507		
A. Jackson	0508		
M. Schmerling	0509		
S. Chamberlain	0510		
D. Clark	0511	x	
S. McVeigh	0512	x	x
D. Pratt	0513		
K. Rothert	0514		
A. Hunt	0515	x	
C. Woodcock	0516		
R. Grover	0517		
J. Sconyers	0518		
R. C. McBeth	0519		
A. Johnson	0520		
F. Kasteel	0521		
D. Ruggiero	0522		
B. Gifford	0523	x	
M. Wood	0524		
R. Lindsey	0525		
L. Wilson	0526		
D. Henderson	0527	x	
R. Berg	0528		
D. Serra	0529	x	
E. Palfrey	0530		
K. Allen	0531		
R. Dick	0532		
A. Hollander	0533		
C. Van Houten	0534		
G. Crouse	0535		
A. Starbuck, Global Finar	0536 (same as 0366)		
C. Stoehr	0537		
E. Levin	0538		

P. Hooper	0539		
D. Ross	0540	x	
D. M. Wichar	0541		
B. Berger	0542		
H. Marsh	0543		
J. Karadi	0544		
M. Hebblewhite	0545		
L. Lewis	0546		
D. Patla	0547		
C. Kutcher	0548		
J. Higgins	0549	x	x
J. Feldman	0550		
K. McLean	0551		
L. Jobe	0552		
R. Dees	0553		
T. Lamborn	0554		
T. Tuley	0555		
K. Atkinson	0556		
J. Engle	0557	x	x
K. Rowlett	0558		
M. Winters	0559		
H. & E. Frank	0560		
J. Heiser	0561	x	
S. M. Frontczak	0562		
J. Wells	0563	x	
J. Chapman	0564		
B. Berger	0565	x	
J. Kotcon	0566		
K. Koh	0567		
E. M. Leite	0568		
A. Gilbertson	0569		
J. L. MacIsssac	0570		
K. Shaffer	0571		
D. Edwards Jr.	0572		
K. Dodson	0573		
S. Fast	0574	x	
S. Napps	0575		
J. Sommer	0576		
W. Koch	0577		
A. Cardea	0578		
M. Allen	0579		
A. Potocki	0580	x	
C. W. Troxler	0581		
S. Kapral	0582		
S. Kepner	0583		
E. Graves	0584		
P. Steinhart	0585		
D. Cake	0586	x	
D. Nygaard	0587		

D. Dickson	0588		
Anonymous	0589		
B. Gardner	0590		
J.P. Jones, Director of En	0591	x	x
B. Winholtz	0592		
D. Jaffe	0593		
B. Moore	0594	x	
H. Carr	0595		
A. Tate	0596	x	x
N. West	0597		
L. Olson	0598		
Mass Comment Campaig	0599		
Mass Comment Campaig	0600	x	
Mass Comment Campaig	0601		
Mass Comment Campaig	0602	x	
Mass Comment Campaig	0603	x	
L. East	0604		
G. Adams	0605		
E. Moon	0606		
K. Kukovich	0607		
C. A. Kidder	0608		
F. P. Andes, Coordinator,	0609		
J. C. Chaves, Attorney	0610	x	x
K. C. Bennett, Vice Presi	0611		
J. W. Myers, Director, En	0612		
M. A. Palmer, E. S. Bernl	0613	x	x
R. C. Huffman, Cabinet S	0614		
K. Mazik	0615		
T. Young	0616	x	
L. Freese	0617		
J. Massey	0618		
K. and G. Selvage et al.	0619	x	
L. Yow	0620		
M. Fox	0621		
M. Wanda	0622		
E. P. Godfrey	0623	x	x
V. Watson	0624		
G. Garrison	0625		
G. Spates	0626		
T. Masanz	0627		
U. Schuler	0628		
T. Withrow	0629		
T. Buckingham	0630		
C. Besse	0631	x	x
K. Larken	0632	x	
V. L. Hall	0633		
G. Bone	0634		
J. and M. Payne	0635		
C. Taylor	0636		

D. McNeill	0637		
Debbie (no last name)	0638		
T. Bennett	0639		
C. Bretheim	0640		
C. Lauderdale	0641		x
C. Wulf	0642		
P. Taylor	0643		
C. Lamm	0644		
M. Matthews	0645		
P. Crouser	0646		
H. Case	0647		
C. L. Moore	0648	x	x
P. Moriarty	0649		
J. A. Keith	0650	x	
S. Hollingsworth	0651		
J. Talkington	0652		
H. Ayers	0653	x	
S. B. Cowgill	0654		
K. Fleming	0655		
C. Calhoun	0656		
R. Wheeler	0657	x	
M. T. Call	0658	x	
E. Potter	0659		
E. Rainwater	0660	x	
F. Otto	0661		
K. Cole	0662		
S. Boyce	0663		
L. Cavanagh	0664		
J. Brannon	0665		
A. Yasuhara	0666	x	
M. H. Sullivan	0667		
C. Polk	0668		
R. Riani	0669		
J. Wozniak	0670		
G. Clearwater	0671		
G. Fields	0672	x	
M. Ulmer	0673		
K. Abbott	0674	x	
W. Canu	0675		
R. Hammond	0676		
N. Littlejohn	0677		
M. Smith	0678		
P. Yahr	0679		
B. (no last name)	0680		
C. Paynter	0681		
J. Dowling	0682		
D. May	0683		
L. Ackison	0684		
J. K. Adams	0685		

S. Benson	0686		
M. Butler	0687		
J. McDowell	0688		
J. Giglio	0689		
L. C. Shader	0690		
A. Shoredits	0691		
B. Benson	0692		
M. Stapleton	0693		
S. Brown	0694		
W. R. Taylor, Director, O	0695		
L. Gagnon	0696		
J. E. Melton	0697		
D. Hornor	0698		
J. Stone-Erdman	0699		
E. Dudley	0700		
J. Cafaro	0701		
T. Hagood	0702		
D. Artley	0703		
E. Mitchell	0704		
M. Hayslip	0705		
A. Mitchell	0706		
S. Woodward	0707		
M. Luce	0708		
E. Vaughan	0709		
A. Drye	0710		
J. Leidecker	0711		
B. Smith	0712		
J. Helm	0713		
G. Artzner	0714		
R. Holmes	0715		
F. Cappuccio	0716		
J. Califf	0717		
J. Deal	0718		
A. Van Thoen	0719		
D. Taulbee	0720		
C. Twigg	0721		
B. Jennings	0722		
K. Davis	0723		
L. Roberts-Raade	0724		
R. W. Cessna	0725		
L. Hixon	0726		
D. R. Nelson	0727		
R. Damron	0728	x	
M. Mayes	0729	x	
J. Powers	0730		
E. Roberts	0731		
C. Greene	0732		
J. Sanders	0733		
C. Hoveland	0734		

R. Fox	0735		
C. Gilliam	0736	x	
E. George	0737		
S. Jackson	0738		
C. Shoolman	0739		
W. Tuttle	0740		
R. Hartsock	0741		
N. DeLoretto-Chudy	0742		
E. Roth	0743		
J. Auxier	0744	x	
N. Myers	0745		
C. Hill	0746		
M. Landis	0747		
J. Dudley	0748		
P. Walsh	0749		
W. Zipp	0750		
C. Dobner	0751		
M. McClure	0752		
T. Brown	0753		
E. Pile	0754		
R. Herrmann	0755		
R. Nickerson	0756		
R. Stambaugh	0757		
M. Gambrel	0758		
L. Stopper	0759		
M. Wildfire	0760		
R. Akers	0761		
W. Combs	0762		
E. Dixon	0763		
A. Smith	0764		
R. H. Hunt	0765		
M. Geck	0766		
J. Butler	0767		
B. Ashley	0768		
D. Weintraub	0769		
N. Givens	0770		
G. Pentecost	0771		
L. Sturm	0772		
N. T. Gibson	0773		
R. Blakeman	0774		
L. B. Sutton, Program An	0775		
N. Reinhart, Kentuckians	0776	x	
J. Busch	0777		
D. Mock	0778		
J. Harwood	0779		
D. Doerrfeld	0780		
B. Okey	0781		
V. Reynolds	0782	x	
L. L. Register	0783		

M. V. Ryzin	0784		
A. Jones	0785		
A. Hogg, Kentuckians Fo	0786		
R. Handshoe	0787		
M. Stelzer	0788		
S. Cude	0789		
B. May	0790		
J. Honeycutt	0791		
J. S. Johnston	0792		
L. Ridenour	0793		
C. Curry	0794		
J. Hardt	0795		
Kevin Pentz, Organizer a	0796	x	
W. McMullin	0797		
Mass Comment Campaig	0798	x	
Willie R. Taylor, Directo	0799 (same as 0695)		

	II. Federal authority to regulate these activities (generally)		
			a. Scientific validity of mater
b. Public participation in the regulatory process	a. Relationship of Clean Water Act, NEPA, and the Executive Order on Environmental Justice to SMCRA	b. Authority, roles, and responsibility of federal and state agencies	i. EPA Office of Research and Development reports
		x	
		x	
x	x	x	x
x	x	x	x
x	x	x	x
		x	x

		x	

		x	
		x	

		x	

		x	
		x	
		x	

	x		
		x	

		x	
		x	

x	x	x	x
			x
x		x	
			x
			x
		x	x
		x	
	x	x	x
			x

		x	
		x	
		x	

		x	
		x	
x			
		x	
		x	

			x
		x	
x		x	x
		x	
		x	
		x	
		x	
	x	x	
			x
x	x	x	x
x			
			x
x	x	x	
		x	
	x	x	

		x	
		x	

x	x	x	
		x	
x			

x			
x			x
		x	

		x	x

III. Science regarding environmental impacts from surface coal mining in Appalachia			
rial referenced in Guidance	b. Scientific materials not reviewed/referenced by Guidance		c. Suitability of ecoregion use in Guidance
ii. Pond/ Passmore study	i. Additional scientific data supportive of recommendations in Guidance	ii. Additional scientific data not supportive of recommendations in Guidance	
x			x

	x		
		x	
x			x
x		x	x
x	x		
x			

	x		

x		x	x
	x		
x			
x	x		
		x	
	x	x	
x	x	x	x

	x		

	x	x	

		IV. Conductivity		
d. Scientific & technical recommendations for project review & monitoring	e. Insufficient scientific evidence	a. Suitability of specific conductance as a benchmark	b. Use of constituent ions instead of conductivity	c. Use of pollutants other than conductivity or constituent ions
		x		
	x			
		x		
	x		x	
x	x	x		
		x	x	

	x			

		x	x	
		x		

		x		

	x			

x				
		x		
		x		

		x		
	x	x		
		x		
	x	x		x
	x	x		
	x	x	x	
	x	x		

	x			
		x		

		x		

		x		
		x		

		x		
		x		

x	x	x	x	x
	x			
	x	x		
	x	x		
	x	x		
		x	x	x
		x		
		x		
		x		
	x	x		
	x	x		x
		x		
		x		
		x		
		x		
		x		

		x		
		x		
		x		
		x		
		x		
		x		
		x		

	x	x		
	x			

		x		
		x		

V. NPDES oversight and review					
a. Federal authority to regulate these activities under 402	b. Application of reasonable potential analysis	c. Incorporation of numeric standards in NPDES permit	d. Monitoring and reporting requirements	e. Compliance schedules	f. Narrative standards
x					
	x	x	x	x	x
x		x			x
		x			x

		x			x
		x			x

		x			x
		x			x

		x			

		x			x

		x			

		x			x
x					
		x			x
	x		x		x
x					

		x			

					x
x	x	x			x
x		x			
x	x	x			x

		x			x

g. Antidegradation	h. Recommended changes in Guidance relating to CWA 402	a. Federal roles of EPA, Corps, and OSM in evaluating CWA 404 applications	b. Independent evaluation of water quality under CWA 404	c. Mine Design
				i. Best Management Practices
		x		
		x		
		x	x	

		x		
		x		

		x		

	x			

	x			

x				
	x			x
	x	x		
		x		

		x	x	
	x	x	x	

			x	

VI. Clean Water Act Section 404				
		d. Relationship of water quality to significant degradation under 230.10(c)	e. Compensatory mitigation under CWA 404	
ii. Sequencing valley fills	iii. Material handling and upland disposal		i. Suitability of stream creation	ii. Ability of mitigation to compensate for water quality impacts
x				
x			x	x

	x			
x				

x				x
x			x	

			x	x

x				x
				x

			x	

x				
x				x
x		x	x	
x				
			x	

	x			

x				
	x			

				x
x		x	x	
x		x	x	
x			x	
x		x	x	x
x			x	x
				x
x				x

	x			
	x			

x				

			VII. Clean Water Act Section 401	VIII. Na
f. Monitoring and reporting requirements	g. Cumulative impact analysis under CWA 404	h. Recommended changes in Guidance relating to CWA 404	a. Recommended changes in Guidance relating to CWA 401	a. Cumulative impact analysis under NEPA
x				
		x		
			x	

		x		

		x		
			x	
		x		

	x			

		x		
		x		

		x		

		x	x	
	x	x		
		x		
	x			

x				
x				
x	x			x
	x			
				x
				x

		x		

tional Environmental Policy Act		IX. Environmental Justice		
b. Need to prepare environmental impact statements	c. Recommended changes in Guidance relative to NEPA	a. Characterization of EJ communities in Appalachia	b. Adverse health effects as a result of mining activity	c. Adverse impacts to private and public water supply systems
			x	x
		x		
		x	x	
x		x		
		x		
		x		x

				x

				x
		x		

x		x		x
			x	x

			x	x
				x
				x

			x	
		x	x	
			x	x
			x	
			x	
			x	
				x
				x
			x	x

		x		
		x		
		x		
	x	x	x	
x		x	x	
			x	

				x
		x		
			x	

		x		
			x	

				x
			x	x
			x	
			x	

			x	x
			x	
			x	
			x	

				x
				x
			x	
			x	x
			x	
		x	x	x
x				
			x	
			x	x
			x	
			x	x

				x
			x	
		x	x	x
			x	
				x
			x	x
				x
				x

				x
				x
			x	
				x
				x
				x

		x	x	x
				x
				x
				x
				x
				x
			x	x
			x	x
		x	x	

				x
			x	
			x	
				x
				x

	X. Economic Considerations					
d. Recommended changes in Guidance relating to EJ	a. Jobs lost	b. Impacts to national economy	c. Impacts to state economy	d. impacts to local/county economy	e. General	a. General support for the Guidance (including where revisions are identified)
	x					x
						x
						x
	x				x	
		x				
	x		x		x	x
x	x	x			x	x
	x			x	x	
	x			x	x	
						x
						x
						x
						x
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XI. Overall Comments		
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I. Background/Basis for Guidance

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners will issue permits for these activities that will prevent harm to public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from affected communities are taken into consideration.

The Background/Basis for Guidance issue includes those comments, recommendations, and opinions, submitted by stakeholders regarding the basis for EPA's decision making in implementing this Guidance. This includes environmental impacts on watersheds, ecosystems, and regional wildlife, and public participation in the regulatory process.

There were a total of 91 tallied comments discussing the Background/Basis for Guidance issue. This issue received several comments from many of the commenter categories. Federal, state, and local governments or elected officials, industry representatives, environmental and other Non-Governmental Organizations (NGOs), congressional delegates, private citizens, mass mailer campaigns, and comment letters of unknown or unspecified origin provided comments on the environmental impacts of Appalachian coal mining. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 1-1 on Page 2 presents the total comment letters by commenter category that address the Background/Basis for Guidance issue.

Most comments in support of the Guidance on this issue area focus on the destructive nature of surface mining operations on the watershed and ecosystem, and the broader, long-term harm to the health of aquatic life within the impacted streams. Comments in opposition to the Guidance focus on the need for public participation and potentially rulemaking.

Federal, state, and local governments or elected officials, congressional delegates, and industry commenters focus on the aspect of public participation with regard to the issuance of the Guidance, generally stating that there was not sufficient public participation in the process, and they thereby challenge the overall validity of the Guidance. One state government agency, the Commonwealth of Kentucky Energy and Environment Cabinet, is generally supportive of the Guidance, but seeks clarification on its implementation through a series of questions.

Environmental and other NGOS, and most of the general public and mass mailing campaigns, focus their comments on the negative impacts of mountaintop mining to watersheds, ecosystems, and Appalachian wildlife, with a few commenters recommending that EPA further strengthen the Guidance, and/or further protect streams through rulemaking.

Below are summaries, presented by commenter category, on the Background/Basis for Guidance issue. Under each commenter category all sub-issues commented on are listed by letter (based

on the issue outline) and discussed. Not all commenter categories discussed all sub-issues; therefore, not all sub-issues are listed under each commenter category.

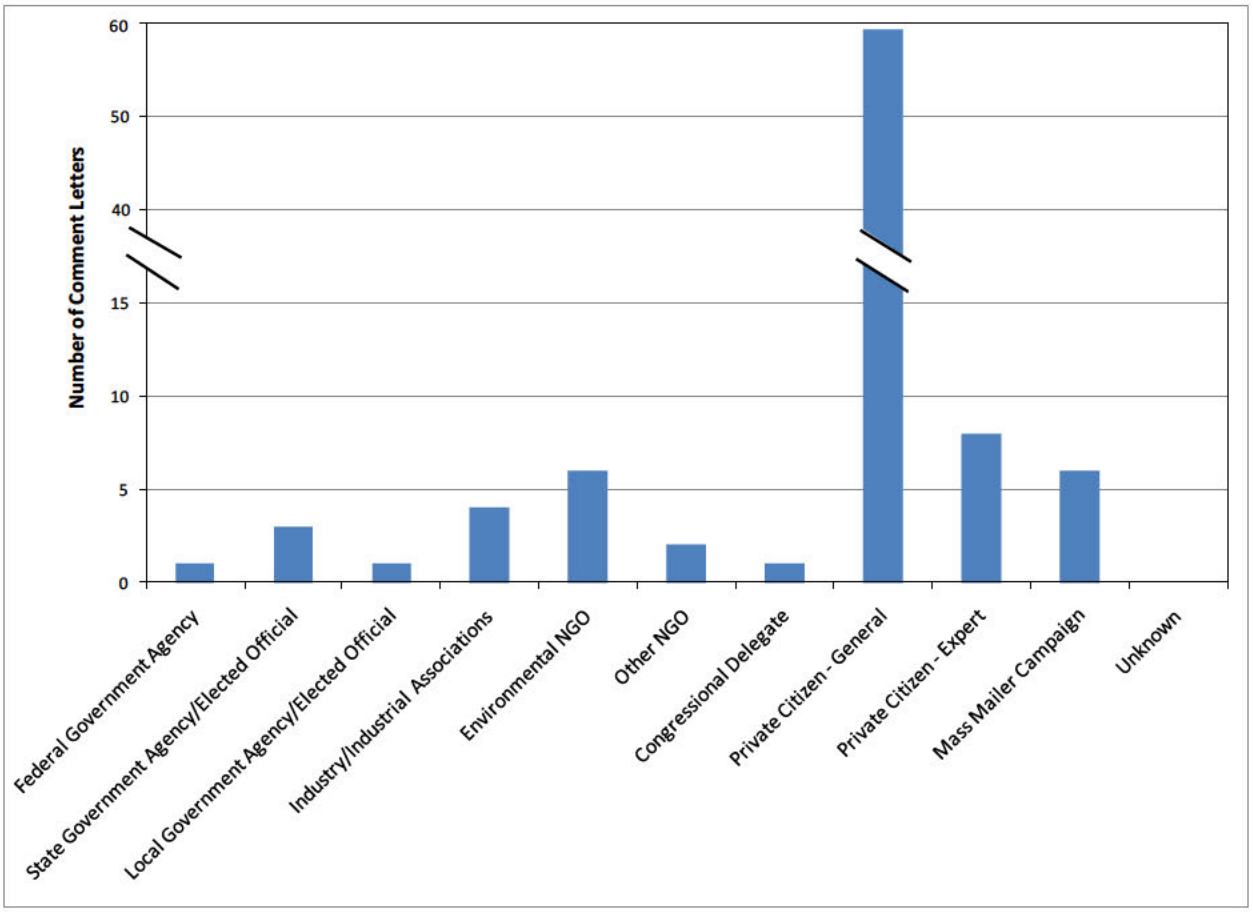

Figure 1-1. Background/Basis for Guidance, Total Comment Letters by Commenter Category

1. Federal Government Agencies

The United States Department of the Interior (DOI) was the only federal agency to submit comments regarding the Guidance. While three documents were submitted by the DOI, two are identical (Doc. #0695 and 0799), and the third document (Doc. #0775) is a placeholder alerting the docket of forthcoming comments. While generally supportive of the Guidance, the DOI comments focus on the process and lack of opportunity for public comment.

b. Public Participation in the Regulatory Process

The DOI expresses some reservations regarding the process by which the Guidance was issued, noting that it "took effect immediately upon publication without an opportunity for public notice and comment" (Doc. #0695; p. 2). The DOI asserts that the Guidance document "should have been issued through a process similar to the requirements of the Administrative Procedure Act" particularly since "its requirements read more like a rule than guidance" (p. 2).

2. STATE GOVERNMENT AGENCIES AND ELECTED OFFICIALS

Three state government agencies submitted comments to the docket: The Commonwealth of Kentucky Energy and Environment Cabinet (Doc. #0012), the Commonwealth of Virginia Department of Mines, Minerals and Energy (DMME; Doc. #0348.1), and the West Virginia Department of Environmental Protection (WVDEP; Doc. #s 0614.1 and 0614.2). Each commented on EPA's Background/Basis for Guidance. Specifically, they express concern over the public participation in the regulatory process, with both the DMME and the WWVDEP challenging the legality of the Guidance, while expressing general lack of support. On the other hand, Kentucky appears to be generally in support of the Guidance, but is requesting additional information related to its objectives and more details on its implementation, by presenting a list of questions and requests for clarification. Kentucky requests "that these inquiries be responded to expeditiously in writing given the CWA § 402 surface coal mining permit applications pending before the Commonwealth, and those that we continue to receive daily" (p. 1).

b. Public Participation in the Regulatory Process

Both the Virginia DMME (Doc. #0348.1) and the WVDEP (Doc. #s 0614.1 and 0614.2) challenge the validity of the Guidance in part because of the process through which it was issued.

WVDEP (Doc. # 0614.1) also objects to the issuance of the Guidance in part because "Neither the State of West Virginia nor WVDEP was consulted about the Detailed Guidance or the standards announced therein," despite the fact that the Guidance was issued to the EPA Regional Administrators "whose jurisdictions include six Appalachian states (including West Virginia)" (p. 1). Similarly, WVDEP contends that such changes in policy "can be implemented only after following the process for doing so – promulgation of rules, adoption of legislation or otherwise – that assures there is the transparency that accompanies public involvement in these processes." WVDEP further states that EPA has "promulgated" the Guidance "without the benefit of these processes or the transparency and legitimacy they bring" (p. 2).

Further in their comment letter, WVDEP takes an even stronger stance, by stating that EPA's issuance of the Guidance constitutes a violation of Section 553 of the federal Administrative Procedure Act (APA), equating the "substantive revisions to applicable regulations" as presented in the Guidance to federal rulemaking (p. 7). Likewise, DMME (Doc. #0348.1) asserts that because the Guidance "establishes new regulatory standards for coal mine water discharge permitting," that these standards cannot be established "through an administratively issued guidance document, but must be promulgated under the federal Administrative Procedures Act to be effective" (p. 1).

Kentucky takes a slightly different approach by posing the following questions related to the issue of public participation in the regulatory process in their comment letter (Doc. #0012, p. 3):
"3. Please explain EPA's decision to make this interim final guidance effective immediately given that: (1) comment is being sought on the guidance which could change its final content, (2) the Science Advisory Board (SAB) process has not been completed;" and
"4. When will the SAB process begin and end, and will states be afforded an opportunity to provide comment and input on that process?"

3. LOCAL GOVERNMENT AGENCIES AND ELECTED OFFICIALS

Only one letter was posted by the docket from a local government agency or elected official, a city councilman from St. Charles, Kentucky (Doc. #0728). As a local government official, as well as a coal miner and electrical engineer, this individual writes to oppose the new water quality guidelines within the Guidance, and comments upon the background and basis for the Guidance as well as its economic implications.

a. Environmental Impact of Appalachian Coal Mining

Speaking to the environmental impact of Appalachian coal mining, the city councilman feels that the Guidance is overreaching in its environmental goals. He notes that "Our water and air are fine now," and that current laws and regulations are sufficient to protect these resources, although seemingly acknowledging that the local laws "just need to be enforced uniformly" (Doc. #0728).

b. Public Participation in the Regulatory Process

Regarding the public participation in the regulatory process, the Kentucky city councilman urges the withdrawal of the Guidance, and recommends that EPA "process pending permit applications under existing rules and regulations while seeking comment from the public on the proposed changes through the formal rulemaking process" (Doc. #0728).

4. INDUSTRY

Twelve comment letters were submitted by representatives of the coal mining industry, and in general are not supportive of the Guidance. Of these 12 letters, five almost identical letters were submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients. The bodies of all five letters are identical, except for the name of the represented clients: Gorman Company, LLC (Doc. #0013); Kentucky Union Company (Doc. #0014); Black Gold Sales, Inc. (Doc. #0016); Hazard Coal Corporation (Doc. #0017); and Kycoga Company, LLC (Doc. #0018). These letters were only summarized once.

In addition to the Frost Brown Todd letter, three other comments were received from industry representatives, namely the Virginia Coal Association (Doc. #0346), the National Mining Association (Doc. #0611), and the Tennessee Valley Authority (Doc. #0612), a federally-owned corporation. These comments are related to public participation in the regulatory process.

b. Public Participation in the Regulatory Process

Frost Brown Todd generally contend that the Guidance has been instituted unlawfully without meeting requirements related to public participation in the regulatory process, by not including a public notice, and without providing the requisite comment period prior to making the Guidance effective. The Virginia Coal Association and Tennessee Valley Authority echo the need for additional public participation.

Specifically, Frost Brown Todd request: "EPA immediately withdraw the April 1 Guidance Memorandum; instruct all relevant state and federal agencies and EPA regions that the requirements of the Guidance are not to be implemented or applied under any circumstances until further notice; and not adopt any further requirements without the benefit of a full and fair public process, based upon input from all interested stakeholders, and in compliance with the requirements of notice-and-comment rulemaking" (p. 2). They also argue: "Because EPA clearly intends to enforce the Guidance as legally binding, and because it did not subject those requirements to notice-and-comment rulemaking prior to their implementation, that implementation is clearly unlawful" (p. 3).

Frost Brown Todd also express concern regarding permits approved under the interim Guidance prior to issuance of the final Guidance. They feel that these permits "are likely to be based upon requirements in the 'interim' Guidance that may prove to be unnecessarily stringent, scientifically invalid, or otherwise legally unnecessary or inappropriate based upon relevant law" (p. 4). Should the Guidance change after the public comment process, Frost Brown Todd express concern about impacts on "permits issued in the interim" (p. 4).

Frost Brown Todd feel the Guidance needs improvement and challenge its validity in that it "suffers from numerous inconsistencies and inaccuracies that threaten to create confusion and uncertainty for the mining industry, regulators, and the larger regulated community. These problems are symptoms of the EPA's rush to issue and implement this Guidance without a thoughtful and thorough public and agency comment period" (p. 7).

Finally, Frost Brown Todd disagree with EPA setting a new benchmark for conductivity prior to receiving comments from the Science Advisory Board (SAB): "…EPA's new 'benchmark' for conductivity has not yet been peer reviewed or subjected to public, agency, or scientific comment" (p. 9).

The Virginia Coal Association also argues for additional public review by stating: "The procedures in the Detailed Guidance were adopted without prior public review and EPA provides no record of having submitted the procedures for review by CEQ" (p. 2).

The National Mining Association also commented on the lack of adequacy of the public review process (p. 2), stating: "If EPA wishes for statutory changes, it must go to the Office of Management and Budget, develop an Administrative legislative proposal, and submit that proposal to Congress. If EPA wishes for regulatory changes, it must go through notice and comment rulemaking." They also add: "EPA has not gone through notice and comment rulemaking to establish numeric Federal standards for conductivity for the Appalachian States" (p. 5).

5. Environmental Non-Governmental Organizations (NGOs)

Six letters submitted by the following environmental NGOs commented on EPA's Background/ Basis for Guidance:

- The Sierra Club (Doc. #0225.1);
- Southern Appalachian Mountain Stewards (Doc. #0344);
- The Southern Environmental Law Center on behalf of the National Parks Conservation Association (Doc. #0347.1);
- American Rivers et al.: one common comment submitted collectively by a number of environmental and other NGOs including American Rivers, Caretakers of God's Creation, Center for Biological Diversity, Citizens Against Longwall Mining, Citizens Coal Council, Clean Water Action, Coal River Mountain Watch, Concerned Citizens of Giles County, Defenders of Wildlife, Earthjustice, Eco-Justice Collaborative, Friends of the Earth, Global Community Monitor, Greenpeace, Kentucky Resources Council, Maryknoll Office for Global Concerns, Mountain Watershed Association, Natural Resources Defense Council, No Biomass Burn, Ohio Valley Environmental Coalition, Public Citizen, Rainforest Action Network, Sierra Club, United Methodist Women, University of KwaZulu-Natal Centre for Civil Society Environmental Justice Project, Waterkeeper Alliance, and West Virginia Highlands Conservancy (Doc. # 0361.1);
- Rainforest Action Network (Doc. #0366); and
- Earthjustice et al.: one common comment submitted collectively by a number of environmental and other NGOs including Earthjustice, Ohio Valley Environmental Coalition, West Virginia Highlands Conservancy, Public Justice, Sierra Club, Coal River Mountain Watch, and Appalachian Center for the Economy and Environment (Doc. #0610.1).

These six letters are in general support of the Guidance and comment on the negative environmental impacts of coal mining on Appalachian watersheds, ecosystems, and wildlife.

a. Environmental Impact of Appalachian Coal Mining

Most environmental NGO comments make a direct connection between mountaintop mining activities and negative impacts to watersheds, streams, and wildlife. Some comments are general, while others are specific to certain impacted watersheds and streams.

The Sierra Club (Doc. #0225.1) describes surface mining in Appalachia as a destructive activity, "devastating a biodiversity hotspot, burying some 2,000 miles of streams, wiping out aquatic habitat in downstream waters, and threatening communities with increased flooding, polluted water sources, and increased health risks." This sentiment of destruction is echoed by most other environmental NGO comment letters. For example, Earthjustice et al. (Doc. #0610.1) qualify impacts from mountaintop removal mining and valley fills as "serious and devastating" for "environmental, human, and wildlife values in the Appalachian coal mining region" (p. 1).

Many environmental NGOs place an emphasis on the negative impacts to streams, particularly headwater streams and their ecosystems. Rainforest Action Network (Doc. #0366) cites the proposed determination on Spruce No. 1 surface mine to discuss adverse impacts of mountaintop mining and the "importance of headwater streams and their contribution to the overall health of the watershed and to wildlife living in the watershed" (p. 3). Another example is from American Rivers et al. (Doc. #0361.1) making a connection between losses of stream and "much broader

dangers to the ecosystems and people who depend on them" and assess that over "2,000 miles of streams have already been polluted or destroyed."

The National Parks Conservation Association (Doc. #0347.1) highlights negative impacts from surface mining to particular streams and watersheds, including the Big South Fork National River and Recreation Area (p. 1) with its federally endangered fish and mussel species, and the Black Warrior River watershed in Alabama with many streams impaired by "sediment laden with heavy metal" (p. 1).

The Southern Appalachian Mountain Stewards (Doc. #0344) do not provide details about the negative impacts but support EPA's actions in that they "brought some hope back to [them] by showing concern regarding protection of our mountains and watersheds" (p. 1).

6. Other Non-Governmental Organizations (NGOs)

Two letters received from the following other NGOs commented on EPA's Background/Basis for Guidance:

- Kentuckians for the Commonwealth (KFTC); and
- Alpha Natural Resources.

The KFTC letter (Doc. #0796) is in general agreement with the Guidance, while the letter from Alpha Natural Resources (Doc. #0591 and attachments) is not in support of the Guidance.

a. Environmental Impact of Appalachian Coal Mining

The KFTC letter comments on the negative impact mining operations have on stream quality. They feel the Guidance is "a necessary first step for stopping and reversing this accumulated poisoning of our streams" (p. 1) and feel the Guidance will both prevent additional stream degradation and allow for improved stream quality.

Alpha Natural Resources is in general disagreement with the Guidance, claiming it is based on biased and incomplete science. They suggest that the impact of mining on stream function, particularly headwater streams, is similar to the impacts created by urbanization and/or agriculture. The letter states: "EPA's study assumes that a MTM-VF, if present, is the sole causal factor affecting water quality and aquatic characteristics of the site, but such is certainly not universally true" (p. 9). Alpha Natural Resources mentions a study (Armstead et al., 2004) that concludes, "neither the changes in the biological community, nor changes in the water chemistry in the filled sites, appear to have significant adverse impacts on the stream function with respect to downstream segments" (p. 19). The letter claims this study is not acknowledged by EPA.

Alpha Natural Resources also claims that EPA has incorrectly identified the coalfield region as having a high degree of biodiversity and argue that the areas to the east and southeast of the coalfields, in the valley and ridge terrain, provide habitats for the greatest number of species.

They further point out reclaimed mine sites also offer a "diverse edge habitat most capable of supporting a rich and diverse wildlife population" (p. 18).

7. CONGRESSIONAL DELEGATES

Two comment letters were submitted by congressional delegates. Both letters are signed by several members of Congress, are in general opposition to the Guidance, but only one letter addresses the issue of Background/Basis for Guidance. The letter (Doc. #0015) is signed by 23 congressional delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming. The letter argues that the Guidance should be subject to formal rulemaking, including the need for public participation.

b. Public Participation in the Regulatory Process

The Congressional commenters express their opinion that the Guidance will have substantial regulatory impacts and will "impose additional regulatory barriers to the issuance of coal mining permits in Central Appalachia" (p. 1). The commenters therefore recommend that EPA issue the Guidance through a formal rulemaking process including a public comment and peer review prior to making the Guidance effective. The commenters also state: "We believe these proposals should be subject to public comment … so as to strike a better balance between environmental protections and responsible governance" (p. 1). They also contend that "… substantive changes [to the CWA] should not be implemented absent extensive public participation and outside peer review" (p. 1).

8. PRIVATE CITIZEN – GENERAL

Two hundred and fifty seven comment letters were posted by the docket from members of the general public; of those, 59 commented on the issue area of Background/Basis for Guidance. Of those that commented on this issue area, all but three generally support the Guidance.

a. Environmental Impact of Appalachian Coal Mining

The opinion of many of the general private citizen letters is that the Appalachian watersheds, and in particular the streams and headwaters, have been destroyed by surface coal mining, having a negative effect on the watersheds and surrounding ecosystem. Several commenters in support of the Guidance comment on the impacts of mining on Appalachian wildlife. There is a general sentiment that coal mining is adversely impacting and destroying Appalachian wildlife, as well as its diverse ecosystem.

Regarding impacts to watersheds, many of the comment letters submitted by private citizens, although dissimilar in overall form, include the following same opinions; more protection is needed to preserve the waters of Appalachia, and to do otherwise would cause permanent damage to the area. For instance, one comment (Doc. # 0259) states that guidelines are "needed to reduce or better yet eliminate burying and poisoning of streams in Appalachia."

Another comment letter (Doc. # 0267) states: "Scientific research tells us that ecological harm to streams caused by coal mining also endangers human health, therefore EPA should ensure that the final guidance recognizes the need to protect public health and preserve waterways…as a top priority." A comment letter in support of the Guidance (Doc. #0009) states: "Thank you for setting this new policy and recognizing the negative impacts mountaintop removal has had on waterways and communities."

One comment letter (Doc. #0515) states: "Mountain removal changes the weather patterns, biodiversity, topography, and potential for tourism income in some of the most ruggedly beautiful and remote portions of our state, all for the negative."

The opinion of another commenter (Doc. #0060) is that: "Mountaintop removal mining is a travesty against nature that is destroying some of the most biologically diverse areas of North America and 'restoring' these lands with eroding grass at best."

Contrary to the general opinions expressed by this commenter category, is the opinion from one commenter opposed to the Guidance (Doc. #0249). This commenter expresses the opinion that the basis for at least part of the Guidance is not supported by facts: "Lobbyists will tell you that scientific research suggests that one valley fill is too many, because of the unique headwater streams filled are lost forever (…) This is not supported by facts."

Regarding impacts to wildlife, one comment letter (Doc. #0191) states: "Mountaintop removal mining is an extremely destructive practice that threatens and often destroys aquatic life, wild life, and communities." Another commenter (Doc. #0496) claims "surface coal mining in Appalachia is killing and poisoning wildlife and destroying water supplies for human communities."

b. Public Participation in Regulatory Process

Three letters comment on public participation in the regulatory process. One of them (Doc. #0566) supports the Guidance, and notes: "Current West Virginia permitting procedures are so obscure that most residents are not able to effectively participate to assure that their voices are heard. At many recent 'hearings' by WV-DEP, agency mining staff refuse to answer questions or provide relevant information, claiming that the hearing is solely for the public to speak."

The other two letters are in opposition to the Guidance and request that EPA "process pending permit applications under existing rules and regulations while seeking comment from the public on the proposed changes through the formal rulemaking process" (e.g., Doc. #0752).

9. PRIVATE CITIZEN – EXPERT

Eleven comment letters were received from private citizen experts; eight of these letters commented on the issue area of Background/Basis for Guidance. Of those, all but one (Doc. #0401) generally support the Guidance, and comment on environmental impacts of Appalachian coal mining.

a. Environmental Impact of Appalachian Coal Mining

Overall, the general opinion of those in support of the Guidance is that the practice of surface coal mining is causing great harm to the watersheds, ecosystems, and Appalachian wildlife.

Three stream ecologists with expertise in aquatic ecology (Doc. #0613.1, p. 1) are of the opinion that surface coal mining has measurable and irreversible negative impacts on ecosystems within affected watersheds. Specifically, they state: "There is now abundant scientific evidence from studies conducted by both EPA scientists and by independent scientists that the environmental impacts of surface coal mining in the Appalachian region cause serious and irreversible harm to aquatic ecosystems. The risks to aquatic systems come not only from direct loss of habitats and species due to the mining process and valley fills but there are substantial risks to aquatic life that extend downstream from mine sites."

In an attachment to their letter, the stream ecologists present the following scientific publication, titled, "*How many mountains can we mine? Ecological thresholds for freshwater ecosystems of the Central Appalachians* (Bernhardt et al. in review)." This publication (written by the commenters) presents findings and analyses of conditions found in watersheds downstream from mining operations, and supports the commenters' theory that surface coal mining has measureable negative effects on the downstream aquatic ecosystems.

Other commenters share similar opinions about the effects of mining on watersheds. Two of the commenters that share this opinon have backgrounds in geology, one of whom is a geologist-hydrologist with a PhD. The PhD commenter (Doc. #0729) states: "You can't simply fill in valleys and remove mountains, without creating disastrous floods and downstream contamination" (p. 1); while the other geologist (Doc. #0744) points out the pollution to the watershed caused by leachate from the debris piles created by mine operations: "MTR operators blast formerly impermeable or semi-permeable layers of limestone and sandstone and shale and then pile all that material back up." The geologist also comments on pollutant leaching: "Acidic natural rainwater then gets into the now separated rock and leaches minerals and heavy metals out of the rock."

Echoing these sentiments, a retired technical writer and editor with experience working on regulatory documentation for contaminated sites (Doc. #0660) states: "When overlaying rock on the coal seams is exploded into small pieces, its natural minimal toxicity increases many fold due to increase in surface area through and over which surface water runs, as it becomes our headwater streams and runs into our precious rivers."

Another supportive point of view on this issue area comes from an ecologist that teaches stream and wetland ecology to high school students in Georgia. His comments (Doc. #0596) focus on the impact of surface coal mining on biodiversity in the ecosystem: "The loss of natural communities on the mountaintop, headwater streams, riparian plant and animal species and the impacts on downstream aquatic systems is a significant step toward destroying the ecosystems that sustain us all with their free services." In general, this commenter expresses concern for both the stream and terrestrial ecosystem communities that in his opinion are destroyed by mountaintop removal practices and points out that "… destroying these communities wholesale

is a devastating blow to efforts of society to stop biodiversity loss and help recover species in decline while they still exist" (p. 1).

Contrary to the general opinions from this commenter category is the opinion of a professional engineer who works in the coal and coal combustion by-products field and is opposed to the Guidance (Doc. #0401). This commenter states: "The evidence of adverse effects to the environment is not substantiated by the record" (p. 2). The commenter references personal experiences growing up in Kentucky and states that due to the requirements of the clean air act, "The fact remains that the coal industry is safer than ever and the air in Kentucky is cleaner than at any time in my life" (p. 2). In general, the commenter focuses on the impacts of coal mining as an air quality issue in the environment rather than a water quality issue.

10. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "modified mass mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. The docket identified a total of nine mass mailing campaigns, with seven campaigns in support of the Guidance, and two campaigns in opposition to the Guidance. Four of the seven campaigns in support of the Guidance (Doc. #0022 sponsored by Earthjustice, and Doc. #s 0600, 0602, and 0603, sponsored by unknown organizations) address the same issues, and exhibit very similar wording.

Of the nine campaigns, six comment on the issue of Background/Basis for the Guidance. These campaigns are sponsored by the following organizations and are identified by a representative comment letter number, as specified by the docket:

- Earthjustice (Doc. #0022);
- Rainforest Action Network (Doc. #0798);
- Unknown (Doc. #0600);
- Unknown (Doc. #0599);
- Unknown (Doc. #0602); and
- Unknown (Doc. #0603).

All campaigns except the Unknown #599 support the Guidance. Campaigns in support of the Guidance address environmental impacts of Appalachian coal mining, while the campaign opposed to the Guidance addresses public participation in the regulatory process.

a. Environmental Impact of Appalachian Coal Mining

Most of the mass mailing campaigns in support of the Guidance comment on impacts of mountaintop mining activities on streams, particularly headwater streams, and express concern about the lost streams. Two campaigns wish to see further protection of streams, and another expresses concern about mountaintop mining impacts to wildlife.

Earthjustice (Doc. #0022) and two other mass mailing campaigns from unknown sponsoring organizations (Doc. #s 0600 and 0602) claim that "more than 2,000 miles of streams have

already been destroyed, and we cannot afford to lose more, especially unique and vital headwater streams." Three mass mailing campaigns from unknown organizations (Doc. #s 0600, 0602, and 0603) blame valley fills for the loss of streams, claiming that "scientific research suggests that one valley fill is too many, because the unique headwater streams are lost forever, along with all of the ecological services they provide." They also argue that "every valley fill becomes a source of pollution that contaminates the watershed downstream."

The Rainforest Action Network campaign (Doc. #0798) expresses concern that permits for activities including valley fills were approved despite the Guidelines, which should protect headwater streams. They argue that "further action is crucial." Another mass mailing campaign sponsored by an unknown organization (Doc. #0600) echoes this sentiment by suggesting that EPA "further increase protections for our streams and our communities."

One mass mailing campaign sponsored by an unknown organization (Doc. #0602) expresses concern about wildlife in Appalachia. They claim that "surface coal mining in Appalachia is killing and poisoning wildlife" and that "the health of aquatic life and people living near or relying on these streams is jeopardized by mountaintop removal" with "endangered mussels, fish, and numerous other rare species (...) being sacrificed to surface coal mining."

b. Public Participation in Regulatory Process

The campaign in opposition to the Guidance and sponsored by an unknown organization (Doc. #0599) requests that EPA withdraw its Guidance and "process pending permit applications under existing rules and regulations while seeking comment from the public on the proposed changes through the formal rulemaking process."

11. UNKNOWN

Eighteen comment letters were received from anonymous commenters, and were classified as an "unknown" commenter category. These appear to have been submitted by the general public, but are not signed. They are approximately equally divided between comments in support and in opposition to the Guidance and/or mountaintop mining in general. None of these letters comment on the issue area of Background/Basis for the Guidance.

IX. Environmental Justice

Pursuant to the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898), the United States Environmental Protection Agency (EPA) has issued Guidance clarifying the review of Appalachian Surface Mining Operations. This Guidance was issued to assure that federal and state partners issue permits for these activities that will prevent harm to public health, water quality, and other environmental impacts associated with surface coal mining operations in Appalachia, and that public comments from affected communities are taken into consideration.

The issue area of Environmental Justice (EJ) includes characterization of EJ communities in Appalachia, comments on the adverse health effects as a result of surface mining activities and the adverse impacts to private and public water supply systems, and provides recommended changes in the Guidance specifically related to EJ.

There were a total of 81 tallied comments discussing the EJ issue. This issue received many comments from the various commenter categories, including those comments from state agencies, industry representatives, environmental and other Non-Governmental Organizations (NGOs), congressional delegates, private citizens, mass mailer campaigns, and comment letters of unknown or unspecified origin. Most comments were received from private citizens and mass mailing campaigns, but were not as substantive as those received from other stakeholders. Figure 9-1 on the next page presents the total comment letters by commenter category that address EJ.

Most comments acknowledge that Appalachia has been historically adversely affected by mountaintop mining operations. Government officials and industry affiliates appear to agree that the Guidance will result in further adverse effects on the Appalachian region, one of the poorest areas of the country. The Kentucky Energy and Environment Cabinet asks the pointed question: "how does the potential elimination of high wage jobs for citizens living in low-income, high unemployment areas of Appalachia, factor into the EJ decision-making process?"

Most comments from NGOs, private citizens, and mass mailers are supportive of the Guidance, and express that it will serve to improve environmental conditions in the Appalachian region by adding further protections toward public health and drinking water supplies.

Industry affiliates and many of the private citizen letters generally agree that further research is needed on the effects of surface mining and valley fills, although for different reasons relating to EJ, and should weigh socio-economic effects against environmental and human health effects.

Below are summaries, presented by commenter category, on the issue of EJ as it relates to the Guidance. Under each commenter category, all sub-issues commented on are listed by letter (based on the issue outline) and are discussed. Not all commenter categories discussed all sub-issues; therefore, not all sub-issues are listed under each commenter category.

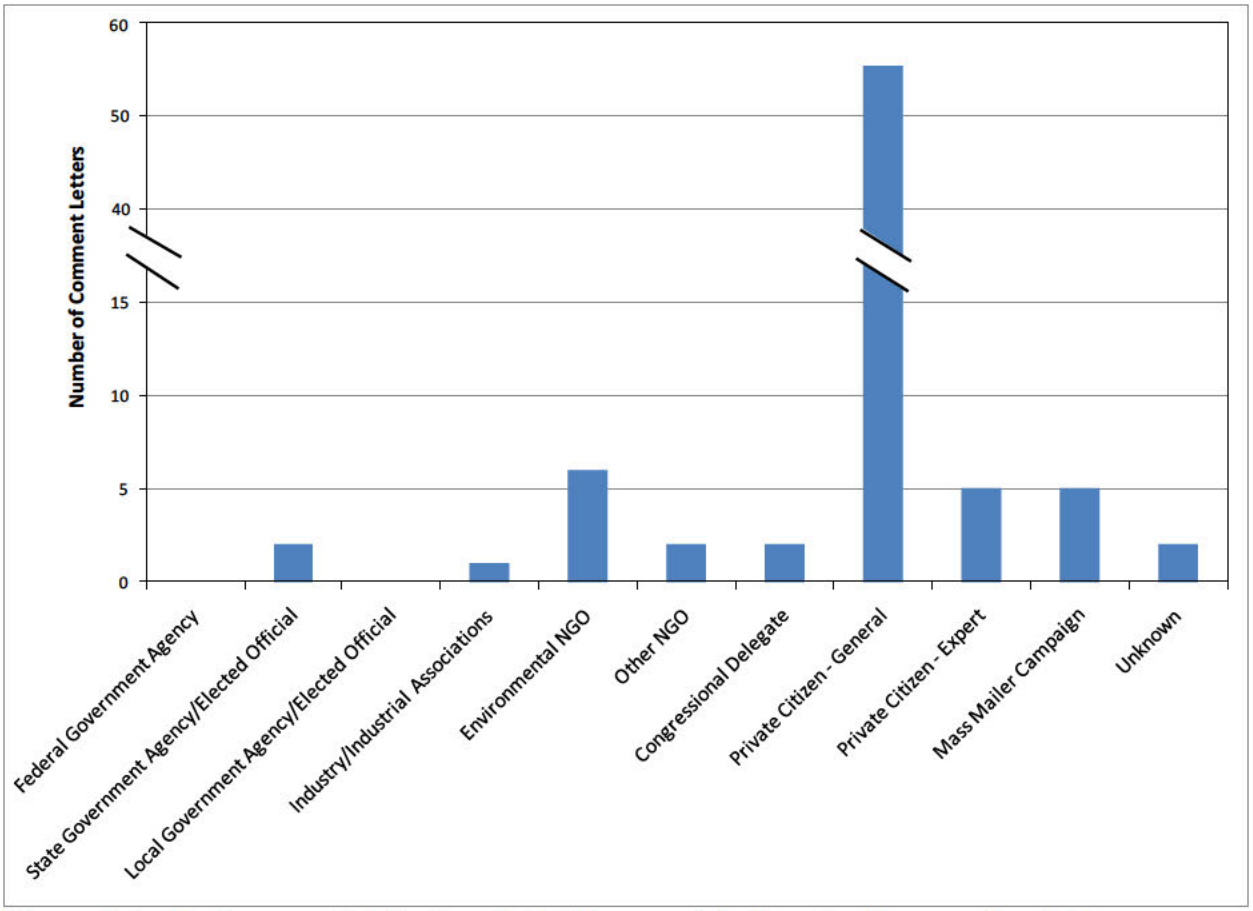

Figure 9-1. Environmental Justice, Total Comment Letters by Commenter Category

1. Federal Government Agencies

The United States Department of the Interior (DOI) was the only federal agency to submit comments regarding the Guidance. While three documents were submitted by the DOI, two are identical (Doc. #0695 and 0799), and the third document (Doc. #0775) is a placeholder alerting the docket of forthcoming comments. The DOI did not comment on the issue area of EJ.

2. State Government Agencies and Elected Officials

A total of three state agencies submitted comments to the docket: The Kentucky Energy and Environment Cabinet (Doc. #0012), the Commonwealth of Virginia Department of Mines, Minerals and Energy (DMME; Doc. #0348.1), and the West Virginia Department of Environmental Protection (WVDEP; Doc. #s 0614.1 and 0614.2). The Commonwealth of Kentucky generally supports the Guidance, but presents a series of questions, seeking clarification to assist them in responding to pending permits for surface coal mining in compliance with existing regulations. The DMME and the WVDEP, on the other hand, are generally not supportive of the Guidance, each contending that the Guidance does not specifically apply to their states. The VWDEP, however, did not comment upon EJ issues.

a. Characterization of EJ Communities in Appalachia

The Kentucky Energy and Environment Cabinet comments that mountaintop mining and valley fills seem to be common only in Central Appalachia and questions EPA's focus on this region by asking, "Is it U.S. EPA's determination that surface coal mining is restricted to Appalachia (p. 6)?"

b. Adverse Health Effects as a Result of Mining Activity

The Kentucky Energy and Environment Cabinet acknowledges that "each Federal agency shall make achieving environmental justice (EJ) part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (p. 4), and poses the question: "How does the potential elimination of high wage jobs for citizens living in low-income, high unemployment areas of Appalachia, factor into the EJ decision-making process?"

Approaching this topic from a different angle, and by way of defending their position regarding the lack of applicability of the Guidance to surface coal mining practices in Virginia, DMME (Doc. #0348.1) makes a passing reference to EJ issues with regard to the adverse effects of surface mining on human health. They note: "Human health studies referenced [in the Guidance] do not take into account the disproportionately high rate of drug abuse, tobacco use, lack of proper sanitation prevalent in the coalfields, and other major factors contributing to poor human health in the region" (p. 2); suggesting that surface mining practices are not the only factors contributing adversely to human health in the region, or at least in Virginia.

3. Local Government Agencies and Elected Officials

The letter from a local government agency or elected official was submitted by a city councilman from St. Charles, Kentucky (Doc. #0728). It does not address EJ.

4. Industry or Industrial Associations

Twelve comment letters were submitted by representatives of the coal mining industry, and in general are not supportive of the Guidance. Of these 12 letters, five almost identical letters were submitted by Frost Brown Todd Attorneys, LLC, (Frost Brown Todd) on behalf of their clients. The bodies of all five letters are identical, except for the name of the represented clients: Gorman Company, LLC (Doc. #0013); Kentucky Union Company (Doc. #0014); Black Gold Sales, Inc. (Doc. #0016); Hazard Coal Corporation (Doc. #0017); and Kycoga Company, LLC (Doc. #0018). The Frost Brown Todd letters were only summarized once, and were the only letters addressing EJ under this category.

a. Characterization of EJ Communities in Appalachia

With respect to EJ, Frost Brown Todd claim that the strict standards in the Guidance will disproportionately impact traditionally poor communities, and that EPA is placing too much

emphasis on environmental impacts while ignoring socio-economic impacts. Specifically, they claim the Guidance will result in "economic devastation of large swaths of one of the poorest regions in the nation," (p. 6) and that EPA is placing "a disproportionate emphasis on potential impacts to community water supplies, as part of the CWA's antidegradation socio-economic analysis, while ignoring the potential severe harmful socio-economic effects that would be inflicted on low-income communities throughout Appalachia" (p. 5).

d. Recommended Changes in Guidance Relating to EJ

Frost Brown Todd request that EPA withdraw its Guidance and "step back from this rash rush to judgment and recommit itself to a regulatory policy based on sound science, economic rationality, and a fair balancing of the many factors that comprise the public interest" (p. 9), claiming that if this is done, "the surface coal mining industry of Appalachia will be able to continue to play a key role in our nation's economic future while serving as proud stewards of our Appalachian environmental heritage" (p. 10).

5. Environmental Non-Governmental Organizations (NGOs)

Six letters submitted by the following environmental NGOs commented on EJ:

- The Sierra Club (Doc. #0225.1);
- Southern Appalachian Mountain Stewards (Doc. #0344);
- Appalachian Voices and Waterkeeper Alliance (Doc. #0362.1);
- American Rivers et al.: one common comment submitted collectively by a number of environmental and other NGOs including American Rivers, Caretakers of God's Creation, Center for Biological Diversity, Citizens Against Longwall Mining, Citizens Coal Council, Clean Water Action, Coal River Mountain Watch, Concerned Citizens of Giles County, Defenders of Wildlife, Earthjustice, Eco-Justice Collaborative, Friends of the Earth, Global Community Monitor, Greenpeace, Kentucky Resources Council, Maryknoll Office for Global Concerns, Mountain Watershed Association, Natural Resources Defense Council, No Biomass Burn, Ohio Valley Environmental Coalition, Public Citizen, Rainforest Action Network, Sierra Club, United Methodist Women, University of KwaZulu-Natal Centre for Civil Society Environmental Justice Project, Waterkeeper Alliance, and West Virginia Highlands Conservancy (Doc. # 0361.1);
- The Rainforest Action Network (Doc. #0366); and
- Earthjustice et al.: one common comment submitted collectively by a number of environmental and other NGOs including Earthjustice, Ohio Valley Environmental Coalition, West Virginia Highlands Conservancy, Public Justice, Sierra Club, Coal River Mountain Watch, and Appalachian Center for the Economy and Environment (Doc. #0610.1).

These six letters are in general support of the Guidance, and comment on EJ communities in Appalachia, and adverse health effects and impacts to water supply systems, and propose recommended changes to the Guidance related to EJ issues.

a. Characterization of EJ Communities in Appalachia

Five of the environmental NGO comments address EJ in Appalachia, with four of them arguing that mountaintop mining has been adversely impacting many communities for too long, and it is time for change. The fifth NGO comment, from Earthjutice et al., points to adverse impacts from mountaintop activities, references an EJ petition submitted to EPA, and argues that sequencing approvals of valley fills represents a prejudice to residents of Appalachia when permittees can modify mitigation plans after the opportunity for public comment has closed.

Specifically, Southern Appalachian Mountain Stewards (Doc. #0344) describe local residents as feeling "hopeless here in the past" and hope that EPA will "adopt permanent regulations that end mountaintop removal mining" so they can "rebuild [their] lives and maybe, what's left of [their] mountains can be saved."

American Rivers et al. (Doc. #0361.1) contend: "The people of Appalachia have suffered too long from the consequences of harmful regulatory loopholes that allowed the region's waters to be used as waste disposal systems, and from the federal government's refusal to enforce the Clean Water Act at every step."

Arguing against the line of reasoning that coal mining is a driving economic force in the area and should be protected, Appalachian Voices (Doc. #0362.1) quote a 2008 article publication in *Environmental Justice* by Dr. Hendrix to contend that "coal mining perpetuates poverty" and "remains an important part of these economies because underdeveloped infrastructure, blasted landscapes, poorly educated workforces, environmental health hazards, and chronically unhealthy populations perpetuate themselves over time and present strong discouragements to new business and population immigration" (p. 10).

Rainforest Action Network (Doc. #0366) commends EPA for recognizing mountaintop mining's potentially "adverse environmental and health impacts on communities in the vicinity of mining operations" (p. 5) and for its "long-overdue focus on developing and implementing rules pertaining to a consideration for environmental justice concerns in the review of MTR/VF permit applications" (p. 5).

Earthjustice et al. (Doc. #0610.1) argue that mountaintop removal mining activities in Appalachia "unquestionably inflict disproportionate impacts upon the health and wellbeing of low-income and minority populations" (p. 9) and support EPA in its decision to identify and address these impacts for "all federal decisions and actions relating to Appalachian surface coal mining" (p. 10). They also argue that the sequencing approvals of valleys fills is a significant EJ issue, in that it does not provide residents of Appalachia an opportunity for public comment on future modifications to an existing mitigation plan, "particularly if the modifications allow the permittees to continue destroying waters after water quality excursions have occurred based on mitigation plans that have not been released for public comment" (p. 9). Earthjustice et al. also provide recommendations to improve the Guidance relative to EJ issues. These are further described under Sub-section d.

b. Adverse Health Effects as a Result of Mining Activity

Three of the four environmental NGOs commenting on adverse health effects from mining activities mention it in passing and do not provide details on the impacts. On the other hand, the fourth letter, submitted by Appalachian Voices and Waterkeeper Alliance, purports a correlation between physical health and surface mining in Appalachia.

The Sierra Club (Doc. #0225, p. 1) argues that steep slope surface mining has threatened the Appalachian communities with increased health risks. Rainforest Action Network (Doc. #0366, p. 2) wishes EPA to "strengthen its focus on the 'elimination' and 'avoidance' of environmental and human health impacts." Finally, Earthjustice et al. (Doc. #0610.1 p. 9) argues that mountaintop mining and waste disposal activities in Appalachia "unquestionably inflict disproportionate impacts upon the health and wellbeing of low-income and minority populations."

Appalachian Voices and Waterkeeper Alliance (Doc. #362.1, p. 10) reference the Gallup-Healthways Well-Being Index™ to demonstrate a correlation between residents' physical heath and the extent of surface mining in their state. They contend: "The three districts where mountaintop removal is most prevalent scored the lowest in the physical well-being rankings of all 435 Congressional districts in 2008 and 2009;" and: "Kentucky's 5th district and West Virginia's 3rd - the two district where almost all mountaintop removal has occurred, ranked last and second to last in the overall rankings (see http://www.ahiphiwire.org/WellBeing/)."

c. Adverse Impacts to Private and Public Water Supply Systems

Two environmental NGOs commented on adverse impacts to private and public water supply systems but do not provide details on the impacts. The Sierra Club (Doc. #0225, p. 1) contends that mountaintop mining threatens Appalachian communities "with increased flooding, polluted water sources, and increased health risks." Earthjustice et al. (Doc. #610.1, p. 10) quote EPA on "adverse effects on drinking water supplies or fisheries ..." to provide recommended changes to the Guidance, further discussed under Sub-section d.

d. Recommended Changes in Guidance Relating to EJ

Three environmental NGOs provided recommendations for changes to the Guidance related to EJ concerns: Appalachian Voices and Waterkeeper Alliance (Doc. #362.1), the Rainforest Action Network (Doc. #0366), and Earthjustice et al. (Doc. #0610.1). Most NGOs approve of EPA's efforts to address EJ, but feel that the Guidance is not specific enough as to how EJ concerns must be addressed. They recommend additional opportunities for public comment in the permitting process so Appalachian communities can voice their concerns.

Appalachian Voices and Waterkeeper Alliance (Doc. #362.1) claim that the lack of specificity for addressing EJ issues will result in "a substantial risk that the Guidance will encourage EPA staff to address environmental justice concerns with rhetoric only, rather than actually providing input and analysis" (p. 9). They make the following two recommendations to EPA and suggest

that: (i) "EPA use and conduct comparative socioeconomic analyses in evaluating environmental justice concern," and (ii) "EPA take a proactive approach to engage residents that are likely to be directly impacted by the specific permitting actions to ensure environmental justice concerns are addressed."

Regarding comparative socioeconomic analyses, Appalachian Voices and Waterkeeper Alliance argue that short-term benefits from job creation provide a narrow economic view that may not be in the best long-term economic interest of a community. They contend that "comparative analyses of Appalachian communities are increasingly available in regard to the impacts of coal mining on the economy and health of communities" (p. 10). They provide examples to their argument, including research by Dr. Michael Hendryx at West Virginia University, information from the Gallup-Healthways Well-Being Index, and a 2005 economic study by the Appalachian Regional Commission regarding long-term trends in economic distress in counties across Appalachia.

Regarding proactive public participation, Appalachian Voices and Waterkeeper Alliance make the case that while communication flows regularly between regional EPA offices and coal companies, efforts to contact residents who may be impacted are insufficient. They recommend that "potential impacts on the homes and water supplies of low-income residents near proposed operations (...) be considered alongside any analysis of practicability by the applicant" (p. 12). They also propose: "The final guidance (...) specifically encourage EPA staff to proactively meet with local residents to learn about their concerns and conditions, represent their views in negotiations with mining companies and other agencies permits, and provide equal weight to the concerns of impacted residents that they provide to the economic practicability concerns of mining companies in their decision-making" (p. 12).

While applauding "USEPA's efforts toward clarifying and implementing articles of Environmental Justice in relation to mountaintop removal mining" (p. 5), the Rainforest Action Network (Doc. #0366) argues that the permit review process lacks clarity on "how the agency will integrate Environmental Justice concerns" (p. 8). They advocate for the development of rules or guidelines to address the issue. The Rainforest Action Network refers to the Pine Creek No. 1 and Hobet 45 mining permits to showcase the insufficient opportunity for public participation in permit reviews, and to the Spruce No. 1 mine to recommend a standard for analysis of impacts to EJ communities. They argue that EPA's recommendation for "additional analysis of the potential for disproportionately high and adverse effects on the low-income populations" (p. 8) for the Spruce No. 1 permit should have been required for the Pine Creek No. 1 and Hobet 45 mining permits and should become a required "standard for all future permits reviewed."

Recommendations from Earthjustice et al. (Doc. #0610.1) related to EJ are focused on the arguments that sequencing of valley fills takes away residents' opportunity to comment on changing mitigation measures, and that the Guidance is not sufficiently specific to address all adverse impacts in a satisfying manner. Earthjustice et al. argue that sequencing valley fills "violates the legal requirements for public notice and comment under section 404(a) and (c), and CWA regulations at 40 C.F.R. § 230.94(b)" (p. 9), and prejudices residents of Appalachia. They also contend that potential impacts on drinking water supplies, fisheries, or wildlife are not

sufficiently addressed by the Guidance, and recommend that EPA "include in its final Guidance a more complete discussion of potential impacts related to Appalachian culture and public health, such as is set forth in EPA's Spruce RD at 74-77 and Hendryx, M., Mortality Rates in Appalcahian Coal Mining Counties: 24 Years Behind the Nation, Environmental Justice, Vol. 1, Num., 1, 2008" (p. 10). They also recommend that EPA staff implement E.O. 12898 "by addressing impacts on: other subsistence food and herb resources (...); decreased property values associated with nearby mining, slurry ponds, and valley fills (...); and increased risks of flooding" (p. 10).

6. OTHER NGOS

Two letters were received from other NGOs that commented on the issue area of EJ. The NGOs are:

- Kentuckians for the Commonwealth; and
- Alpha Natural Resources.

The Kentuckians for the Commonwealth's (KFTC) letter (Doc. #0796) is in general agreement with the Guidance, while the letter from Alpha Natural Resources (Doc. #0591 and attachments) is not in support of the Guidance.

c. Adverse Impacts to Private and Public Water Supply Systems

Many members of the KFTC live in communities where the water quality has been negatively impacted from coalmining activities. KFTC welcomes the Guidance and states, "this Guidance is a necessary first step for stopping and reversing this accumulated poisoning of our streams" (p. 1).

Alpha Natural Resources argues that there are other factors that could impact water quality, such as untreated domestic sewage. They claim that EPA has overlooked the impact that untreated domestic sewage has on water quality, stating this is a major factor that is "well-known among those involved in water quality issues in the region" (p. 4).

7. CONGRESSIONAL DELEGATES

Two comment letters were submitted by congressional delegates. Both letters are signed by several members of Congress, are in general opposition to the Guidance, and address EJ concerns. The first letter (Doc. #0011) is signed by three congressional delegates representing the States of Virginia and West Virginia. The second letter (Doc. #0015) is signed by 23 congressional delegates from 14 different states, including Alabama, Alaska, Colorado, Illinois, Kentucky, Michigan, Montana, Ohio, Pennsylvania, Tennessee, Utah, Virginia, West Virginia, and Wyoming.

a. Characterization of EJ Communities in Appalachia

Both letters are opposed to EPA's Guidance, with one letter (Doc. #0011, p. 1) expressing concern that "aiming this guidance only at surface coal mining in Appalachia increases the disadvantage already suffered by the industry in this region when compared to Western mining operations." The other letter (Doc. #0015, p. 1) further recommends withdrawing the Guidance altogether given the "far reaching effects of this guidance on the people who live and work in Central Appalachia."

8. PRIVATE CITIZEN - GENERAL

Fifty-six comment letters, typically one page in length, received from members of the general public commented on the issue of EJ. Two letters (Doc. #s0249 and 0442) disagree with the Guidance, while the remaining private citizens either support the Guidance or are opposed to mountaintop mining in general.

a. Characterization of EJ Communities in Appalachia

The two letters in disagreement with EPA's Guidance suggest that the Guidance will further destroy an economy that is already struggling. One commenter (Doc. #0249) suggests that valley fills are common in other areas of the country stating: "We do it all the time outside of this region to prepare land for housing development, shopping malls, community centers, and government building. Why should Central Appalachia be any different, because the people there are seen as ignorant and poor?"

Several letters in support of the Guidance also comment on this issue. One commenter (Doc. #0736) states: "Poverty-stricken citizens cannot afford the thousands of dollars (for which they, not the country are financially responsible) to replace polluted wells with 'town water'." Another commenter (Doc. #0422) states: "the EPA needs to be realistic about the environmental justice issues related to permitting and placement of new industrial sites, especially considering new evidence that some populations may be negatively affected more than others because of the effects of particulates and heavy metals and how they influence specific genes."

b. Adverse Health Effects as a Result of Mining Activity

More than half of the comment letters received by general private citizens discuss mountaintop mining and valley fills as they relate to public health. Many feel one of the top priorities of EPA should be to protect the people of Appalachia and several commenters suggest that EPA implement additional restrictions to protect the local people and wildlife (e.g., Doc. #0266). One commenter (Doc. #0790) cites research that "shows an increased incidence of chronic illness, including kidney disease, in communities with surface mining and that these health disparities occur in proportion to the level of coal production in the area." Even the single commenter in disagreement with the Guidance (Doc. #0249) suggests that "EPA should fund research to fully understand the impacts of valley fills on public health."

c. Adverse Impacts to Private and Public Water Supply Systems

Impacts to water supply systems are a concern for over half of the general public. Many people suggest mountaintop mining destroys water sources. One commenter (Doc. #0239) remarks "It is a disgrace that in large areas of eastern Kentucky one cannot drink the local water." One commenter (Doc. #0242) summarizes many general opinions that "every American not only has the right to access water but the right to clean, drinkable water." Another commenter (Doc. #0631) discusses the statewide impacts on clean water saying: "What is put in the streams and rivers in eastern Kentucky eventually affects the water quality of everyone in our states."

d. Recommended Changes in Guidance Relating to EJ

Two letters recommend changes regarding EJ in the Guidance. Both letters are in support of the Guidance, with one letter (Doc. #0267) stating: "the final guidance recognizes the need to protect human health and preserve waterways for the benefit and enjoyment of local communities as a top priority." The other letter (Doc. #0566) urges EPA to "strengthen the Environmental Justice components of the guidance by requiring specific public involvement procedures to assure that low-income residents who are disproportionately affected by mining have adequate opportunities to be involved in decision-making."

9. PRIVATE CITIZEN - EXPERT

Five comment letters submitted by private citizen experts address the issue EJ. The letters focus on the characterization of EJ communities in Appalachia, adverse health effects as a result of mining, and the adverse impacts to private and public water supply systems. All five letters from this commenter category group generally support the Guidance. Three of the commenters identify themselves as having a background in geology, the fourth is a proclaimed expert in the field of biology, and the fifth is a retired writer and editor who worked on regulatory documents for many contaminated sites.

a. Characterization of EJ Communities in Appalachia

The general feeling from two of the commenters on this issue is concern for the Appalachian communities. One commenter expresses support for the Guidance as well as the belief that the Guidance should be even more stringent to better protect the communities affected by surface coal mining. This commenter (Doc. #0112, p. 2.) states: "After years of neglect by EPA, Appalachia deserves better than another failed experiment that allows for the damage to start before the impact of the permit is appropriately assessed, in permits that put a local community in limbo while decisions about the future of their waters get made behind closed doors." The other commenter (Doc. #0782, p. 1) feels that the heritage, biodiversity, and culture of the Appalachian region has been detrimentally impacted by mining and states: "As an American, I am affected by the lack of concern for the people of Appalachia."

b. Adverse Health Effects as a Result of Mining Activity

The commenter mentioned above as being "affected by the lack of concern for the people of Appalachia" (Doc. #0782) also comments on the issue of adverse health effects resulting from mining. This commenter requests: "I am asking you to please take a closer look at the mounting scientific evidence which clearly shows the severe negative impact that mountaintop removal mining has on the environment and human health. The EPA developed standards for healthy stream environment. The EPA should be held accountable for maintaining these standards by preventing MTR [mountain top removal] facilities from exceeding safe contaminant levels in streams." This statement further emphasizes the commenter's point of view that the Guidance standards should be enforced on permits to protect the Appalachian communities from the adverse health effects caused by mining activities.

c. Adverse Impacts to Private and Public Water Supply Systems

Three of the expert commenters addressing this issue area are from the Appalachian region, and express their concern for the protection of drinking water. One of them states (Doc. #0729, p. 1): "Headwater streams need protection from this destructive and unsustainable practice, to endure quality groundwater for us to drink, and to preserve our mountain views and heritage". The second commenter (Doc. #0744) states in reference to the leachate from the surface coal mining debris piles, "The minerals and heavy metals go right into my water supply." Similarly, the third commenter (Doc. #0660, p.1) contends: "A claim that a mountain can be 'put together again' always reminds me of the Humpty Dumpty rhyme. No. All of the kings horses and men cannot put our mountains back together again – nor can they gather up all the heavy metals, etc. that leach out of the rocks and coal and prevent serious contamination of our headwaters, and thus our surface and groundwater (in a fractured bedrock topography). OUR DRINKING WATER, and the water that grows much of our food."

10. Form Letters and Mass Mailer Campaigns

A number of comment letters were sponsored by mass mailing campaigns, or were identified as being "modified mass mailers" when multiple copies of the same letter with a few minor changes were submitted to the docket under different document numbers. The docket identified a total of nine mass mailing campaigns, with seven campaigns in support of the Guidance, and two campaigns in opposition to the Guidance. Four of the seven campaigns in support of the Guidance (Doc. #0022 sponsored by Earthjustice, and Doc. #s 0600, 0602, and 0603, sponsored by unknown organizations) address the same issues, and exhibit very similar wording.

Of the nine campaigns, five comment on the EJ issues. These campaigns are sponsored by the following organizations, and are identified by a representative comment letter number, as specified by the docket:

- Earthjustice (Doc. #0022);
- The Sierra Club (Doc. #0103);
- Unknown (Doc. #0600);
- Unknown (Doc. #0602); and

- Unknown (Doc. #0603).

All five campaigns listed above support the Guidance, and suggest that the Guidance be strengthened and finalized. Altogether, these campaigns address EJ communities, adverse health effects, and impacts to water supply systems.

a. Characterization of EJ Communities in Appalachia

Earthjustice (Doc. #0022) believes that it is time for a change in Appalachia: "After years of neglect by EPA, Appalachia deserves better than another failed experiment that allows for the damage to start before the impact of the permit is appropriately assessed" (p. 2).

b. Adverse Health Effects as a Result of Mining Activity

Arguing that mountaintop mining has negative health impacts, three mass mailing campaigns from unknown sponsoring organizations (Doc. #s 0600, 0602, and 0603) recommend that EPA "take specific steps in the permitting process to collect information about public health impacts, and (...) fund research to further develop this vital information to fully understand the impacts of valley fills on public health."

c. Adverse Impacts to Private and Public Water Supply Systems

Three mass mailing campaigns acknowledge adverse impacts to water supply systems associated with mountaintop mining. The Sierra Club contends "Appalachia cannot afford to continue to bury its streams and pollute entire watersheds (Doc. #0103)." Earthjustice (Doc. #0022) agrees "watersheds cannot afford to lose more waters, especially unique and vital headwater streams" (p. 2). Finally, the campaign sponsored by an unknown organization (Doc. #0602) argues that "surface coal mining in Appalachia is (...) destroying water supplies for human communities."

11. UNKNOWN

Eighteen comment letters were received from anonymous commenters, and were classified in the "unknown" commenter category. These appear to have been submitted by the general public, but are not signed. They are approximately equally divided between comments in support and in opposition to the Guidance and/or mountaintop mining in general, but only two of these letters comment on the issue of EJ.

a. Characterization of EJ Communities in Appalachia

While not clearly stating a position of support or opposition to the Guidance, one commenter (Doc. #0422) expresses concern about the toxic effects of heavy metals in coal and requests that EPA "be realistic about the environmental justice issues related to permitting and placement of industrial sites." The other anonymous comment (Doc. #0183) is in general support of the Guidance and is concerned that contamination of private wells will reduce local opportunities, particularly for the poor who "are pushed from their homes by mining activities" and experience rapidly decreasing property values.

c. Adverse Impacts to Private and Public Water Supply Systems

One of the anonymous comments (Doc. #0183) in general support of the Guidance established a relation between mountaintop mining activities and impacts to drinking water by claiming that "private wells are contaminated."

Matthew Klasen/DC/USEPA/US
01/25/2011 08:43 AM

To Cliff Rader
cc Christopher Hunter
bcc
Subject Re: Word version of April 1, 2010 Guidance

Hey Cliff,

In case it's helpful, attached is a Word version (though I assume copying the PDF worked yesterday).

Chris: This might be helpful to add to the invite for tomorrow so folks have the Word version (or we can just mention tomorrow that it exists).

Thanks,
Matt

Mining FINAL Draft Silva-Giles Memo - Clean.doc

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Cliff Rader | Matt - I'm having a brain flash at the moment an... | 01/23/2011 04:30:19 PM

From: Cliff Rader/DC/USEPA/US
To: Matthew Klasen/DC/USEPA/US@EPA
Date: 01/23/2011 04:30 PM
Subject: Word version of April 1, 2010 Guidance

Matt -

I'm having a brain flash at the moment and would like to start making changes to the NEPA section - do you have the Word version of the Guidance?

thanks,

Cliff

MEMORANDUM

SUBJECT: Detailed Guidance: Improving EPA Review of Appalachian Surface Coal Mining Operations under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order

FROM: Peter S. Silva
Assistant Administrator for Water

Cynthia Giles
Assistant Administrator for Enforcement and Compliance Assurance

TO: Shawn Garvin
Regional Administrator, EPA Region 3

A. Stanley Meiburg
Acting Regional Administrator, EPA Region 4

Bharat Mathur
Acting Regional Administrator, EPA Region 5

I. Purpose

The purpose of this detailed memorandum is to provide further clarification of EPA's roles and expectations, in coordinating with our federal and state partners, to assure more consistent, effective, and timely compliance of Appalachian surface coal mining operations with the provisions of the Clean Water Act (CWA), National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898).[1,2] This memorandum reflects reviews of past practices and emerging science to improve and strengthen permit decision-making in order

[1] This memorandum is effective immediately. Concurrent with its release, however, EPA is seeking public comment on this interim final document. We fully understand the importance of this memorandum to our federal and state partners, the coal industry, and the public, and we recognize the value in receiving their input based on experience with its implementation. The public comment period will conclude on December 1, 2010. No later than April 1, 2011, EPA will issue final guidance after consideration of public comments and the results of the Science Advisory Board (SAB) review, and consistent with our experience in implementation of this memorandum. EPA may revise the guidance sooner, as appropriate, consistent with the SAB review. EPA is publishing a notice in the *Federal Register* that provides additional details on the public comment process.

[2] In addition to this memorandum, EPA is working with other federal agency partners to develop and implement an interagency environmental justice strategy to more fully evaluate environmental justice considerations in review of Appalachian surface coal mining activities. This strategy will provide more detailed information and specific actions to avoid and mitigate adverse impacts to low-income and minority populations.

to better ensure compliance with federal environmental statutes, implementing regulations, and policies.[3] We hope this memorandum will also be helpful to our federal and state partners, the regulated public, and others in clarifying EPA's expectations regarding the need to reduce harmful impacts on public health and the environment associated with Appalachian surface coal mining and to more effectively include the voices of adversely affected communities in the Appalachian coalfields, including low-income or minority populations.[4] We expect you to begin using this interim final guidance immediately in your review of Appalachian surface coal mining activities.

II. Introduction

A. Background

The CWA entrusts EPA with overall responsibility to administer its provisions, including protection of human health, water quality, and the environment in coalfield communities throughout Appalachia. CWA protections, including water quality requirements, extend to all waters of the United States, from headwater streams to the larger downstream systems that they feed. In particular, EPA's CWA responsibility includes preserving the long-term integrity of Appalachian watersheds, which is important in protecting their ecological condition and maintaining safe, clean, and abundant water for local communities. We make every effort to fulfill these responsibilities without compromising the economic and energy benefits that coal mining provides to both the Appalachian region and the entire nation.

In recent months, the Obama Administration has worked to ensure timely review of permit applications that have faced delays in the courts for many years. It is our hope that our efforts to make responsible and expeditious decisions on these applications will reduce the likelihood of judicial challenges to the permits and thus will be seen as a demonstration of our commitment to an Appalachian coal industry that provides economic security and protects the health of Appalachian communities, without violating environmental standards established under the law.

The environmental legacy of mining operations in the Appalachian region is far-reaching. Recent studies, as well as the experiences of Appalachian coalfield communities, point to new environmental and health challenges that were largely unknown even ten years ago. Since 1992, nearly 2,000 miles of Appalachian streams have been filled at a rate of 120 miles per year by

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[3] The CWA and NEPA provisions and regulations described in this document contain legally binding requirements. This guidance does not substitute for those provisions or regulations, nor is it a regulation itself. It does not impose legally binding requirements on EPA, the U.S. Army Corps of Engineers (Corps), the States, or the regulated community, and may not apply to a particular situation depending on the circumstances. Any decisions regarding a particular permit will be based on the applicable statutes, regulations, case-specific facts and circumstances, and case law. Therefore, interested persons are free to raise questions about the appropriateness of the application of this guidance to a particular situation, and EPA and/or the Corps will consider whether or not the recommendations or interpretations of this guidance are appropriate in that situation based on the statutes, regulations, and case law.

[4] The discussion of the provisions of the CWA, NEPA, and E.O. 12898 in this memorandum focuses on their applicability to Appalachian surface coal mining operations in Kentucky, West Virginia, Virginia, Ohio, Tennessee, and Pennsylvania.

surface mining practices. A recent EPA study found that nine out of every 10 streams downstream from surface mining operations were impaired based on a genus-level assessment of aquatic life.[5] Another federal study found elevated levels of highly toxic and bioaccumulative selenium in streams downstream from valley fills.[6] These impairments are linked to contamination of surface water supplies and resulting health concerns, as well as widespread impacts to stream life in downstream rivers and streams. Further, the estimated scale of deforestation from existing Appalachian surface mining operations is equivalent in size to the state of Delaware. Appalachian deforestation has been linked to significant changes in aquatic communities as well as to modified storm runoff regimes, accelerated sediment and nutrient transport, reduced organic matter inputs, shifts in the stream's energy base, and altered thermal regimes.[7] Such impacts have placed further stresses on water quality and the ecological viability of watersheds.

It has been a high priority of this Administration – and EPA Administrator Lisa P. Jackson – to reduce the substantial environmental and human health consequences of surface coal mining in Appalachia, and minimize further impairment of already compromised watersheds. Administrator Jackson has also made working toward environmental justice a priority. EPA seeks to enhance water quality and environmental protection in close partnership with the states and other federal agencies, which have key implementation roles under the CWA, and under NEPA and E.O. 12898, respectively. As scientific evidence grows, EPA has a legal responsibility to address the environmental consequences of Appalachian surface coal mining.

In June 2009, the Department of the Army, EPA, and the Department of the Interior (DOI) signed a Memorandum of Understanding (MOU) to minimize the harmful consequences of Appalachian surface coal mining practices. The MOU reflects an agreement among the agencies to strengthen the environmental reviews of Appalachian surface coal mining projects under the CWA, NEPA, and the Surface Mining Control and Reclamation Act (SMCRA). EPA committed to improve its review of permits issued under Section 404 and to bolster coordination with states on both Section 402 permits for pollutant discharges from valley fills and state water quality certifications (Section 401) for mining operations. The Corps committed to reassess Nationwide Permit 21, a general permit used to authorize some surface coal mining activities, and to work with EPA to clarify Section 404 policies for environmental review and mitigation. DOI committed to evaluate how the Office of Surface Mining Reclamation and Enforcement (OSM) can more effectively oversee state permitting and enforcement activities under SMCRA.

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[5] Pond, G.J., M. E. Passmore, F.A. Borsuk, L. Reynolds, and C. J. Rose. 2008. Downstream effects of mountaintop coal mining: comparing biological conditions using family- and genus-level macroinvertebrate bioassessment tools. J. N. Am. Benthol. Soc. 27(3):717–737.

[6] Bryant, G., S. McPhillamy, and H. Childers. 2002. A Survey of the Water Quality of Streams in the Primary Region of Mountaintop / Valley Fill Coal Mining. Mountaintop Mining Valley Fill Programmatic Environmental Impact Statement. USEPA Region 3. Wheeling, WV. http://www.epa.gov/region03/mtntop/eis2003appendices.htm#appd

[7] Webster, J.R., S.W. Golladay, E.F. Benfield, J.L. Meyer, W.T. Swank, and J.B. Wallace. 1992. Catchment disturbance and stream response: an overview of stream research at Coweeta Hydrologic Laboratory. In P.J. Boon, P. Calow, and G.E. Petts (eds.). River Conservation. and Management. John Wiley and Sons, New York, N.Y.

B. CWA, NEPA, and E.O. 12898

The CWA, 33 U.S.C. 1251 *et seq.*, establishes a comprehensive program designed "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. Section 1251(a). To achieve that objective, CWA Section 301(a) prohibits the "discharge of any pollutant" – defined as the addition of any pollutant to the waters of the U.S. from any point source – except "as in compliance with" specified provisions of the CWA. 33 U.S.C. Sections 1311(a), 1362(7), 1362(12). In most cases, regulated entities achieve compliance with the relevant CWA provisions by obeying the terms of a permit issued under one of the CWA's two complementary permitting programs: (1) a permit program for discharges of dredged or fill material, which is administered primarily by the Corps pursuant to Section 404 of the CWA, 33 U.S.C. 1344; or (2) the National Pollutant Discharge Elimination System (NPDES), which is administered by the EPA and authorized states pursuant to Section 402 of the CWA, 33 U.S.C. 1342. Section 401 of the CWA also applies where federal permits are issued, enabling states to certify (or waive) that discharges from permitted operations are in compliance with state environmental regulations. Typically, surface coal mining operations in the steep slopes of Central Appalachia require Section 404 permits for the discharge of mining overburden into waters of the United States (e.g., valley fills, mine-through operations), mine faceups, stream diversions, road crossings, coal process waste impoundments, and for discharges to create sediment ponds. Discharges from the sediment ponds and any other stormwater discharges require Section 402 permits. Because the Corps issues Section 404 permits in Appalachia, states have authority to condition those permits under Section 401.

In addition, NEPA requires an assessment of the environmental impacts of federal actions, including the preparation of an Environmental Impact Statement (EIS) for federal actions that have a significant effect on the quality of the human environment. For example, the Section 404 review by the Corps of a proposed mining operation with discharges into waters of the U.S. triggers review under NEPA. An EIS presents a comprehensive and transparent evaluation of the wide range of potential environmental and human health impacts associated with a federal action, as well as project alternatives that may avoid and minimize significant adverse impacts.

E.O. 12898 and the Presidential Memorandum that accompanies it also need to be addressed appropriately in the context of any federal action – such as federal permitting under the CWA and SMCRA – including federal actions that are subject to NEPA. E.O. 12898 provides that: "To the greatest extent practicable and permitted by law…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

Consideration of environmental justice concerns is vital to understanding the potential human health and environmental impacts of surface coal mining during the CWA and SMCRA permitting and NEPA review processes. The Presidential Memorandum articulates the role of federal environmental statutes in securing human health and environmental protection of vulnerable populations and assuring their participation in the process.

E.O. 12898 calls for actions that can address several key environmental justice issues associated with surface coal mining. These include: conducting research, data collection, and analysis on direct, indirect and cumulative impacts; identifying patterns of subsistence consumption of fish and wildlife; and providing effective public participation and access to information. EPA will implement the E.O. by identifying and addressing, as appropriate, any adverse effects of proposed federal activities on low-income and minority populations, including ways or measures to mitigate any adverse effects.

C. Recent Program Reviews and Emerging Science

Three key considerations have motivated the Agency's development of this memorandum. First has been the collection and publication of technical information documenting the scope and significance of adverse environmental and water quality effects associated with surface coal mining practices. Second, EPA has recently completed reviews of permitting actions under CWA Sections 402 and 404 for Appalachian surface coal mining. These reviews demonstrate that current permitting practices can be more effective in addressing adverse environmental and water quality effects associated with coal mining by more robustly conducting analyses required by the CWA. Third, EPA scientific offices are conducting extensive work evaluating the relationship between pollutants in streams associated with surface coal mining and impacts from these pollutants on aquatic ecosystems. As a result of this work, EPA is poised to initiate additional independent technical review and public evaluation of potential new water quality values for conductivity based on effective science and the need to improve protection of water quality, public health, and the environment.

Numerous studies, data submitted to permitting authorities for proposed mining activities, and some state impaired waters lists published pursuant to CWA Section 303(d), have shown that high levels of conductivity, dissolved solids, and sulfates are a primary cause of water quality impairments downstream from mine discharges. These studies build upon existing research from other regions that demonstrated the toxicity of specific ions, such as sulfate, as well as the complex interplay of ionic constituents associated with coal mining operations.[8] Dissolved solids contained in waters draining from valley fills are a primary cause of biological impairment resulting from changes in benthic species richness and diversity (particularly species of mayflies, a key component of headwater stream communities). An example of these studies is Pond et al. (2008), which found evidence that mining activities have subtle to severe impacts on downstream aquatic life and the biological conditions of a stream.[9] A 2003 published study by Kennedy et al. linked elevated conductivity levels in coal effluent to impaired, sensitive aquatic fauna.[10] A 2004 Kentucky Department for Environmental Protection study found that the loss of mayflies in streams below mined sites indicates that these organisms are especially sensitive to

[8] Soucek, D.J. and A.J. Kennedy. 2005. Effects of hardness, chloride, and acclimation on the acute toxicity of sulfate to freshwater invertebrates. Environmental Toxicology and Chemistry 24:1204-1210.
[9] Pond et al. 2008.
[10] Kennedy, A.J., DS. Cherry, and R.J. Currie. Field and laboratory assessment of a coal processing effluent in the Leading Creek Watershed, Meigs County, Ohio. Archives of Environmental Contamination and Toxicology 44:324–331.

coal mine drainage.[11] A 2005 published study by Kennedy et al. linked impairment of aquatic life to elevated levels of Total Dissolved Solids (TDS).[12] Finally, a 2010 published study by Pond links specific conductance as the most strongly correlated factor to a reduction of *Ephemeroptera* in streams impacted by mining and residential development.[13]

In addition, an analysis of peer-reviewed studies recently published in the journal *Science* shows that ecological losses downstream of coal mining valley fills are associated with increased levels of TDS and conductivity, sulfates, and selenium.[14] EPA's Office of Research and Development (ORD) recently completed a review of the scientific literature on surface coal mining and found effects that included resource loss, water quality impairment, and adverse effects on aquatic ecosystems. This report is being submitted to the EPA Science Advisory Board (SAB) for review and is also publicly available.

EPA recently conducted assessments of permitting practices under CWA Sections 402 and 404 for surface coal mining projects in Appalachia. The Permit Quality Review of Section 402 permits in West Virginia, Kentucky, Tennessee and Ohio, conducted in September and October 2009, identified concerns related to effective protection of downstream water quality consistent with requirements of the CWA. The concerns focus on the interpretation of narrative and numeric criteria in CWA Section 402 permits for surface coal mining projects. In addition, the evaluation of pending coal mining projects under the EPA-Corps Section 404 Enhanced Coordination Procedures (ECP) found that many of these projects may not be consistent with EPA and Corps regulations, including the Section 404(b)(1) Guidelines. As many as 80% of these permits raised concerns with respect to compliance with state narrative water quality standards, while more than half raised concern for the potential for significant degradation of aquatic ecosystems.

The emerging science related to adverse environmental and water quality effects is based on data and analyses subjected to the rigors of peer-reviewed science and quality assurance reviews. EPA places a high priority on quality assurance and agency policy specifies necessary quality assurance activities be performed to ensure data are of sufficient quantity and adequate quality for their intended use. EPA's reviews of ambient chemical and biological data and analyses that support some permitting decisions have revealed consistent and serious issues with underlying data quality, such as erroneous field meter readings, biological samples collected outside of state index periods or during extreme low flows, and inclusion of non-endemic taxa in taxonomic lists. Analyses of these data also have demonstrated concerns, such as inappropriate aggregation of biological data from several stream types (headwater to larger river) or several

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[11] Kentucky Department for Environmental Protection, Division of Water, Water Quality Branch. Effects of Surface Mining and Residential Land Use on Headwater Stream Biotic Integrity in the Eastern Kentucky Coalfield Region.
[12] Kennedy A. J., D.S. Cherry and C.E. Zipper. Evaluation of Ionic Contribution to the Toxicity of a Coal-Mine Effluent Using *Ceriodaphnia dubia*. Archives of environmental contamination and toxicology vol. 49.2:155-162.
[13] Pond, G.J. "Patterns of *Ephemeroptera* taxa loss in Appalachian headwater streams (Kentucky, USA)." Hydrobiologia 641(1):185-201.
[14] Palmer, M.A., E.S. Bernhardt, W.H. Schlesinger, K.N. Eshleman, E. Foufoula-Georgiou, M.S. Hendryx, A.D. Lemly, G.E. Likens, O.L. Loucks, M.E. Power, P.S. White, P.R. Wilcock. 2010. Mountaintop Mining Consequences. Science 327(5962):148-149.

seasons, failing to reflect natural data variability, and inappropriately including several samples from one site as independent samples in a statistical analysis (pseudoreplication).

Regions should ensure that the environmental data supporting CWA decision-making are carefully scrutinized to ensure they are of sufficient quality to support their intended use. Regions should encourage the incorporation of Quality Assurance Project Plans (QAPPs) for sampling data and Quality Assurance/Quality Control (QA/QC) data within data submitted to EPA through the permitting process. For guidance in ensuring environmental data are of sufficient quality, Regions should consult the agency's quality assurance policy at http://www.epa.gov/quality/index.html.

EPA has made substantial progress in recent months in the development of high-quality scientific information to support new numeric water quality values for conductivity, which is regularly observed at high levels in streams downstream from Appalachian surface coal mining operations. EPA expects, consistent with the requirements of the CWA, that the use of these values and the extensive scientific information that supports these numbers will be extremely helpful to states in the development of water quality-based effluent limits for Section 402 permits. Establishing enforceable numeric limits for conductivity, selenium, and other parameters in state Section 402 permits will help to improve water quality and better protect public health and aquatic life in streams downstream from Appalachian surface coal mining operations.

III. EPA Oversight of NPDES Permitting for Surface Coal Mining Operations in Appalachia

EPA has reason to believe that discharges from surface mining activities have a significant potential to cause nonattainment of applicable water quality standards downstream from valley fills, impoundments, and sediment ponds. Discharges from Appalachian surface coal mining activities have been found to have a high potential to impact aquatic life uses.[15] Numerous studies, data submitted to permitting authorities for proposed mining activities, and some state Section 303(d) lists have shown high levels of conductivity and dissolved solids and sulfates to be a primary cause of water quality impairments downstream from such mine discharges.

The Office of Water has been working closely with Regions 3, 4, and 5 to assess the quality of state-issued CWA Section 402 (NPDES) permits for surface coal mining operations with respect to the requirements of each state's permitting program in the Appalachian states of Tennessee, Ohio, Kentucky, and West Virginia. EPA has also been assessing permits for their compliance with applicable federal requirements. The goal of this assessment is to strengthen these state-issued NPDES permits to better address the impacts discussed above.

The CWA and EPA's implementing regulations require NPDES permits to contain technology-based effluent limits and, where necessary to protect water quality, water quality-based effluent limits. All permits reviewed by EPA included appropriate technology-based

[15] Pond et al. 2008.

limits for pollutant parameters listed in the effluent limitation guidelines for coal mining (40 CFR Part 434). However, based on observations from both ongoing program oversight and a focused Permit Quality Review of permits for surface coal mining activities, including detailed discussions with state permit writers, EPA has identified certain concerns common to many of the reviewed permits that warrant immediate attention to ensure that water quality is protected. Therefore, when Regional offices exercise their authority to review draft or proposed state NPDES permits for discharges to waters of the U.S. associated with Appalachian surface coal mining operations, Regions should evaluate several aspects of those permits as detailed below.

The sections below detail requirements of the Act and issues identified during EPA's recent Permit Quality Review. Should Regions identify similar concerns when reviewing draft or proposed permits in the future, we encourage you to work with your authorized states to resolve these concerns. As noted below, however, where discussions with the state do not produce a proposed permit that, in the Region's judgment, satisfies the requirements of the Act, an objection to the issuance of the proposed permit would be an appropriate response. We encourage the Water Division Directors of the three Regions to work together to ensure a comparable level of review and response across Appalachia.

A. Completion of Required Reasonable Potential Analyses

As noted above, the CWA requires NPDES permits to contain water quality-based effluent limits when necessary to meet water quality standards (CWA Section 301(b)(1)(C); 40 CFR Section 122.44(d)(1)). In order to determine whether water quality-based effluent limits are necessary, the permitting authority is required to conduct a "reasonable potential analysis." A reasonable potential analysis determines whether a discharge will cause, or has the reasonable potential to cause or contribute to, an excursion above a numeric or narrative water quality standard. EPA's regulations, EPA's 1991 Technical Support Document (TSD) for Water Quality-based Toxics Control (EPA/505/2-90-001 PB91-127415)[16], and established state procedures explain how to conduct this analysis.

EPA's review of NPDES permit administrative records found that parameters known to be present in the effluent, based on data submitted with the permit applications, were often not assessed for the reasonable potential to cause or contribute to an excursion above water quality standards. Although each permit requires a case-specific analysis, in general, an NPDES permit that fails to show evidence of a parameter-specific reasonable potential analysis will be inconsistent with the requirements of the CWA. Furthermore, EPA expects that in many, if not most, cases the available science will demonstrate that there is a reasonable potential for these discharges to cause or contribute to an excursion above numeric or narrative water quality standards, thus making water quality-based effluent limits necessary.

To characterize the effluent, existing dischargers applying or reapplying for NPDES permit coverage should provide the permitting authority with screening data for a suite of pollutants and pollutant parameters listed in the applicable NPDES permit application form. However, for new (proposed) discharges, the application form for an individual permit requires

[16] This publication is available at http://www.epa.gov/npdes/pubs/owm0264.pdf.

only an estimate of the effluent characteristics. In addition to data specifically required by permit applications, 40 CFR Section 122.21 allows permitting authorities to request any additional data as necessary to support an assessment of potential water quality impacts (e.g., conductivity and total dissolved solids). Facilities applying for coverage under an NPDES general permit are required to submit information specifically identified in the Notice of Intent provisions of the general permit. EPA's review of permits and associated records found that states generally did not adequately document or explain how information submitted by applicants was used to characterize the nature of their actual or proposed discharges. In particular, where facilities had proposed to discharge, but had not yet begun construction or operation, the files contained little discussion of how the permitting authority projected or anticipated the types and concentrations of pollutants expected in the effluent.

Where effluent data are available (i.e., for existing discharges), EPA's expectation is that permitting authorities will use all valid and representative data to determine whether the discharge causes, has the reasonable potential to cause, or contributes to an excursion of numeric and/or narrative water quality criteria and standards. For new (proposed) discharges, the permitting authority should require the applicant to characterize the anticipated pollutant concentrations and loads using data from similar discharges and/or based on characteristics of local soils and geology. For example, these data may be from mining facilities located adjacent to or having similar geologic characteristics as the mine under review, or from ambient data collected as part of the Section 404 or SMCRA permit applications. Permitting authorities should independently seek to obtain such data if not submitted by the applicant or can reject the application as not sufficient. Ambient water quality data collected as part of the SMCRA and Section 404 permitting processes should be included in the NPDES permit development process and, where appropriate, should be incorporated as "background" conditions in reasonable potential analyses.

B. Incorporation of Numeric Water Quality Standards in Terms of NPDES Permits

Where a surface coal mining discharge is found to have reasonable potential to exceed a numeric water quality standard, the regulations require that NPDES permits include water quality-based effluent limits (WQBELs) based on the existing numeric water quality criteria in state water quality standards. While EPA's Permit Quality Review found that many permits did incorporate all relevant numeric water quality standards, some permits omitted them. As one example, all Appalachian states have adopted a chronic numeric criterion for selenium of 5 µg/l for the protection of aquatic life. Should a reasonable potential analysis indicate that the discharge of selenium (or another parameter) has the potential to cause or contribute to an excursion above any state standard and a state fails to include a WQBEL based on the existing state water quality standard, EPA expects that such a permit would not be consistent with the CWA.

It is the responsibility of the applicant to characterize the wastewater to be discharged from the permitted facility. In order to have a complete NPDES permit application, data must be presented by the applicant to properly characterize its discharge to enable a reasonable potential analysis to be completed by the permit writer at the time of permit issuance. Data may be

secured through evaluation of similarly situated facilities in adjacent watersheds or similar practices in the same ecological or geological setting.

Where there is an approved Total Maximum Daily Load (TMDL) for the receiving waterbody, the receiving waterbody is listed as impaired on the state's approved Section 303(d) list, or a downstream waterbody may be affected by the discharge, it will be important that the reasonable potential analysis include an analysis of the pollutants for which the TMDL was established or for which the waterbody is listed as impaired, or for pollutants that may affect downstream waters.

1. Specific Guidance Regarding Compliance Schedules

Compliance with all NPDES permit terms is required at the time of permit issuance. However, federal regulations at 40 CFR Section 122.47 allow for NPDES permits to include compliance schedules for the achievement of WQBELs, when determined to be appropriate under discharger-specific circumstances. When determined to be appropriate, a compliance schedule must require compliance with the WQBEL within a time determined to be "as soon as possible" based on a discharger-specific evaluation. Compliance schedules are only available for WQBELs based on water quality standards that have been newly adopted after July 1, 1977, and where the applicable water quality standards authorize the use of such schedules. For further guidance regarding considerations for Regions when evaluating compliance schedules, please see the May 10, 2007, Memorandum from James Hanlon, Director, Office of Wastewater Management to Alexis Strauss, Director, Water Division, EPA Region IX, and the November 16, 2007, Letter from Jon M. Capacasa, Director, Water Protection Division, US EPA Region III, to Lisa A. McClung, Director, Division of Water and Water Management, West Virginia DEP, and Randy Huffman, Director, Division of Mining And Reclamation, West Virginia DEP.[17]

C. Incorporation of Narrative Water Quality Standards in the Terms of NPDES Permits

In addition to those parameters for which there are numeric water quality standards, all Appalachian states have adopted narrative water quality standards. Of particular relevance here, nearly all Appalachian states do not currently have applicable numeric water quality criteria that account for the effects associated with high levels of conductivity, total dissolved solids, and sulfates. In lieu of such numeric criteria, all Appalachian states have applicable narrative water quality criteria. EPA regulations are clear that NPDES permits must contain provisions that implement both numeric water quality standards <u>and</u> narrative water quality standards and that the same reasonable potential analysis completed for numeric standards must be completed for narrative standards as well. 40 CFR Sections 122.44(d)(1) and (d)(1)(vi).

EPA's review of permits found that states did not incorporate provisions that would implement the relevant narrative water quality standards relating to discharges that increase the levels of conductivity, total dissolved solids, and sulfates. The permits do not contain limits based on whole effluent toxicity (WET) and/or a chemical-specific numeric interpretation of the

[17] These documents are available at http://www.epa.gov/owow/wetlands/guidance/mining.html

narrative criteria as required by 40 CFR Sections 122.44(d)(1)(v) and (vi). In addition, the permits' statements of basis or fact sheets do not provide information indicating that the narrative criteria were considered as part of the determination of which effluent limitations are necessary. Although EPA's review of each permit is case-specific, EPA expects that a permit that fails to include provisions implementing the narrative water quality standards and fails to explain why such omission is appropriate under the regulations will not be consistent with the requirements of the CWA.[18]

1. Documentation on How States Will Derive Effluent Limits Based on Narrative Water Quality Standards

EPA Regions should request that states provide documentation describing how the states will perform a reasonable potential analysis and, where necessary, develop effluent limits (or other permit conditions), to ensure compliance with the state's narrative water quality standards. The state should provide a detailed description of the decision-making process, including the types and sources of data used to characterize both expected effluent quality and receiving water quality with respect to narrative water quality standards. Baseline water quality analyses required for SMCRA permit applications and projected or estimated effluent concentrations characterizing expected effluent quality are expected to be used to inform each state's decisions.

In documenting how they will interpret and implement their narrative standards, the states should take into account that the NPDES regulations at 40 CFR Section 122.44(d)(1)(vi) require the consideration of relevant information pertaining to a pollutant that may cause or contribute to an excursion above an applicable state narrative water quality standard. The scientific literature is increasingly recognizing the relationship between conductivity levels in Appalachian streams and impacts to aquatic biota in streams below surface coal mining operations. Based on field measurements comparing unmined and mined watersheds in Central Appalachia, the peer-reviewed 2008 "Pond-Passmore" study concluded that aquatic life at sites with specific conductance greater than 500 µS/cm were observed to have been adversely impacted based on a genus-level multi-metric biological index.[19] In addition, EPA's draft report, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*,[20] also recognizes stream-life impacts associated with conductivity. This study, which is publicly available and will undergo external peer review by the SAB, applies EPA's standard method for

[18] In the limited cases in which a state determines that it is infeasible to calculate a numeric effluent limit to implement a narrative water quality standard, the state should include in the permit appropriate WET limits and best management practices (BMPs) to control or abate the discharge of pollutants, consistent with 40 C.F.R. Section 122.44(k)(3). In these limited circumstances, the state would need to document the basis for its determination that a numeric effluent limit for the narrative standard was infeasible to calculate, and would need to include associated provisions for monitoring the effectiveness of BMPs. Monitoring should include in-stream conditions of aquatic biota consistent with state biocriteria. Should downstream impacts exceed biocriteria, provisions for adaptive remedial action should be included.

[19] Pond et al. 2008.

[20] This methodology and benchmark were developed in a parallel but unrelated track to a literature review summary of the effects of mountaintop mining and valley fills produced by EPA that has also been issued for Science Advisory Board review and consultation.

deriving water quality criteria to field measurements and concludes that genus-level impacts to the biological community occur at conductivity levels of 300 µS/cm.[21]

During the SAB review process, EPA believes that this report should be considered by Appalachian states as relevant information per 40 CFR Section 122.44(d)(1)(vi) in implementing applicable state narrative water quality standards in NPDES permits, and by Regions in your review of these permits. Documentation of how each state will interpret and implement its narrative water quality standards (in light of the data and conclusions of this conductivity report and other relevant information) will help ensure that the public and the regulated community have a better understanding of the state's decision-making process and increased certainty that narrative water quality standards are adequately met. As a general matter, EPA expects that the conductivity impacts of projects with predicted conductivity levels below 300 µS/cm generally will not cause a water quality standard violation and that in-stream conductivity levels above 500 µS/cm are likely to be associated with adverse impacts that may rise to the level of exceedances of narrative state water quality standards.[22] If water quality modeling suggests that in-stream levels will exceed 500 µS/cm, EPA believes that reasonable potential likely exists to cause or contribute to an excursion above applicable water quality standards; unless, based on site-specific data, the state has an alternative interpretation of their water quality standards that is supported by relevant science. Similarly, if water quality monitoring suggests that in-stream levels will exceed 300 µS/cm but will be below 500 µS/cm, EPA should work with the permitting authority to ensure that the permit includes conditions that protect against conductivity levels exceeding 500 µS/cm. In circumstances where conductivity levels in waters proposed for new mining related discharges already exceed 500 µS/cm, EPA will coordinate with the permitting authority on a site-specific basis to ensure these new discharges will not cause or contribute to a violation of water quality standards. Once EPA's draft conductivity report is finalized following SAB review, we will evaluate whether changes to the conductivity benchmarks identified here are appropriate.

At a minimum, should the record indicate that a reasonable potential exists, the permitting authority must demonstrate in the administrative record, based on site- or receiving-water-specific information, how the permit implements the narrative water quality standards in a manner that is consistent with the CWA, and Regions are encouraged to review such a record carefully. For new (proposed) discharges, the permitting authority should require the applicant to characterize the anticipated pollutant concentrations and loads using data from similar discharges and/or based on the characteristics of local soils and geology. As noted above, as a general matter, EPA expects that in-stream conductivity levels above 500 µS/cm are likely to be associated with adverse impacts to water quality. The scientific literature has identified conductivity levels above this level in impaired streams below surface coal mining operations in Appalachian ecoregions 68, 69, and 70 and, therefore, it is generally likely that such surface coal mining operations will have a reasonable potential to cause or contribute to an exceedance of

[21] As described in the report, this study may be applied to all waters in the Appalachian region that are dominated by salts of SO_4^{2-} and HCO_3^- at circum-neutral pH and low levels of chloride.
[22] In certain fact-specific circumstances, conductivity levels above 500 µS/cm may not be associated with adverse aquatic impacts. EPA will work with permitting authorities on a site-specific basis to assess reasonable potential.

water quality standards.[23] Permits for discharges associated with activities other than surface coal mining should also be evaluated to determine whether they are likely to result in in-stream conductivity levels above 500 µS/cm. We believe that circumstances unique to surface coal mining, however, are principally responsible for the increase in conductivity levels observed in surface waters downstream of mining practices. Surface coal mining involves disturbing large volumes of rock and dirt, land clearing, and spoil disposal activities at a scale not typically associated with activities such as development practices or forestry. We do not have studies of other non-mining activities demonstrating a likelihood that they will have a reasonable potential to cause or contribute to an exceedance of water quality standards. EPA should coordinate with the permitting authority to consider relevant information when conducting a reasonable potential analysis for other activities on a case by case basis.

The state must provide adequate documentation in the permit fact sheet or statement of basis to demonstrate that it has assessed reasonable potential and, where necessary, developed effluent limits (or other permit conditions) adequate to protect all applicable water quality standards, including narrative water quality standards. EPA will review the adequacy of the state's explanation in its fact sheet or statement of basis, considering the available scientific and other information. Where EPA concludes that the state's explanation is not adequate, or the state fails to provide an explanation of how it has interpreted or applied its narrative water quality standards, EPA may object to the permit in accordance with the provisions of 40 CFR Section 123.44(c).

D. Completing an Appropriate Antidegradation Analysis

As EPA increases its oversight of permits associated with surface coal mining activities, EPA will also focus on ensuring that permits are issued consistent with water quality standards-related antidegradation regulations, policies and procedures. State antidegradation policies provide protection of waters from degradation. EPA will, in its oversight of NPDES permits, ensure that adequate antidegradation reviews have been conducted for the receiving water consistent with applicable state water quality standards.

Antidegradation regulations require that all permits include limits sufficient to maintain and protect existing uses (Tier 1). For outstanding national resource waters (Tier 3), antidegradation requires the maintenance and protection of ambient water quality (e.g., no lowering of water quality). For high quality waters (Tier 2), where the quality of waters exceeds the level necessary to protect the use, EPA will particularly focus on ensuring that the state has made the finding that allowing lower water quality is "necessary to accommodate important social or economic development in the area in which the waters are located." 40 CFR Section 131.12(a)(2). This amounts to a two-part test: demonstration of the extent to which the discharge is "necessary" in the manner and magnitude proposed, and of its importance for social or economic development.

[23] Ecoregions 68, 69, and 70 include portions of the six Appalachian states referenced earlier in this memorandum. A map of these ecoregions is available at http://www.epa.gov/wed/pages/ecoregions/level_iii htm.

The finding of necessity is among the most important and useful aspects of an antidegradation program. EPA expects an alternatives analysis to evaluate whether the proposed discharge is "necessary." This analysis should include consideration of a range of less-degrading or non-degrading alternatives to the direct discharge or to the manner of discharge (e.g., non-discharging options, relocation of discharge, alternative processes, and innovative treatments). In the finding of social or economic importance of the proposed activity, EPA expects the state to analyze the social and/or economic impact associated with the lowering of water quality. The state should provide documentation to support its antidegradation analysis.

There are similar analyses of alternatives performed under CWA Sections 401, 402, and 404; NEPA; and SMCRA. To the extent that a Section 402 antidegradation analysis has been completed concurrently or in advance of analyses performed under these related authorities, Regions should encourage permitting authorities to use the Section 402 antidegradation analysis to inform similar analyses under these related authorities.

E. Conclusions Regarding Improved NPDES Permitting

Initially, we want to encourage the Regions to continue to work proactively with authorized states to improve the quality of state-issued NPDES permits for surface coal mining. In that regard, we offer eight specific suggestions:

1. Regions should request information from each state as to how that state is interpreting and incorporating applicable numeric and narrative water quality standards within its permitting decisions.

2. The permitting authority must demonstrate in the administrative record, based on site- or receiving-water-specific information, the reasonable potential determination and the basis for any limits or other permit requirements including how the permit implements the narrative water quality standards in a manner that is consistent with the CWA.

3. In recognition of the fact that during discussions with state permitting staff, some state permit writers indicated they did not have sufficient tools to interpret the narrative water quality standards for these discharges, Regions should foster additional dialogue on information and tools EPA could provide to assist the states in translating their narrative criteria into numeric effluent limits.

4. Permitting authorities should consider data from similarly situated mines in their reasonable potential analyses for new facilities. In addition, as noted in Chapter 3.2 of EPA's "Technical Support Document for Water Quality-based Toxics Control,"[24] permitting authorities may determine reasonable potential based on information other than effluent data, such as the nature of the operation and its potential impact on the receiving water. Regions should evaluate whether required and appropriate data are

[24] "Technical Support Document for Water Quality-based Toxics Control." EPA Office of Water, March 1991.

submitted with permit applications and encourage permitting authorities to consider permit applications incomplete if the data characterization is not sufficient.

5. Regions should consider objecting to permits that do not assess reasonable potential effectively or fail to implement numeric and narrative standards.

6. Regions should review, as appropriate, general permits, notices of intent, individual permits, and public participation efforts, and provide comments on eligibility, WQBELs, and antidegradation in particular.

7. In situations where an NPDES permit has already been issued, but other permits or authorizations are required before a project may proceed, we encourage Regions to work with the other permitting or authorizing authorities to address any concerns left unaddressed by the NPDES permit, as appropriate.

8. Regions should evaluate the consistency of a permit's monitoring provisions with the statutory and regulatory requirements.

When reviewing state-issued permits, we strongly encourage you to ensure that the items discussed above are addressed in a manner consistent with the CWA and EPA's implementing regulations. In instances in which the Region concludes that a proposed permit is not consistent with the CWA and EPA's implementing regulations, Regions should work closely with the state to make improvements. Historically, Regions have used several tools to try and resolve concerns regarding the sufficiency of state NPDES permits, ranging from comment letters to face-to-face meetings. We encourage Regions to continue to utilize those tools. If, however, in the Region's judgment discussions with the state do not produce a proposed permit that satisfies the requirements of the Act, an objection to the issuance of the proposed permit would be an appropriate response.[25]

1. Specific Guidance Regarding Oversight of General Permits

Some discharges at surface coal mining sites are authorized through state-issued general NPDES permits. In light of the case-specific analysis necessary to ensure that surface coal mining activities will achieve water quality standards, general permits will often be inadequate. Regions are strongly encouraged to advise the permitting authorities whether the Region agrees that general permits are appropriate for these discharges or whether the Region believes that, in light of the environmental impacts caused by these discharges and the need for tailoring permit conditions by receiving water, permitting authorities should require individual permits in all instances.

[25] Following such an objection, the state or other interested parties may request a hearing and provide additional information supporting their position. After such a hearing is held (if requested), EPA can reassert its objection, modify its objection, or withdraw its objection. If EPA continues to object (or if no hearing is requested) and if EPA's objections are not satisfactorily resolved by the state permitting authority, authority to issue the permit will pass to EPA (40 CFR Section 123.44(h)).

When reviewing a general permit, Regions should review it closely to ensure that it includes all relevant CWA requirements. Some general permits and state NPDES Memoranda of Agreement (MOAs) provide EPA with the opportunity to review notices of intent to be covered under a general permit. When you have that opportunity, we encourage you to review the notices of intent. For example, EPA and Kentucky have entered into a MOA that sets out EPA's role in reviewing both individual NPDES permits and individual NOIs to be covered under a general permit. As provided for in the MOA, EPA notified Kentucky in a June 16, 2009, letter that EPA was exercising its option to review and comment, prior to issuance or modification, on all draft NPDES individual permits, and NOIs for all proposed coverages under an NPDES general permit for proposed projects being evaluated under the ECP process. As a result, under the MOA, EPA will review the general permit NOIs and has 10 days to notify the Kentucky Division of Water of any objection to the applicant's suitability for coverage under the General Permit.

2. Specific Guidance on Environmental Justice Considerations under CWA Section 402

There are important provisions under CWA Section 402 that may be relevant to environmental justice issues stemming from surface coal mining and its impact on human health and the environment. EPA will address the adequacy of the technical and scientific aspects of the permit, as well as public participation, in reviewing NPDES draft permits. In particular, EPA will consider whether the public has been given meaningful opportunity for participation in development of the permit pursuant to 40 CFR Section 124.11.

As explained above, when EPA determines that a draft or proposed permit fails to comply with the CWA, EPA has the authority to object to the issuance of that permit. When Regions review draft or proposed permits for compliance with the Act, we encourage you to also review those permits to determine the extent to which issuing the permit may result in adverse human health or environmental effects on low-income and minority populations. For example, a Region may determine that the issuance of a permit will have adverse effects on drinking water supplies or fisheries that are relied on by subsistence fishers, or wildlife used as a subsistence food source by the local population. If EPA determines that issuing the NPDES permit may result in adverse human health or environmental effects, EPA will consider such effects when determining whether to exercise its discretion to object to a draft state permit under CWA Section 402(d) and EPA's implementing regulations.

IV. Strengthening EPA's Environmental Review Under CWA Section 404 in Coordination with the Corps of Engineers

EPA has long played a role in assessing environmental and water quality implications of proposed Section 404 permits, and is authorized to prohibit or deny projects that do not meet the criteria in the CWA and implementing regulations. While states are responsible, in coordination with EPA, for establishing state water quality standards, EPA has the critical authority under CWA Section 404(b)(1) to make independent judgments about threats to water quality. In

addition to the documented impacts from increased sediment loading, a growing body of data demonstrates that high conductivity and/or selenium levels in streams downstream from mining operations contribute to the impairment of biological diversity and ecological integrity of these streams and can lead to significant adverse impacts on the aquatic ecosystem and contamination of drinking water supplies. EPA and Corps regulations require consideration of these environmental and water quality concerns in the evaluations of applications for permits under CWA Section 404.

Under Section 404(a) of the CWA, the Corps is authorized to issue permits, after notice and opportunity for public hearings, for the discharge of dredged or fill material into waters of the U.S., including wetlands. Under Section 404(b)(1), EPA is authorized to develop guidelines, in conjunction with the Corps, to ensure that the goals of the CWA are met. These regulations are located at 40 C.F.R. Section 230. These Section 404(b)(1) Guidelines (Guidelines) are applicable to all discharges of dredged or fill material to waters of the U.S, and the Corps issues Section 404 permits after evaluating proposed discharges for consistency with the Guidelines and its own implementing regulations. 40 C.F.R. Section 230.2. EPA also reviews public notices and general permit pre-construction notifications for Section 404 permits for consistency with the Guidelines. Under Section 404(q) of the CWA, the Agencies have entered into a Memorandum of Agreement (404(q) MOA) governing the sharing of information and elevating of decisions when there is a dispute between regional and district offices over implementation of the Guidelines.[26] Finally, under Section 404(c) of the CWA, the Administrator is authorized to "veto" a permit if the Administrator determines that a discharge will have an unacceptable adverse effect.[27]

When reviewing Corps public notices and general permit pre-construction notifications for CWA Section 404 authorizations for surface coal mining-related discharges to waters of the United States in Appalachian states, Regions should be guided by the following sections.

A. Principles for Regional Review of Appalachian Surface Coal Mining Section 404 Permit Applications

The fundamental premise of the Guidelines is that no discharge of dredged or fill material may be permitted if: (1) it causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable state water quality standard; (2) a practicable alternative exists that is less damaging to the aquatic environment; or (3) the nation's waters

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[26] Clean Water Act Section 404(q): Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army (1992). Available at http://www.usace.army.mil/CECW/Documents/cecwo/reg/mou/moa_epa404q.pdf.

[27] "The Administrator is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site, and he is authorized to deny or restrict the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever he determines, after notice and opportunity for public hearings, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. Before making such determination, the Administrator shall consult with the Secretary. The Administrator shall set forth in writing and make public his findings and his reasons for making any determination under this subsection." CWA Section 404(c).

would be significantly degraded. 40 C.F.R. Section 230.10. In addition, if the proposed discharge is associated with a non-water-dependent activity, upland alternatives are presumed to exist. 40 C.F.R. Section 230.10(a)(3). Avoidance and minimization of the direct, indirect, and cumulative adverse environmental and water quality impacts to streams, wetlands, and other aquatic resources should be required. A demonstration must first be made that there is no practicable alternative to the proposed discharge to the waters of the United States that would have less adverse impact on the aquatic ecosystem. If there is no less damaging practicable alternative, then all appropriate and practicable steps to minimize potential adverse impacts of the discharge must be taken. Finally, mitigation is required to compensate for any remaining aquatic impacts.

To better ensure that surface mining proposals meet these requirements, Regions should affirm in their review that mining projects are consistent with the following principles:

1. Mining activities will not cause or contribute to violations of water quality standards, contaminate drinking water supplies, or add toxic pollutants that kill or impair stream life. 40 C.F.R. Section 230.10(b). Mining discharges must also not result in significant degradation of the aquatic environment, including contamination of water supplies. 40 C.F.R. Section 230.10(c).

2. Applicants have evaluated a full range of potential alternatives to discharging into waters of the U.S., including off-site and/or other disposal alternatives, with clear documentation regarding practicability for each alternative. 40 C.F.R. Section 230.10(a). Alternative mining methods that reduce generation of excess spoil should also be analyzed. Practicable, modern engineering and materials handling practices should be used to reduce the size and number of valley fills or the extent of streams impacted as a result of mine-through operations that bury, eliminate, and pollute local streams.

3. Mining companies have avoided and minimized their direct, indirect, and cumulative adverse environmental impacts to streams, wetlands, watersheds, and other aquatic resources. 40 C.F.R. Sections 230.10(a) and 230.10(d).

4. Remaining mining-related aquatic impacts have been effectively mitigated by establishing, restoring, enhancing, or preserving streams and wetlands; protecting water quality, including drinking water; and reclaiming watersheds when mining is completed. 40 C.F.R. Section 230.10(d).

Water quality standards are fundamental to achieving the purposes of the CWA. EPA has a role and responsibility for ensuring that water quality standards are not exceeded because of discharges regulated under Section 404 from Appalachian surface coal mining operations. In their review to determine whether a proposed discharge will cause or contribute to an exceedance of water quality standards, Regions should be guided by the principles articulated in Sections III.B. and III.C. of this memorandum addressing implementation of both numeric and narrative water quality standards. EPA retains its responsibility for ensuring that neither numeric nor narrative water quality standards are exceeded due to discharges of fill material even if a state has issued a water quality certification under Section 401 of the CWA. State certifications of

compliance with applicable water quality standards will be considered conclusive by the Corps with respect to water quality considerations unless the Regional Administrator advises the Corps of other water quality aspects to be taken into consideration. 33 C.F.R. Section 320.4(d). Thus, Regions should convey their conclusions with respect to possible exceedances of water quality standards to the Corps and, if appropriate changes to the permit are not made in response to these water quality concerns, may proceed under the 404(q) MOA and/or Section 404(c).

Similarly, with respect to the four review principles identified in this section and the guidance for applying the Guidelines in the next section, Regions should convey the results of their reviews to the Corps, the permit applicant, and the state and, if appropriate changes to the permit are not made in response to these water quality concerns, may proceed under the 404(q) MOA and/ or Section 404(c).

B. Key Information for Evaluating Permit Applications for Appalachian Surface Coal Mining

Because of the complexity, size, and scale of surface coal mining projects, in reviewing proposed Section 404 permit applications for these activities, it is essential that federal and state agencies have appropriate data to fully review the aquatic ecosystem impacts anticipated to occur. EPA Regions should evaluate project-specific data including, but not limited to, the following information. Where such data are also required by other federal and state regulatory partners, the agencies are encouraged to collaborate in sharing this information among one another to increase efficiency and better ensure regulatory decisions are being made using the same base of technical information.

- Geospatial information – Digital geospatial boundaries for the proposed project and individual valley fills. Location of nearby, reference, or unmined tributaries in the same catchment.
- Surface area disturbed – Total acreage of surface disturbance area (mineral extraction area).
- Spoil material – Volume of overburden excavated and volume of excess spoil (in cubic yards).
- Disposal location – Detailed as on site, off site, or a combination or percentage.
- Spoil for each valley fill – In cubic yards, where applicable.
- Drainage area – Above each toe of fill and each sediment pond, whichever is further downstream (in acres).
- Impacts – Aquatic resource impacts resulting from, but not limited to, valley fills, sediment ponds, slurry ponds, in-stream mining, or other mining operation features, in linear feet by type of stream (perennial, intermittent, ephemeral) or acres for other resource types, and by type of impact (permanent or temporary).
- Baseline monitoring – Pre-mine (land disturbance) sampling data and sampling location for total suspended solids, total dissolved solids, conductivity, sulfates, bicarbonate, chloride, magnesium, potassium, calcium, sodium, pH, selenium, and list of the presence and abundance of aquatic organisms identified to the loweset

practicable taxonomic level, usually genus-level for invertebrates and species-level for vertebrates.

- Hydrology – Cumulative Hydrologic Impact Assessments (CHIAs) and Probable Hydrologic Consequences (PHC).
- Watershed condition – Any sampling data for total suspended solids, total dissolved solids, conductivity, sulfates, bicarbonate, chloride, magnesium, potassium, calcium, and macroinvertebrate presence and abundance for adjacent mines included with the CHIA or other sources.
- Geology – Geologic strata information from core samples, including analysis of selenium, pyrite, calcium carbonate, acid-producing strata, and any strata that may cause or contribute to conductivity.
- Drinking water supplies – Location of drinking water supplies that could be affected, including private wells.
- Subsistence consumption – Patterns of local consumption of fish and wildlife that may be affected by loss of waters and impacts to surface water quality.

C. Applying the 404(b)(1) Guidelines for Surface Coal Mining Activities

The Section 404(b)(1) Guidelines prohibit issuance of a permit that will cause or contribute to excursions from applicable state water quality standards or to significant degradation of the aquatic ecosystem. 40 C.F.R. Sections 230.10(b) and (c). While issuance of the Section 402 permit is required to control discharges of pollutants into waters of the United States from surface mining operations, the discharge of fill material resulting in physical modification and elimination of portions of headwater streams may have water quality impacts that are not addressed in the NPDES permit. For example, elimination of all or even part of a headwater stream may remove from the overall watershed system an important source of freshwater dilution that contributes to water quality. Accordingly, even where a NPDES permit has been issued, the Section 404 permit must independently ensure that water quality is protected. The applicant should be required to demonstrate up front, based on proposed mining techniques, best management practices, or other actions, that the project will not cause or contribute to an excursion from applicable water quality standards or to significant degradation. The permit should include a condition, pursuant to 40 C.F.R. Sections 230.10(b) and (c), prohibiting the project from causing or contributing to an excursion from applicable water quality standards or to significant degradation.

The following discussion represents EPA's expectations for the analyses necessary to ensure compliance with water quality standards, prevention of significant degradation, and full analysis of avoidance, minimization, and (where necessary) mitigation, to achieve full compliance with the 404(b)(1) Guidelines.

1. Preventing Violations of Water Quality Standards

The Section 404(b)(1) Guidelines require that Section 404 permits must not cause or contribute, after consideration of site dilution and dispersion, to violations of applicable state

water quality standards. 40 CFR Section 230.10(b)(1). As explained more fully above in Section III, Appalachian states have narrative water quality standards that protect the native aquatic community, including protection from adverse effects associated with elevated levels of in-stream conductivity. Nearly all Appalachian states, however, have not established numeric water quality criteria for conductivity or TDS and historically have not included numeric effluent limitations to address conductivity or TDS in state-issued NPDES permits. The absence of necessary WQBELs in 402 permits has meant that EPA has needed to consider whether issuance of a 404 permit would be inconsistent with the Guidelines because authorization of a particular mining project would result in exceedances of a state's narrative standards. Section III.C. of this memorandum provides specific guidance to the Regions on how to evaluate whether provisions of NPDES permits are adequate to protect against violations of water quality standards, and that guidance also applies to how Regions should conduct that evaluation for Section 404 permits. As discussed below, even where a Section 402 permit has addressed protection of water quality standards, the Guidelines establish an independent obligation to address potential violations of water quality standards associated with discharges of dredged or fill material and to protect against significant degradation.

2. Preventing Significant Degradation

In addition to the provision in the Section 404(b)(1) Guidelines requiring that Section 404 permits must not cause or contribute, after consideration of site dilution and dispersion, to violations of applicable state water quality standards (Section 230.10(b)(1)), a separate, additional provision prohibits the permitting of a discharge that will cause or contribute to significant degradation of the waters of the U.S. (Section 230.10(c)). The Corps and EPA therefore have a responsibility to ensure sufficiently protective requirements are included when reviewing mining projects in draft Section 404 permits. To date, this has involved coordination with the Corps to develop adequate numeric action triggers in 404 permits. Our general approach has been to rely on peer-reviewed studies (including those by EPA) examining the relationship between conductivity values and water quality impairment in Appalachia. These studies point to a strong relationship between conductivity values in the range of 400-500 µS/cm in headwater streams and significant degradation of benthic communities in Appalachian streams as a result of mining activity. In response to these studies, the Corps and EPA included conditions in the recent Section 404 permit for the Hobet 45 mine that trigger remedial action requirements when conductivity levels in streams associated with this mine reach the 400-500 µS/cm level.

A recently prepared EPA ORD study, which is being noticed in the Federal Register for public comment and which will be submitted for SAB review, augments existing studies and provides an additional analysis of the relationship between impairment of stream quality in Appalachia and conductivity levels. This study identifies conductivity levels of 300 µS/cm or below in Appalachian headwater streams as a benchmark for retaining 95% of native benthic species. The study also identifies substantial impacts to native invertebrate species at conductivity levels exceeding 500 µS/cm. Because the study will be reviewed by the SAB, it does not represent a final Agency position at this time. However, EPA will need to continue reviewing 404 permits while this external peer review process is underway.

For purposes of Section 230.10(c) of the Guidelines, the Regions should consider the ORD report when examining whether a draft 404 permit is likely to result in significant degradation of waters of the U.S. During this interim period, the Regions should make a case-by-case determination based upon all available relevant scientific information including the ORD report. EPA anticipates that the conductivity impacts of projects with predicted conductivity levels below 300 µS/cm generally will not cause a water quality standard violation or significant degradation of the aquatic ecosystem. On the other hand, EPA expects that in-stream conductivity levels above 500 µS/cm are likely to be associated with adverse impacts that could rise to the level of significant degradation of the aquatic ecosystem. At a minimum, should a proposed Section 404 permit allow for increases in levels of conductivity above 500 µS/cm, the administrative record for the permit should demonstrate, based on site or receiving water specific information, how the permit is consistent with the CWA and the 404(b)(1) Guidelines, and Regions are encouraged to review such a record carefully. EPA, the Corps, and individual mining operators should be coordinating, in the context of a "sequenced" permitting approach (see IV.C.4 below), or other similarly protective measures, to ensure conductivity levels remain at levels not likely to contribute to degraded water quality, as discussed above in III.C.1. Projects projected to increase conductivity levels above 300 µS/cm should include permit conditions requiring adaptive remedial action to prevent conductivity levels from rising to levels that may contribute to water quality degradation, as discussed in III.C.1. After EPA's draft conductivity report is finalized after peer review, we will reexamine this approach.

In conjunction with the conductivity threshold, ORD's review of the scientific literature on surface coal mining (as mentioned above, scheduled to be reviewed by the SAB) and *Science* magazine found effects, including resource loss, water quality impairment, and adverse effects on aquatic ecosystems, that could support a conclusion of significant degradation of waters of the U.S. under applicable regulations.

3. Ensuring Effective Monitoring

To ensure compliance with these provisions of the Guidelines, the permit should effectively require water quality and biological monitoring in streams below surface coal mining operations to ensure permit conditions are being met and to collect data to inform continued operations as described below. Monitoring should be conducted during construction and post-construction. The permittee should be required to submit baseline monitoring data for biological condition, conductivity, total dissolved solids, sulfates, bicarbonate, chloride, magnesium, potassium, calcium, sodium, pH, and selenium to help provide information necessary to assure compliance with water quality standards and prevent significant degradation. The permittee should use the methodology employed by the state for assessing its waters pursuant to Section 303(d) or other methodology utilized by the state. In addition, with respect to biological data, the permittee should identify taxa to the genus level where the state methodology does not do so. The permittee should implement a monitoring plan for the foregoing parameters at appropriate locations upstream and downstream of the project, where applicable. As set forth in more detail below, the permit should include clear requirements for remedial actions to protect water quality

in the event monitoring reveals a trend toward excursion from water quality standards or a trend toward significant degradation.

4. Ensuring Independent Water Quality Protection from Section 404 Permits

Regions should ensure that, if a Section 402 permit has already been issued and does not address current science-based values for contaminants, the Section 404 permit includes needed conditions to protect water quality and to prevent significant degradation of the aquatic ecosystem. In addition to the monitoring requirements discussed in #1 above, additional conditions should explicitly address the levels of specific contaminants that must be achieved. These conditions should also address the adaptive remedial actions that will be implemented if water quality protection values are exceeded.

5. Ensuring Adequate Cumulative Impact Assessment Consistent with the 404(b)(1) Guidelines

Regions should ensure that watershed-scale (e.g., Hydrologic Unit Code 12 (HUC-12)) cumulative impact analyses are conducted as an element of the factual determinations required by the 404(b)(1) Guidelines. 40 CFR Section 230.11(g). These analyses should assess the consequences of past, present, and reasonably foreseeable future discharges of dredged or fill material (federal and non-federal) in the affected watersheds, on water quality and the aquatic environment. To the extent the cumulative impacts to water quality and the aquatic environment also affect human use characteristics, such as water supplies or fisheries, those impacts also should be addressed. Regions are encouraged to ensure that cumulative impact assessments conducted pursuant to the Guidelines are coordinated with required NEPA evaluations described in Section VI. below.

6. Assessing and Mitigating for Affected Stream Functions

Regions should ensure that applicants or the Corps conduct functional stream impact assessments and ensure they are effectively used to quantify the environmental effects of individual mining projects on streams. Regions are encouraged to work with and provide technical assistance to the Corps and states on the development and implementation of effective assessment methods. These assessments should be used to ensure that compensatory mitigation adequately replaces lost stream functions. For example, EPA should recommend alternatives to drainageways (e.g., groin ditches) as methods of stream mitigation, as they do not replace lost stream functions and are therefore not an acceptable form of compensatory mitigation. Some additional specific expectations for compensatory mitigation consistent with the agencies mitigation regulations include:

a. Timeframe – An expected timeframe for success should be identified and the mitigation should be monitored for that length of time in order to ensure success.

b. Mitigation monitoring – A detailed monitoring plan outlining the observable and measureable physical, chemical and biological criteria, and expected standards to be achieved, should be incorporated into permit conditions.

c. Adaptive remedial action – Include an adaptive remedial action plan that identifies specific triggers in the performance standards and alternate plans and strategies should the desired targets not be achieved. The plan should require additional actions and/or supplemental mitigation in the event success criteria are not achieved within an appropriate timeframe.

d. Stream establishment – Created stream channels should be designed to develop good water quality, healthy and diverse biological communities, and similar hydrologic regimes as streams to be impacted by mining activities. The goal of these compensation projects is to replace the lost stream functions impacted through mining activities; therefore, they should be designed to achieve designated uses for aquatic life support.

e. Ditches – No Section 404 compensation credit should be given for sediment, groin, or other water control ditches required for mining projects under SMCRA and CWA Section 402.

7. Ensuring Environmental Justice in Section 404 Permitting

Regions should identify whether issuing a permit would result in adverse human health or environmental effects on low-income and minority populations, including impacts to water supplies and fisheries. Where such effects are likely, EPA Regions should suggest ways and measures to avoid and/or mitigate such impacts through comments to the Corps.

In addition to the principles outlined above, EPA expects that the following best management practices will help to reduce or eliminate potential increases in conductivity levels in surface waters downstream of mining-related discharges to levels consistent with meeting narrative water quality standards and preventing significant degradation, as discussed in this memo, and to minimize associated impacts to the aquatic environment.

1. Sequencing Multiple Valley Fills for Projects Proposing More Than One Fill

Many of the proposed best management practices associated with the design of mining operations are currently unproven in their effectiveness to protect water quality and to prevent significant degradation. As a general matter, an effective approach for managing this uncertainty is to sequence multiple fills on a project. The sequenced approach, or another comparably effective measure, should be employed to account for uncertainty regarding the ability of current project best management practices to address the potential adverse impacts of multiple fills. In this context, the term "sequenced" means:

a. Valley fills that are part of the same project or complex should generally be constructed one at a time, unless site-specific data suggest no potential downstream water quality concerns; and

b. The permittee should demonstrate compliance with applicable water quality standards, and that significant degradation has not occurred, at each valley fill before the permittee may begin construction of subsequent valley fills.

EPA encourages applicants to fully sequence fills (e.g., one at a time) where monitoring and watershed-specific factors suggest water quality impacts may occur. On a case-by-case basis, if available data suggest that concurrently constructing more than one initial fill would not be likely to lead to water quality concerns, such an approach may be evaluated. A trends analysis as referenced above should be performed from the conductivity monitoring data. The trends analysis should then be evaluated against two threshold conductivity values established within the permit. The first value would establish a threshold at which a trend toward causing or contributing to water quality exceedances and significant degradation is identified, and the operator would be required to implement an adaptive remedial action plan to prevent further degradation. The second value would establish a threshold at which an excursion from applicable water quality standards and/or significant degradation is likely, and the permittee would be prohibited from constructing additional valley fills until such time as the excursion from water quality standards and/or significant degradation has been remediated and the permittee has demonstrated that no further excursion from water quality standards and/or significant degradation will occur. As discussed above, for many Appalachian streams, available scientific evidence supports using thresholds of 300 and 500 uS/cm in this context, though site-specific evidence may support alternate thresholds.

2. Protecting Water Quality for Projects Proposing One Valley Fill

For operations proposing a single valley fill, the sequencing as described above is not an option. As stated above, the applicant should be required to demonstrate prior to authorization and construction, based on proposed mining techniques, best management practices, or other actions, that the project will not cause or contribute to an excursion from applicable water quality standards or to significant degradation. The permit should include a condition, pursuant to 40 CFR Sections 230.10(b) and (c), prohibiting the project from causing or contributing to an excursion from applicable water quality standards or to significant degradation. In order to carry out this requirement and to assure that the permit will not cause or contribute to an excursion from applicable state water quality standards or to significant degradation of downstream waters, a monitoring plan as described above should generally still be required. Such permit conditions are also applicable and should be required for projects proposing multiple valley fills.

3. Minimizing Spoil Generation and Water Quality Impacts Through Avoidance and Minimization

Because larger and more numerous valley fills in waters of the U.S. are associated with increasing both direct adverse impacts to streams and watersheds and indirect downstream water quality impacts, projects should incorporate cost effective and technologically feasible limits on the quantity of excess spoil being generated per ton of coal produced by conducting a robust alternatives analysis. By relying on more efficient mining practices, impacts to streams and watersheds can be reduced. High-ratio mining operations generally do not represent the least environmentally damaging alternative. Consistent with the June 2009 interagency surface coal mining MOU, applicable federal and state regulatory agencies should coordinate environmental reviews of pending permit applications under the CWA and SMCRA to require practicable mining techniques that maximize the amount of spoil returned to the mine bench and minimize the amount of excess spoil that must be disposed of in streams and other aquatic systems. For mine-through operations, stream impacts should be avoided to the maximum practicable extent and spoil placement should be controlled to reduce drainage through overburden into streams. Options for disposing of mine waste in uplands, including relying on remaining excess spoil capacity at adjacent mine sites, must be fully evaluated. "Piecemealing" of multiple small mines to replace fewer large mines should be carefully evaluated to ensure that substitution of smaller mines is not resulting in greater direct, secondary, and cumulative adverse environmental impacts, which is not consistent with the Guidelines.

Projects should also incorporate environmentally effective limits on the linear extent of stream impacts per ton of excess spoil produced through a robust alternatives analysis. Such limits provide for improved efficiencies in spoil handling to minimize impacts to streams and is applicable to most mining operations, including mine-through projects. Where valley fills are necessary to accommodate disposal of excess spoil, overburden should be configured to maximize disposal as far up the valley as is feasible from an engineering perspective. To reduce direct stream impacts, valley fill construction should generally be from the head of the valley downwards instead of beginning at a point downstream and moving back upstream.

4. Certifying Mine Plan and Ensuring Full Utilization of Fill Disposal Sites

It is EPA's experience that permitted mine plans do not always reflect the "on-the-ground" construction and operation of a mine project. For many reasons, as construction and operation of the mine is underway, it is possible that the mine plan may change and that an operation may not fully utilize authorized capacity in valley fills. To prevent under-utilization of fills and to encourage additional avoidance and minimization of impacts to waters of the United States during construction, EPA should recommend that an issued permit be conditioned to require the operator to certify the mine plan and provide such certification to the Corps and EPA prior to construction of each valley fill. The operator should also be required to provide post-mining "as-built" plans.

5. Minimizing Conductivity Impacts and In-Stream Impoundments

Projects should fully evaluate and, where feasible, incorporate the following specific aspects of effective impacts avoidance and minimization:

a. Materials handling plans – Ensure that soils and rock on the mine site have been tested for concentrations of acid-, selenium- or heavy-metals-bearing or soluble strata that are likely to lead to high conductivity concerns. Overburden with high concentrations of these pollutants should be handled to minimize exposure to rainwater and groundwater and subsequent drainage into surface waters.

b. Fill construction – To prevent infiltration of surface runoff into the fill mass whenever possible, overburden should be compacted, leaving the top six feet unconsolidated. The use of end dumps should be discouraged whenever possible.

c. Sedimentation ponds – While achieving adequate sediment control, minimize the number of sediment ponds placed in waters of the U.S. and ensure that post-mining reclamation plans remove such ponds and restore affected streams.

6. Reducing Drainage Area Flowing Through Fills

Projects should reduce the drainage area flowing through valley fills to the maximum practicable extent consistent with sound engineering and safety considerations. Recent studies have suggested that water (e.g., precipitation and groundwater) flowing through valley fills contributes significantly to downstream water quality concerns as infiltrating water accumulates metals, dissolved solids, and sulfates. Designing mines (including mine-through operations) and valley fills to minimize drainage through mining spoil can contribute significantly to protecting downstream water quality. Regions should ensure that projects evaluate and, where feasible, incorporate current best mining practices that reduce infiltration and protect water quality, such as constructing valley fills as "side-hill" fills to reduce infiltration by precipitation, incorporating drains in valley fills to intercept and divert groundwater, and designing mines to take more consistent advantage of natural drainage through coal and rock formations that divert flow away from surface waters.

D. Addressing a Broad Range of Environmental Impacts

While the Guidelines evaluation process addresses impacts to the aquatic environment and the consequences of those impacts, we recognize that issuance of Section 404 permits can have other important environmental and human health impacts that are considered by the Corps as part of the "public interest review" process (33 CFR Section 320.4(a)). The public interest review process explicitly requires a "careful weighing" of up to 21 relevant public interest factors, including economics, aesthetics, energy needs, safety, and the general "needs and welfare of the people." In that light, we recommend that Regions provide comments to the Corps that address relevant public interest factors associated with the discharge of fill material

into waters of the United States, with a particular emphasis on ways or measures to mitigate potential adverse impacts to low-income and minority populations.

E. Conclusion

We encourage the Regions to discuss these general strategies with Corps Districts and states. Consistent with long-standing practice, we encourage Regional staff to offer specific recommendations to permit applicants who want to work with EPA to resolve individual permit issues. We have, in fact, engaged in productive dialogues with several permit applicants. Experience has shown that these discussions can provide an efficient and effective path to agreement on permit conditions that meet the requirements of the law while allowing mining companies to proceed on a cost-effective and environmentally responsible basis. We encourage more interaction between industry and EPA to resolve permit issues through dialogue and technical cooperation.

V. CWA Section 401 Certifications by States

Section 401 conveys to states directly and eligible Tribes the authority to approve (certify), condition, or deny all federal permits or licenses authorizing a discharge to waters of the U.S., including wetlands, including CWA Section 404 permits and federally issued SMCRA permits. States and Tribes may choose to waive their Section 401 certification authority and, if they fail to respond to a request for certification within the proscribed time (generally one year), their Section 401 authority is waived by default.

States and Tribes most commonly make their decisions to deny, certify, or condition permits or licenses primarily in consideration of whether the activity will comply with state water quality standards. However, they also look at whether the activity will violate effluent limitations, new source performance standards, toxic pollutant controls, or other appropriate requirements of state or Tribal law or regulation. EPA is in the process of developing an updated handbook on the basics of state Section 401 certification actions, which is intended to help clarify how states and tribes can most effectively employ this statutory water quality management tool for applicable projects, including surface coal mining projects permitted under Section 404.

Although Section 401 certification authority rests with the jurisdiction where the discharge originates, neighboring states and tribes downstream or otherwise potentially affected by the discharge have an opportunity to raise objections to, and comment on, the federal permit or license. EPA should determine if a discharge subject to Section 401 certification may affect the water quality of other states or tribes and, if there may be such an effect, EPA Regions should notify other jurisdictions whose water quality may be affected. The other jurisdictions should then be provided an opportunity to submit their views and objections, including opportunities for public hearings, consistent with CWA Section 401(a)(2). Although, the nature of recommendations from neighboring jurisdictions do not have the same force as conditions from a

Section 401 certifying state, the federal agency must develop measures to address the downstream jurisdictions' concerns.

Section 401(a)(1) requires that a state "establish procedures for public notice in the case of all applications for certification by it and, to the extent it deems appropriate, procedures for public hearings in connection with specific applications." 33 U.S.C. Section 401(a)(1). To enable meaningful participation by affected communities, we recommend that Regions work with the states to ensure that these public participation procedures are in place, and encourage the states to provide appropriate opportunities for public hearings on specific certifications.

VI. **National Environmental Policy Act Considerations**

The Regions should work with the Corps and OSM to ensure that the NEPA analyses associated with federal permit decisions provide, through an open and accountable process, a comprehensive evaluation of the potential impacts associated with proposed actions, as well as an analysis of reasonable alternatives that may avoid or minimize adverse impacts. The Corps has announced its intention to issue a notice of proposed rulemaking expanding the Corps NEPA scope of review to consider all of the effects of proposed surface coal mining "valley fills" on the aquatic environment. EPA will work with the Corps toward that objective, and furthering the purpose of NEPA to provide information to the decision maker, other federal and state agencies, and the public. In the interim, EPA will work with the Corps on a case by case basis to review permit applications and ensure that all relevant environmental information, as well as potential alternatives that may avoid or minimize the extent of the valley fills, is fully considered.

We also recommend that Regions work with the Corps and OSM to help establish opportunities for early and meaningful community input. These opportunities for increased community input may include Regions requesting that Corps Districts and OSM make draft Environmental Assessments (EAs) readily available to the public using a variety of methods, including online and print media, as early in the permitting process as possible. In addition, it is important that all agencies work with local communities, including low-income and minority populations, to identify potential adverse human health and environmental impacts and mitigation measures and improve the accessibility of meetings, crucial documents, and notices.

As discussed earlier, the NEPA process is also an effective vehicle for considering the potential cumulative effects of mining proposals. Using a watershed-scale analysis (e.g., HUC-12 analyses) would be an effective way to examine the cumulative environmental and human health impacts from past, present and reasonably foreseeable actions, including federal and non-federal actions. When working with the Corps and OSM to help define the proper scope of a NEPA cumulative impact assessment, Regions should be clear that while cumulative hydrological impact assessments (CHIAs) prepared as part of the SMCRA process can provide useful information regarding impacts to the hydrologic balance of an area, a NEPA cumulative impact assessment should consider the full suite of relevant environmental impacts.

When an agency develops and makes a commitment to require mitigation measures to avoid, minimize, rectify, reduce, or compensate for significant environmental impacts, NEPA

compliance can be accomplished with an EA, coupled with a Finding of No Significant Impact (FONSI) ("Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026 (March 23, 1981)). The Regions should, in evaluating permit applications and NEPA analyses, carefully evaluate any proposed mitigation measures to ensure that they will not only be effective at eliminating or reducing impacts, but also that they are clearly stated, include binding commitments and monitoring plans, and include provisions for public access to monitoring results and related documents. Recent scientific evidence referenced earlier in this memorandum, as well as field experience with surface coal mining mitigation projects, has raised technical concerns about the capacity of some forms of mitigation to reduce on-site and downstream impacts associated with Appalachian surface coal mining to below levels of significance. For example, as noted earlier, EPA believes that no mitigation credit should be given for sediment, groin, or other water control ditches. Consequently, construction of these ditches should not be used as a basis for supporting a FONSI. Moreover, mitigation measures that rely on establishing or re-establishing streams, rather than rehabilitating or enhancing existing streams, have less certainty of successfully offsetting impacts and should generally not be used to support a FONSI.

While no specific regulatory thresholds exist for determining whether a potential impact is significant under NEPA, it is EPA's general experience with surface coal mining projects in Appalachia that there are a number of factors that should be considered. First, the scale of the proposed impacts to stream habitats is of primary importance. While smaller projects should be reviewed to determine whether potential impacts warrant preparation of an EIS, it is EPA's experience that projects that involve more than one mile of stream loss or more than one valley fill are likely to result in significant adverse impacts.

Finally, consistent with EPA's *Policy and Procedures for the Review of Federal Actions Impacting the Environment*, the Regions should consult with the Office of Federal Activities (OFA) when recommending to the Corps or OSM that an EIS be prepared. OFA can also provide assistance when Regions are unable to reach agreement with Corps Districts or OSM on whether an EIS should be prepared in a particular case. Further, although the decision to prepare an EIS rests with the Corps and OSM, under EPA's Clean Air Act Section 309 authority, EPA must "refer" to CEQ matters that the Administrator finds are "unsatisfactory from the standpoint of public health or welfare or environmental quality." OFA will work with Regions to determine an appropriate course for resolving such disputes, including the potential for a referral to CEQ, if appropriate.

VII. Conclusions

EPA will continue to work with our federal regulatory partners, state agencies, the mining industry and the public to fulfill our common goals of reducing adverse impacts to water quality, aquatic ecosystems, and human health. We will also communicate effectively with local communities and mining companies to provide the transparency, consistency, and efficiency expected of government agencies in dealing with issues of such importance to health, the environment, and the economy. EPA's Regional offices will continue to be the Agency's primary field representatives to co-implementing agencies, mining companies, affected

communities, and interested members of the public as we work to respond to CWA, NEPA, and environmental justice issues associated with Appalachian surface coal mining permits. We look forward to your leadership as we coordinate to develop environmentally effective, scientifically sound, and economically responsible approaches for meeting the requirements of the law.

cc: Regional Water and Enforcement Division Directors, Regions 3, 4, and 5
Robert Sussman, Senior Policy Counsel to the Administrator
C. Scott Fulton, General Counsel

Greg Pond/R3/USEPA/US
01/26/2011 07:39 PM

To Justin Babendreier
cc Janet Kremer, Kristopher DeNardi, Margaret Passmore, Cynthia Stahl, Cimorelli.Alan
bcc
Subject Re: HUCs

Hey Justin et al.,

Here are the data from the HUCs you requested. I accidentally included Headwaters Spruce and Fork Lick HUCs too. You can delete.

I was able to get flow (CFS) for many observations that have chemistry. Let me know if you have questions. All chems (except pH, and conductivity) are in mg/l.

Greg

Coal River Headwater HUCs WQ_HAB_BIO Data.xls

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Justin Babendreier | Green highlighted are the Headwater 12s in the... | 01/26/2011 06:00:53 PM

From: Justin Babendreier/ATH/USEPA/US
To: Greg Pond/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA
Cc: Janet Kremer/R3/USEPA/US@EPA, Kristopher DeNardi/R3/USEPA/US@EPA
Date: 01/26/2011 06:00 PM
Subject: HUCs

Green highlighted are the Headwater 12s in the Coal River HUC8

Nice talking with you today.
Thanks.

Justin

[attachment "CoalRiverHUCs.xlsx" deleted by Greg Pond/R3/USEPA/US]

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KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00244-0	WVKC-47-L-1	Headwaters Clear Fork	0101
KC-00245-0	WVKC-47-M	Headwaters Clear Fork	0101
KC-00245-0	WVKC-47-M	Headwaters Clear Fork	0101
KC-00245-0	WVKC-47-M	Headwaters Clear Fork	0101
KC-00245-0	WVKC-47-M	Headwaters Clear Fork	0101
KC-00245-0	WVKC-47-M	Headwaters Clear Fork	0101
KC-00246-1.2	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00246-0	WVKC-47-N	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-2.4	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-1.9	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-1.9	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-1.9	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-1.9	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-1.9	WVKC-47-O	Headwaters Clear Fork	0101

KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-1.9	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-1.9	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00247-0	WVKC-47-O	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-1	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-0.2	WVKC-47-P	Headwaters Clear Fork	0101
KC-00248-1	WVKC-47-P	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00249-0.1	WVKC-47-P.5	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101

KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00250-0	WVKC-47-Q	Headwaters Clear Fork	0101
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00215-0.1	WVKC-46-P	Stephens Lake	0201
KC-00215-2	WVKC-46-P	Stephens Lake	0201
KC-00215-3.3	WVKC-46-P	Stephens Lake	0201
KC-00216-0	WVKC-46-P-0.5	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-1	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201

KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201
KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00217-0	WVKC-46-Q	Stephens Lake	0201

KC-00217-2.5	WVKC-46-Q	Stephens Lake	0201
KC-00217-4.2	WVKC-46-Q	Stephens Lake	0201
KC-00217-5	WVKC-46-Q	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00218-0.9	WVKC-46-Q-0.1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00219-0	WVKC-46-Q-1	Stephens Lake	0201
KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201
KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201
KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201
KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201
KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201
KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201
KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201
KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201

KC-00220-0	WVKC-46-Q-2	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00221-0	WVKC-46-Q-3	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00222-0	WVKC-46-Q-4	Stephens Lake	0201
KC-00223	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00223-0	WVKC-46-Q-5	Stephens Lake	0201
KC-00176-32.9	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202

KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-25.7	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-28.8	WVKC-46	Upper Marsh Fork	0202
KC-00176-32	WVKC-46	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202

KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-0.7	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-3.1	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-5.4	WVKC-46-J	Upper Marsh Fork	0202
KC-00197-6.5	WVKC-46-J	Upper Marsh Fork	0202
KC-00198	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202

KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00198-0.7	WVKC-46-J-2	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2.85	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-2	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-1.4	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.75	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.5	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00199-0.1	WVKC-46-J-3	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202

KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00200-0.2	WVKC-46-J-4	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00201-0.2	WVKC-46-J-7	Upper Marsh Fork	0202
KC-00202-0	WVKC-46-J-7-A	Upper Marsh Fork	0202
KC-00203-0.1	WVKC-46-J-7-D	Upper Marsh Fork	0202
KC-00204	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202

KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-0.1	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.2	WVKC-46-K	Upper Marsh Fork	0202
KC-00204-1.8	WVKC-46-K	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00205-0	WVKC-46-K-2	Upper Marsh Fork	0202
KC-00206-0.1	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-0.1	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-0.1	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-0.1	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-0.1	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202

KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-1.6	WVKC-46-L	Upper Marsh Fork	0202
KC-00206-2.8	WVKC-46-L	Upper Marsh Fork	0202
KC-00207	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00207-0.6	WVKC-46-L.5	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00208-0	WVKC-46-L-1	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202

KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.2	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-1.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00210-0.4	WVKC-46-M	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-3	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-3	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-3	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-3	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-3	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-3	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-3	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-0.1	WVKC-46-N	Upper Marsh Fork	0202
KC-00211-3	WVKC-46-N	Upper Marsh Fork	0202
KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202

KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-0.2	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00212-1.1	WVKC-46-N.9	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00213-0.1	WVKC-46-N-1	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202

KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-0.1	WVKC-46-O	Upper Marsh Fork	0202
KC-00214-1.5	WVKC-46-O	Upper Marsh Fork	0202
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-15.3	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-4.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-14.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-14.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-14.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-14.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-10.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-10.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-10.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-10.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-10.7	WVKC-10-T-11	Spruce Laurel Fork	0301

KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-0.2	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-3.5	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-8.1	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00037-10.7	WVKC-10-T-11	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00038-0	WVKC-10-T-11-B	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00039-0	WVKC-10-T-11-D	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00040-0	E.5	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301

KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-0	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00041-1.3	WVKC-10-T-11-F	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00042-0	WVKC-10-T-11-G	Spruce Laurel Fork	0301
KC-00043-0.3	H.5	Spruce Laurel Fork	0301
KC-00034-17.2	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.5	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.6	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302

KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
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KC-00034-14	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-18.1	WVKC-10-T	Headwaters Spruce Fork	0302
KC-00034-23.7	WVKC-10-T	Headwaters Spruce Fork	0302
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KC-00044-0	WVKC-10-T-12	Headwaters Spruce Fork	0302
KC-00044-0.71	WVKC-10-T-12	Headwaters Spruce Fork	0302
KC-00045	{0.1}-Mine	Headwaters Spruce Fork	0302
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KC-00046-0.8	WVKC-10-T-13	Headwaters Spruce Fork	0302
KC-00046-0	WVKC-10-T-13	Headwaters Spruce Fork	0302
KC-00046-0.8	WVKC-10-T-13	Headwaters Spruce Fork	0302
KC-00046-0	WVKC-10-T-13	Headwaters Spruce Fork	0302
KC-00046-0.8	WVKC-10-T-13	Headwaters Spruce Fork	0302
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KC-00046-0.8	WVKC-10-T-13	Headwaters Spruce Fork	0302

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KC-00046-0.8	WVKC-10-T-13	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-3.85	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-3.85	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-3.85	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-3.85	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-3.85	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-0	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-3.85	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-3.85	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.7	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.4	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00047-1.4	WVKC-10-T-15	Headwaters Spruce Fork	0302
KC-00047-1.4	WVKC-10-T-15	Headwaters Spruce Fork	0302
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KC-00049-0	WVKC-10-T-15-A	Headwaters Spruce Fork	0302
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KC-00055-0	WVKC-10-T-18	Headwaters Spruce Fork	0302
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KC-00055-0	WVKC-10-T-18	Headwaters Spruce Fork	0302
KC-00055-0	WVKC-10-T-18	Headwaters Spruce Fork	0302
KC-00055-0	WVKC-10-T-18	Headwaters Spruce Fork	0302
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KC-00058-0	WVKC-10-T-20	Headwaters Spruce Fork	0302

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KC-00058-0	WVKC-10-T-20	Headwaters Spruce Fork	0302
KC-00058-0	WVKC-10-T-20	Headwaters Spruce Fork	0302
KC-00058-0	WVKC-10-T-20	Headwaters Spruce Fork	0302
KC-00058-0	WVKC-10-T-20	Headwaters Spruce Fork	0302
KC-00059-0	WVKC-10-T-21	Headwaters Spruce Fork	0302
KC-00059-0	WVKC-10-T-21	Headwaters Spruce Fork	0302
KC-00059-1.7	WVKC-10-T-21	Headwaters Spruce Fork	0302
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KC-00059-1.7	WVKC-10-T-21	Headwaters Spruce Fork	0302
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KC-00059-1.7	WVKC-10-T-21	Headwaters Spruce Fork	0302
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KC-00059-0.5	WVKC-10-T-21	Headwaters Spruce Fork	0302
KC-00059-0	WVKC-10-T-21	Headwaters Spruce Fork	0302
KC-00059-0.5	WVKC-10-T-21	Headwaters Spruce Fork	0302
KC-00060	{0.2}-Mine	Headwaters Spruce Fork	0302
KC-00060	{0.2}-Mine	Headwaters Spruce Fork	0302
KC-00060	{0.2}-Mine	Headwaters Spruce Fork	0302
KC-00060	{0.2}-Mine	Headwaters Spruce Fork	0302
KC-00060	{0.2}-Mine	Headwaters Spruce Fork	0302
KC-00061-0.5	WVKC-10-T-22	Headwaters Spruce Fork	0302
KC-00061-0.5	WVKC-10-T-22	Headwaters Spruce Fork	0302
KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302
KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302
KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302

KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302
KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302
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KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302
KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302
KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302
KC-00062-0	WVKC-10-T-22.5	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00063-0	WVKC-10-T-23	Headwaters Spruce Fork	0302
KC-00064-0.6	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00064-0	WVKC-10-T-24	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302
KC-00065-0	WVKC-10-T-25	Headwaters Spruce Fork	0302

KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00057-0.1	WVKC-10-T-2	Outlet Spruce Fork	0303
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00083-26.6	WVKC-10-U	Upper Pond Fork	0401
KC-00083-32.3	WVKC-10-U	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401

KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00091-0	WVKC-10-U-16	Upper Pond Fork	0401
KC-00092	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00092-0.1	WVKC-10-U-17	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00097-0	WVKC-10-U-20	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401

KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-0	WVKC-10-U-21	Upper Pond Fork	0401
KC-00098-1.4	WVKC-10-U-21	Upper Pond Fork	0401
KC-00104-0	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.3	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402

KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-10.8	WVKC-10-U-7	West Fork	0402
KC-00104-12.1	WVKC-10-U-7	West Fork	0402
KC-00104-0.5	WVKC-10-U-7	West Fork	0402
KC-00104-4.2	WVKC-10-U-7	West Fork	0402
KC-00104-7.9	WVKC-10-U-7	West Fork	0402
KC-00104-2.3	WVKC-10-U-7	West Fork	0402
KC-00104-4.7	WVKC-10-U-7	West Fork	0402
KC-00104-4.7	WVKC-10-U-7	West Fork	0402
KC-00106	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00106-0	WVKC-10-U-7-A	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402

KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00107-0	WVKC-10-U-7-B	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00108-0	WVKC-10-U-7-D	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00109	{0.2}-Discharge	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00112-0	WVKC-10-U-7-E	West Fork	0402
KC-00396-1.1	WVKC-10-U-7-E-1	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402

KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00113-0	WVKC-10-U-7-F	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00114-0	WVKC-10-U-7-H	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00115-0	WVKC-10-U-7-I	West Fork	0402
KC-00116-0	WVKC-10-U-7-J	West Fork	0402
KC-00116-0	WVKC-10-U-7-J	West Fork	0402
KC-00116-0	WVKC-10-U-7-J	West Fork	0402
KC-00116-0	WVKC-10-U-7-J	West Fork	0402
KC-00116-0	WVKC-10-U-7-J	West Fork	0402
KC-00010-0.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9.3	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501

KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501

KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-0.6	WVKC-10-I	Big Horse Creek	0501
KC-00010-3.1	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
KC-00010-7.8	WVKC-10-I	Big Horse Creek	0501
KC-00010-9	WVKC-10-I	Big Horse Creek	0501
KC-00010-5.9	WVKC-10-I	Big Horse Creek	0501
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KC-00012-0	WVKC-10-I-2	Big Horse Creek	0501
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KC-00012-0	WVKC-10-I-2	Big Horse Creek	0501
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KC-00013-0	WVKC-10-I-3	Big Horse Creek	0501
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KC-00015	WVKC-10-I-6-C	Big Horse Creek	0501
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KC-00015-0	WVKC-10-I-6-C	Big Horse Creek	0501
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KC-00016-0	WVKC-10-I-7	Big Horse Creek	0501
KC-00016-0	WVKC-10-I-7	Big Horse Creek	0501
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KC-00016-0	WVKC-10-I-7	Big Horse Creek	0501
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KC-00016-0	WVKC-10-I-7	Big Horse Creek	0501
KC-00016-0	WVKC-10-I-7	Big Horse Creek	0501
KC-00017	{0.0}-Mine	Big Horse Creek	0501
KC-00018	{0.4}-Mine	Big Horse Creek	0501
KC-00019-0	WVKC-10-I-8	Big Horse Creek	0501
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KC-00019-0	WVKC-10-I-8	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501

KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00020-0	WVKC-10-I-9	Big Horse Creek	0501
KC-00155-3.1	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601

KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-0.1	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-3.9	WVKC-35	White Oak Creek	0601
KC-00155-5.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
KC-00155-2.7	WVKC-35	White Oak Creek	0601
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KC-00157-0	WVKC-35-A	White Oak Creek	0601
KC-00157-0	WVKC-35-A	White Oak Creek	0601
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KC-00157-0	WVKC-35-A	White Oak Creek	0601
KC-00157-0	WVKC-35-A	White Oak Creek	0601
KC-00158-0	WVKC-35-C	White Oak Creek	0601
KC-00158-0	WVKC-35-C	White Oak Creek	0601
KC-00158-0	WVKC-35-C	White Oak Creek	0601
KC-00158-0	WVKC-35-C	White Oak Creek	0601
KC-00158-0	WVKC-35-C	White Oak Creek	0601
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KC-00158-0	WVKC-35-C	White Oak Creek	0601

KC-00158-0	WVKC-35-C	White Oak Creek	0601
KC-00159-0	WVKC-35-D	White Oak Creek	0601
KC-00159-0	WVKC-35-D	White Oak Creek	0601
KC-00159-0	WVKC-35-D	White Oak Creek	0601
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KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00160-3.7	WVKC-35-E	White Oak Creek	0601
KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00160-0	WVKC-35-E	White Oak Creek	0601
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KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00160-0	WVKC-35-E	White Oak Creek	0601
KC-00487-0.5	WVKC-35-H	White Oak Creek	0601
KC-00146-0.4	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0.1	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602

KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
KC-00146-0	WVKC-31	Laurel Creek	0602
KC-00146-2.3	WVKC-31	Laurel Creek	0602
KC-00146-4.9	WVKC-31	Laurel Creek	0602
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KC-00147-0.1	WVKC-31-A	Laurel Creek	0602
KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
KC-00147-0.1	WVKC-31-A	Laurel Creek	0602
KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
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KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
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KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
KC-00147-0.1	WVKC-31-A	Laurel Creek	0602
KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
KC-00147-0.1	WVKC-31-A	Laurel Creek	0602
KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
KC-00147-0.1	WVKC-31-A	Laurel Creek	0602
KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
KC-00147-0.1	WVKC-31-A	Laurel Creek	0602
KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
KC-00147-0.1	WVKC-31-A	Laurel Creek	0602
KC-00147-0.11	WVKC-31-A	Laurel Creek	0602
KC-00148-0.2	WVKC-31-B	Laurel Creek	0602
KC-00148-10.9	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602

KC-00148-0	WVKC-31-B	Laurel Creek	0602
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KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-0	WVKC-31-B	Laurel Creek	0602
KC-00148-6.3	WVKC-31-B	Laurel Creek	0602
KC-00148-6.2	WVKC-31-B	Laurel Creek	0602
KC-00148-2.4	WVKC-31-B	Laurel Creek	0602
KC-00149-0.8	WVKC-31-B.4	Laurel Creek	0602
KC-00150-0	WVKC-31-B-2	Laurel Creek	0602
KC-00150-0	WVKC-31-B-2	Laurel Creek	0602
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KC-00151-0	WVKC-31-C	Laurel Creek	0602
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KC-00151-0	WVKC-31-C	Laurel Creek	0602
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KC-00151-0	WVKC-31-C	Laurel Creek	0602
KC-00151-0	WVKC-31-C	Laurel Creek	0602
KC-00151-0	WVKC-31-C	Laurel Creek	0602
KC-00151-0	WVKC-31-C	Laurel Creek	0602

KC-00152-1.9	WVKC-31-G	Laurel Creek	0602
KC-00122-0	WVKC-13	Brier Creek	0605
KC-00122-0	WVKC-13	Brier Creek	0605
KC-00122-0	WVKC-13	Brier Creek	0605
KC-00122-0	WVKC-13	Brier Creek	0605
KC-00122-0	WVKC-13	Brier Creek	0605
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KC-00122-0	WVKC-13	Brier Creek	0605
KC-00122-0	WVKC-13	Brier Creek	0605
KC-00122-0	WVKC-13	Brier Creek	0605
KC-00122-0	WVKC-13	Brier Creek	0605
KC-00122-4.6	WVKC-13	Brier Creek	0605
KC-00123-0.45	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00123-0	WVKC-14	Fork Creek-Big Coal River	0606
KC-00124-0	WVKC-14-C	Fork Creek-Big Coal River	0606
KC-00124-0.5	WVKC-14-C	Fork Creek-Big Coal River	0606
KC-00125	WVKC-14-D	Fork Creek-Big Coal River	0606
KC-00126	WVKC-14-D-2	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00127-0	WVKC-16	Fork Creek-Big Coal River	0606
KC-00128	WVKC-16-A	Fork Creek-Big Coal River	0606
KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606
KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606

KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606
KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606
KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606
KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606
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KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606
KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606
KC-00129-0	WVKC-18	Fork Creek-Big Coal River	0606

STREAM_NAME	SAMPLE_DATE	OR_LAT_D	OR_LON_D	SAMPLE_I	ific Conduc
Clear Fork	7/10/2002	37.93914	-81.3791	10330	861
Clear Fork	7/1/2002	37.91553	-81.3454	10331	772
Clear Fork	7/8/2002	37.89697	-81.3443	10332	729
Clear Fork	7/8/2002	37.86761	-81.3185	10333	461
Clear Fork	9/4/2002	37.93914	-81.3791	10943	974
Clear Fork	9/3/2002	37.91553	-81.3454	10944	828
Clear Fork	9/3/2002	37.89697	-81.3443	10945	717
Clear Fork	9/3/2002	37.86761	-81.3185	10946	827
Clear Fork	6/27/2002	37.93914	-81.3791	11190	929
Clear Fork	6/25/2002	37.91553	-81.3454	11191	828
Clear Fork	6/25/2002	37.89697	-81.3443	11192	751
Clear Fork	7/22/2002	37.86761	-81.3185	11193	486
Clear Fork	10/17/2002	37.93914	-81.3791	11854	503
Clear Fork	10/17/2002	37.93914	-81.3791	11854	
Clear Fork	10/17/2002	37.91553	-81.3454	11855	433
Clear Fork	10/15/2002	37.89697	-81.3443	11856	622
Clear Fork	10/15/2002	37.86761	-81.3185	11857	625
Clear Fork	10/15/2002	37.86761	-81.3185	11857	
Clear Fork	10/30/2002	37.93914	-81.3791	12635	365
Clear Fork	10/30/2002	37.91553	-81.3454	12636	330
Clear Fork	10/30/2002	37.89697	-81.3443	12637	299
Clear Fork	10/30/2002	37.86761	-81.3185	12638	186
Clear Fork	11/14/2002	37.93914	-81.3791	13328	370
Clear Fork	11/13/2002	37.91553	-81.3454	13329	267
Clear Fork	11/13/2002	37.89697	-81.3443	13330	234
Clear Fork	11/13/2002	37.86761	-81.3185	13331	129
Clear Fork	12/10/2002	37.93914	-81.3791	13755	472
Clear Fork	12/10/2002	37.91553	-81.3454	13756	352
Clear Fork	12/11/2002	37.89697	-81.3443	13757	270
Clear Fork	12/11/2002	37.86761	-81.3185	13758	148
Clear Fork	1/30/2003	37.93914	-81.3791	14245	700
Clear Fork	1/29/2003	37.91553	-81.3454	14246	575
Clear Fork	1/29/2003	37.89697	-81.3443	14247	580
Clear Fork	1/29/2003	37.86761	-81.3185	14248	479
Clear Fork	2/25/2003	37.93914	-81.3791	15163	425
Clear Fork	2/25/2003	37.91553	-81.3454	15164	330
Clear Fork	2/26/2003	37.89697	-81.3443	15165	372
Clear Fork	2/26/2003	37.86761	-81.3185	15166	191
Clear Fork	3/24/2003	37.93914	-81.3791	15613	637
Clear Fork	4/2/2003	37.91553	-81.3454	15614	447
Clear Fork	4/3/2003	37.89697	-81.3443	15615	365
Clear Fork	4/3/2003	37.86761	-81.3185	15616	168
Clear Fork	4/16/2003	37.93914	-81.3791	16116	477

Clear Fork	4/16/2003	37.91553	-81.3454	16117	370
Clear Fork	4/17/2003	37.89697	-81.3443	16118	379
Clear Fork	4/17/2003	37.86761	-81.3185	16119	190
Clear Fork	5/13/2003	37.93914	-81.3791	16566	558
Clear Fork	5/14/2003	37.91553	-81.3454	16567	458
Clear Fork	5/15/2003	37.89697	-81.3443	16568	382
Clear Fork	5/15/2003	37.86761	-81.3185	16569	179
Fulton Creek	7/10/2002	37.94022	-81.3805	10343	651
Fulton Creek	9/21/2002	37.94022	-81.3805	10954	678
Fulton Creek	6/27/2002	37.94022	-81.3805	11203	641
Fulton Creek	10/17/2002	37.94022	-81.3805	11865	525
Fulton Creek	10/29/2002	37.94022	-81.3805	12646	350
Fulton Creek	11/14/2002	37.94022	-81.3805	13339	575
Fulton Creek	12/11/2002	37.94022	-81.3805	13766	323
Fulton Creek	1/29/2003	37.94022	-81.3805	14256	616
Fulton Creek	2/25/2003	37.94022	-81.3805	15175	472
Fulton Creek	4/3/2003	37.94022	-81.3805	15625	493
Fulton Creek	4/15/2003	37.94022	-81.3805	16128	470
Fulton Creek	5/14/2003	37.94022	-81.3805	16578	545
Bear Hollow	7/22/2002	37.94192	-81.3784	11204	182
White Oak Creek	7/8/2002	37.93372	-81.3594	10344	690
White Oak Creek	9/3/2002	37.93372	-81.3594	10955	750
White Oak Creek	6/27/2002	37.93372	-81.3594	11205	727
White Oak Creek	10/17/2002	37.93372	-81.3594	11866	384
White Oak Creek	10/17/2002	37.93372	-81.3594	11866	
White Oak Creek	10/30/2002	37.93372	-81.3594	12647	260
White Oak Creek	10/30/2002	37.93372	-81.3594	12648	
White Oak Creek	11/13/2002	37.93372	-81.3594	13340	249
White Oak Creek	12/10/2002	37.93372	-81.3594	13767	425
White Oak Creek	1/30/2003	37.93372	-81.3594	14257	538
White Oak Creek	2/26/2003	37.93372	-81.3594	15176	389
White Oak Creek	2/26/2003	37.93372	-81.3594	15177	
White Oak Creek	3/24/2003	37.93372	-81.3594	15626	559
White Oak Creek	4/16/2003	37.93372	-81.3594	16129	410
White Oak Creek	5/14/2003	37.93372	-81.3594	16579	512
Horse Creek	12/10/2002	37.92567	-81.3487	13769	236
Horse Creek	1/29/2003	37.92567	-81.3487	14260	434
Horse Creek	2/26/2003	37.92567	-81.3487	15180	217
Horse Creek	4/3/2003	37.92567	-81.3487	15629	350
Horse Creek	4/15/2003	37.92567	-81.3487	16132	245
Horse Creek	5/14/2003	37.92567	-81.3487	16582	374
Wolfpen Branch	1/29/2003	37.92133	-81.3472	14261	259
Wolfpen Branch	2/26/2003	37.92133	-81.3472	15181	115
Wolfpen Branch	4/2/2003	37.92133	-81.3472	15630	122

Wolfpen Branch	4/16/2003	37.92133	-81.3472	16133	120
Wolfpen Branch	5/14/2003	37.92133	-81.3472	16583	109
Left Fork/White Oak Creek	7/8/2002	37.94592	-81.3452	10345	704
Left Fork/White Oak Creek	10/15/2002	37.94592	-81.3452	11867	636
Left Fork/White Oak Creek	10/30/2002	37.94592	-81.3452	12649	324
Left Fork/White Oak Creek	11/13/2002	37.94592	-81.3452	13341	214
Left Fork/White Oak Creek	12/11/2002	37.94592	-81.3452	13768	395
Left Fork/White Oak Creek	1/29/2003	37.94592	-81.3452	14258	587
Left Fork/White Oak Creek	2/26/2003	37.94592	-81.3452	15178	433
Left Fork/White Oak Creek	3/24/2003	37.94592	-81.3452	15627	615
Left Fork/White Oak Creek	4/15/2003	37.94592	-81.3452	16130	458
Left Fork/White Oak Creek	5/14/2003	37.94592	-81.3452	16580	576
Road Branch	1/30/2003	37.9433	-81.3386	14259	349
Road Branch	2/26/2003	37.9433	-81.3386	15179	193
Road Branch	3/24/2003	37.9433	-81.3386	15628	258
Road Branch	4/16/2003	37.9433	-81.3386	16131	191
Road Branch	5/13/2003	37.9433	-81.3386	16581	217
Toney Fork	9/22/1997	37.90972	-81.3365	441	1100
Toney Fork	7/1/2002	37.91561	-81.3437	10346	1374
Toney Fork	7/1/2002	37.90972	-81.3365	10347	1337
Toney Fork	9/3/2002	37.91561	-81.3437	10957	1537
Toney Fork	9/3/2002	37.90972	-81.3365	10958	1499
Toney Fork	6/24/2002	37.91561	-81.3437	11206	1496
Toney Fork	6/25/2002	37.90972	-81.3365	11207	1464
Toney Fork	10/15/2002	37.91561	-81.3437	11868	1393
Toney Fork	10/15/2002	37.91561	-81.3437	11868	
Toney Fork	10/15/2002	37.90972	-81.3365	11869	1333
Toney Fork	10/15/2002	37.90972	-81.3365	11869	
Toney Fork	10/30/2002	37.91561	-81.3437	12650	739
Toney Fork	10/30/2002	37.90972	-81.3365	12651	661
Toney Fork	11/13/2002	37.91561	-81.3437	13342	656
Toney Fork	11/13/2002	37.90972	-81.3365	13343	605
Toney Fork	12/11/2002	37.91561	-81.3437	13770	689
Toney Fork	12/11/2002	37.90972	-81.3365	13771	591
Toney Fork	1/30/2003	37.91561	-81.3437	14262	1068
Toney Fork	1/30/2003	37.90972	-81.3365	14263	1051
Toney Fork	2/25/2003	37.91561	-81.3437	15182	733
Toney Fork	2/25/2003	37.90972	-81.3365	15183	739
Toney Fork	4/2/2003	37.91561	-81.3437	15631	1052
Toney Fork	4/2/2003	37.90972	-81.3365	15632	1017
Toney Fork	4/16/2003	37.91561	-81.3437	16134	813
Toney Fork	4/16/2003	37.90972	-81.3365	16135	821
Toney Fork	5/14/2003	37.91561	-81.3437	16584	1045
Toney Fork	5/14/2003	37.90972	-81.3365	16585	1027

Buffalo Fork	7/1/2002	37.90953	-81.3365	10348	1351
Buffalo Fork	9/3/2002	37.90953	-81.3365	10959	1650
Buffalo Fork	6/25/2002	37.90953	-81.3365	11208	1649
Buffalo Fork	10/15/2002	37.90953	-81.3365	11870	1558
Buffalo Fork	10/15/2002	37.90953	-81.3365	11870	
Buffalo Fork	10/30/2002	37.90953	-81.3365	12652	919
Buffalo Fork	11/13/2002	37.90953	-81.3365	13344	835
Buffalo Fork	12/11/2002	37.90953	-81.3365	13772	937
Buffalo Fork	1/30/2003	37.90953	-81.3365	14264	1224
Buffalo Fork	2/25/2003	37.90953	-81.3365	15184	844
Buffalo Fork	4/2/2003	37.90953	-81.3365	15633	1188
Buffalo Fork	4/16/2003	37.90953	-81.3365	16136	930
Buffalo Fork	5/14/2003	37.90953	-81.3365	16586	1244
McGinnis Branch	1/29/2003	37.91317	-81.3476	14265	207
McGinnis Branch	2/26/2003	37.91317	-81.3476	15185	50
McGinnis Branch	4/2/2003	37.91317	-81.3476	15634	42
McGinnis Branch	4/16/2003	37.91317	-81.3476	16137	47
McGinnis Branch	5/14/2003	37.91317	-81.3476	16587	52
McDowell Branch	9/22/1997	37.90231	-81.3709	442	749
McDowell Branch	7/1/2002	37.90553	-81.3519	10349	358
McDowell Branch	9/3/2002	37.90553	-81.3519	10960	354
McDowell Branch	6/27/2002	37.90553	-81.3519	11210	359
McDowell Branch	10/15/2002	37.90553	-81.3519	11871	248
McDowell Branch	10/30/2002	37.90553	-81.3519	12653	212
McDowell Branch	11/13/2002	37.90553	-81.3519	13345	186
McDowell Branch	12/11/2002	37.90553	-81.3519	13773	197
McDowell Branch	1/29/2003	37.90553	-81.3519	14266	360
McDowell Branch	2/26/2003	37.90553	-81.3519	15186	212
McDowell Branch	4/2/2003	37.90553	-81.3519	15635	246
McDowell Branch	4/17/2003	37.90553	-81.3519	16138	223
McDowell Branch	5/15/2003	37.90553	-81.3519	16588	237
Workman Creek	9/22/1997	37.89997	-81.3464	443	1297
Workman Creek	9/22/1997	37.876	-81.3661	444	931
Workman Creek	7/8/2002	37.89997	-81.3464	10350	767
Workman Creek	7/8/2002	37.88086	-81.3674	10351	839
Workman Creek	9/3/2002	37.89997	-81.3464	10961	1118
Workman Creek	9/3/2002	37.88086	-81.3674	10962	908
Workman Creek	6/24/2002	37.89997	-81.3464	11211	1083
Workman Creek	10/15/2002	37.89997	-81.3464	11872	964
Workman Creek	10/15/2002	37.88086	-81.3674	11873	830
Workman Creek	10/30/2002	37.89997	-81.3464	12654	543
Workman Creek	10/30/2002	37.88086	-81.3674	12655	499
Workman Creek	11/13/2002	37.89997	-81.3464	13346	476
Workman Creek	11/13/2002	37.88086	-81.3674	13347	433

Workman Creek	12/10/2002	37.89997	-81.3464	13774	585
Workman Creek	12/10/2002	37.88086	-81.3674	13775	594
Workman Creek	1/29/2003	37.89997	-81.3464	14267	643
Workman Creek	1/29/2003	37.88086	-81.3674	14268	672
Workman Creek	2/26/2003	37.89997	-81.3464	15187	460
Workman Creek	4/3/2003	37.89997	-81.3464	15636	679
Workman Creek	4/17/2003	37.89997	-81.3464	16139	497
Workman Creek	5/15/2003	37.89997	-81.3464	16589	477
Stover Fork	7/8/2002	37.87933	-81.3345	10352	848
Stover Fork	4/22/2002	37.87072	-81.3429	10382	418
Stover Fork	9/3/2002	37.87933	-81.3345	10963	920
Stover Fork	6/24/2002	37.87933	-81.3345	11212	847
Stover Fork	10/15/2002	37.87933	-81.3345	11874	801
Stover Fork	10/30/2002	37.87933	-81.3345	12656	462
Stover Fork	11/13/2002	37.87933	-81.3345	13348	371
Stover Fork	12/11/2002	37.87933	-81.3345	13776	430
Stover Fork	1/29/2003	37.87933	-81.3345	14269	658
Stover Fork	2/26/2003	37.87933	-81.3345	15189	636
Stover Fork	4/3/2003	37.87933	-81.3345	15638	586
Stover Fork	4/3/2003	37.87933	-81.3345	15639	
Stover Fork	4/17/2003	37.87933	-81.3345	16141	605
Stover Fork	5/15/2003	37.87933	-81.3345	16591	498
Stover Fork	5/3/2007	37.87072	-81.3429	36332	595
Lick Run	7/8/2002	37.87219	-81.3208	10353	804
Lick Run	9/3/2002	37.87219	-81.3208	10964	688
Lick Run	7/22/2002	37.87219	-81.3208	11213	559
Lick Run	10/15/2002	37.87219	-81.3208	11875	565
Lick Run	10/30/2002	37.87219	-81.3208	12657	293
Lick Run	11/13/2002	37.87219	-81.3208	13349	263
Lick Run	12/11/2002	37.87219	-81.3208	13777	328
Lick Run	1/29/2003	37.87219	-81.3208	14270	654
Lick Run	2/26/2003	37.87219	-81.3208	15190	311
Lick Run	4/3/2003	37.87219	-81.3208	15640	562
Lick Run	4/17/2003	37.87219	-81.3208	16142	390
Lick Run	4/17/2003	37.87219	-81.3208	16143	
Lick Run	5/15/2003	37.87219	-81.3208	16592	391
Lick Run	5/15/2003	37.87219	-81.3208	16593	
Spruce Fork	7/8/2002	37.86742	-81.3184	10354	287
Spruce Fork	10/15/2002	37.86742	-81.3184	11876	221
Spruce Fork	10/30/2002	37.86742	-81.3184	12658	117
Spruce Fork	11/13/2002	37.86742	-81.3184	13350	94
Spruce Fork	12/11/2002	37.86742	-81.3184	13778	136
Spruce Fork	1/29/2003	37.86742	-81.3184	14271	373
Spruce Fork	2/26/2003	37.86742	-81.3184	15191	114

Spruce Fork	4/3/2003	37.86742	-81.3184	15641	112
Spruce Fork	4/17/2003	37.86742	-81.3184	16144	98
Spruce Fork	5/15/2003	37.86742	-81.3184	16594	92
Surveyor Creek	10/7/1997	37.76652	-81.3206	429	502
Surveyor Creek	8/12/2002	37.76652	-81.3206	10310	518
Surveyor Creek	8/12/2002	37.74023	-81.305	10311	531
Surveyor Creek	8/12/2002	37.72883	-81.3036	10312	549
Surveyor Creek	9/4/2002	37.76652	-81.3206	10925	547
Surveyor Creek	9/4/2002	37.74023	-81.305	10926	552
Surveyor Creek	9/4/2002	37.72883	-81.3036	10927	568
Surveyor Creek	8/14/2002	37.76652	-81.3206	11174	522
Surveyor Creek	8/14/2002	37.74023	-81.305	11175	527
Surveyor Creek	8/14/2002	37.72883	-81.3036	11176	531
Surveyor Creek	9/25/2002	37.76652	-81.3206	11835	537
Surveyor Creek	9/25/2002	37.74023	-81.305	11836	548
Surveyor Creek	9/25/2002	37.72883	-81.3036	11837	567
Surveyor Creek	10/22/2002	37.76652	-81.3206	12616	430
Surveyor Creek	10/21/2002	37.74023	-81.305	12617	455
Surveyor Creek	10/21/2002	37.72883	-81.3036	12618	508
Surveyor Creek	11/22/2002	37.76652	-81.3206	13310	150
Surveyor Creek	11/19/2002	37.74023	-81.305	13311	177
Surveyor Creek	11/21/2002	37.72883	-81.3036	13312	235
Surveyor Creek	12/12/2002	37.76652	-81.3206	13737	101
Surveyor Creek	12/11/2002	37.74023	-81.305	13738	123
Surveyor Creek	12/9/2002	37.72883	-81.3036	13739	308
Surveyor Creek	1/14/2003	37.76652	-81.3206	14226	212
Surveyor Creek	1/7/2003	37.74023	-81.305	14227	290
Surveyor Creek	1/7/2003	37.72883	-81.3036	14228	266
Surveyor Creek	2/10/2003	37.76652	-81.3206	15145	245
Surveyor Creek	2/4/2003	37.74023	-81.305	15146	151
Surveyor Creek	2/4/2003	37.72883	-81.3036	15147	155
Surveyor Creek	3/12/2003	37.76652	-81.3206	15595	276
Surveyor Creek	3/4/2003	37.74023	-81.305	15596	214
Surveyor Creek	3/3/2003	37.72883	-81.3036	15597	224
Surveyor Creek	4/22/2003	37.76652	-81.3206	16099	134
Surveyor Creek	4/14/2003	37.74023	-81.305	16100	219
Surveyor Creek	4/15/2003	37.72883	-81.3036	16101	304
Surveyor Creek	5/7/2003	37.76652	-81.3206	16549	180
Surveyor Creek	5/6/2003	37.74023	-81.305	16550	195
Surveyor Creek	5/6/2003	37.72883	-81.3036	16551	193
UNT/Surveyor Creek RM 2.11	8/13/2002	37.74333	-81.3077	10313	213
Millers Camp Branch	10/7/1997	37.76786	-81.3202	430	353
Millers Camp Branch	8/13/2002	37.76972	-81.3076	10314	443
Millers Camp Branch	8/13/2002	37.76239	-81.2892	10315	332

Millers Camp Branch	8/14/2002	37.77239	-81.2677	10316	688
Millers Camp Branch	8/14/2002	37.7833	-81.2664	10317	738
Millers Camp Branch	9/5/2002	37.76786	-81.3202	10928	546
Millers Camp Branch	9/5/2002	37.76239	-81.2892	10929	330
Millers Camp Branch	9/5/2002	37.77239	-81.2677	10930	848
Millers Camp Branch	9/5/2002	37.7833	-81.2664	10931	986
Millers Camp Branch	8/14/2002	37.76786	-81.3202	11177	464
Millers Camp Branch	8/15/2002	37.76239	-81.2892	11178	338
Millers Camp Branch	8/16/2002	37.7833	-81.2664	11180	835
Millers Camp Branch	9/25/2002	37.76786	-81.3202	11838	559
Millers Camp Branch	10/10/2002	37.76239	-81.2892	11839	356
Millers Camp Branch	10/10/2002	37.77239	-81.2677	11840	932
Millers Camp Branch	10/10/2002	37.7833	-81.2664	11841	1068
Millers Camp Branch	10/22/2002	37.76786	-81.3202	12619	483
Millers Camp Branch	10/24/2002	37.76239	-81.2892	12620	374
Millers Camp Branch	10/24/2002	37.76239	-81.2892	12621	
Millers Camp Branch	10/31/2002	37.77239	-81.2677	12622	401
Millers Camp Branch	10/31/2002	37.7833	-81.2664	12623	440
Millers Camp Branch	11/25/2002	37.76786	-81.3202	13313	198
Millers Camp Branch	11/25/2002	37.76239	-81.2892	13314	239
Millers Camp Branch	11/26/2002	37.77239	-81.2677	13315	297
Millers Camp Branch	11/25/2002	37.7833	-81.2664	13316	316
Millers Camp Branch	12/17/2002	37.76786	-81.3202	13740	168
Millers Camp Branch	12/19/2002	37.76239	-81.2892	13741	243
Millers Camp Branch	12/19/2002	37.76239	-81.2892	13742	
Millers Camp Branch	12/19/2002	37.77239	-81.2677	13743	271
Millers Camp Branch	12/19/2002	37.7833	-81.2664	13744	300
Millers Camp Branch	1/14/2003	37.76786	-81.3202	14229	182
Millers Camp Branch	1/15/2003	37.76239	-81.2892	14230	230
Millers Camp Branch	1/15/2003	37.77239	-81.2677	14231	271
Millers Camp Branch	1/15/2003	37.7833	-81.2664	14232	304
Millers Camp Branch	2/10/2003	37.76786	-81.3202	15148	176
Millers Camp Branch	2/12/2003	37.76239	-81.2892	15149	254
Millers Camp Branch	2/10/2003	37.77239	-81.2677	15150	296
Millers Camp Branch	2/7/2003	37.7833	-81.2664	15151	252
Millers Camp Branch	3/11/2003	37.76786	-81.3202	15598	214
Millers Camp Branch	3/6/2003	37.76239	-81.2892	15599	216
Millers Camp Branch	3/12/2003	37.77239	-81.2677	15600	290
Millers Camp Branch	3/6/2003	37.7833	-81.2664	15601	251
Millers Camp Branch	4/22/2003	37.76786	-81.3202	16102	117
Millers Camp Branch	4/21/2003	37.76239	-81.2892	16103	175
Millers Camp Branch	4/21/2003	37.77239	-81.2677	16104	191
Millers Camp Branch	4/22/2003	37.7833	-81.2664	16105	184
Millers Camp Branch	5/7/2003	37.76786	-81.3202	16552	160

Millers Camp Branch	5/7/2003	37.76239	-81.2892	16553	191
Millers Camp Branch	5/8/2003	37.77239	-81.2677	16554	272
Millers Camp Branch	5/8/2003	37.7833	-81.2664	16555	314
Clay Branch	8/7/2002	37.77011	-81.319	10318	155
Clay Branch	8/7/2002	37.77942	-81.3184	10319	100
Clay Branch	9/5/2002	37.77011	-81.319	10932	229
Clay Branch	9/5/2002	37.77942	-81.3184	10933	120
Clay Branch	9/25/2002	37.77011	-81.319	11842	115
Clay Branch	9/25/2002	37.77942	-81.3184	11843	127
Clay Branch	10/24/2002	37.77011	-81.319	12624	154
Clay Branch	10/21/2002	37.77942	-81.3184	12625	117
Clay Branch	11/22/2002	37.77011	-81.319	13317	187
Clay Branch	11/21/2002	37.77942	-81.3184	13318	59
Clay Branch	12/12/2002	37.77011	-81.319	13745	206
Clay Branch	12/11/2002	37.77942	-81.3184	13746	42
Clay Branch	1/9/2003	37.77011	-81.319	14233	119
Clay Branch	1/7/2003	37.77942	-81.3184	14234	52
Clay Branch	2/4/2003	37.77011	-81.319	15152	144
Clay Branch	2/4/2003	37.77942	-81.3184	15153	46
Clay Branch	3/4/2003	37.77011	-81.319	15602	67
Clay Branch	3/4/2003	37.77942	-81.3184	15603	52
Clay Branch	4/15/2003	37.77011	-81.319	16106	74
Clay Branch	4/15/2003	37.77942	-81.3184	16107	50
Clay Branch	5/7/2003	37.77011	-81.319	16556	59
Clay Branch	5/7/2003	37.77942	-81.3184	16557	53
Stephens Branch	8/7/2002	37.77036	-81.3072	10320	38
Stephens Branch	9/5/2002	37.77036	-81.3072	10934	47
Stephens Branch	9/25/2002	37.77036	-81.3072	11844	50
Stephens Branch	10/23/2002	37.77036	-81.3072	12626	64
Stephens Branch	11/25/2002	37.77036	-81.3072	13319	42
Stephens Branch	12/19/2002	37.77036	-81.3072	13747	40
Stephens Branch	1/15/2003	37.77036	-81.3072	14235	44
Stephens Branch	2/11/2003	37.77036	-81.3072	15154	44
Stephens Branch	3/11/2003	37.77036	-81.3072	15604	41
Stephens Branch	4/21/2003	37.77036	-81.3072	16108	39
Stephens Branch	5/7/2003	37.77036	-81.3072	16558	38
Ugly Branch	8/7/2002	37.76825	-81.2995	10321	79
Ugly Branch	11/25/2002	37.76825	-81.2995	13320	45
Ugly Branch	12/18/2002	37.76825	-81.2995	13748	47
Ugly Branch	1/15/2003	37.76825	-81.2995	14236	55
Ugly Branch	2/7/2003	37.76825	-81.2995	15155	49
Ugly Branch	2/7/2003	37.76825	-81.2995	15156	
Ugly Branch	3/6/2003	37.76825	-81.2995	15605	59
Ugly Branch	4/17/2003	37.76825	-81.2995	16109	58

Ugly Branch	5/7/2003	37.76825	-81.2995	16559	50
Shockley Branch	8/7/2002	37.75983	-81.2927	10322	254
Shockley Branch	9/5/2002	37.75983	-81.2927	10936	309
Shockley Branch	10/9/2002	37.75983	-81.2927	11846	280
Shockley Branch	10/24/2002	37.75983	-81.2927	12628	255
Shockley Branch	11/26/2002	37.75983	-81.2927	13321	180
Shockley Branch	12/19/2002	37.75983	-81.2927	13749	195
Shockley Branch	1/16/2003	37.75983	-81.2927	14237	224
Shockley Branch	1/16/2003	37.75983	-81.2927	14238	
Shockley Branch	2/12/2003	37.75983	-81.2927	15157	221
Shockley Branch	3/12/2003	37.75983	-81.2927	15606	228
Shockley Branch	4/21/2003	37.75983	-81.2927	16110	160
Shockley Branch	5/7/2003	37.75983	-81.2927	16560	168
Laurel Branch	8/14/2002	37.76308	-81.2854	10323	124
Laurel Branch	9/5/2002	37.76308	-81.2854	10937	248
Laurel Branch	10/10/2002	37.76308	-81.2854	11847	222
Laurel Branch	10/24/2002	37.76308	-81.2854	12629	109
Laurel Branch	11/26/2002	37.76308	-81.2854	13322	166
Laurel Branch	12/19/2002	37.76308	-81.2854	13750	105
Laurel Branch	1/16/2003	37.76308	-81.2854	14239	247
Laurel Branch	2/12/2003	37.76308	-81.2854	15158	254
Laurel Branch	3/13/2003	37.76308	-81.2854	15607	86
Laurel Branch	3/13/2003	37.76308	-81.2854	15608	
Laurel Branch	4/21/2003	37.76308	-81.2854	16111	68
Laurel Branch	5/8/2003	37.76308	-81.2854	16561	104
Jehu Branch	10/7/1997	37.77128	-81.2672	432	317
Jehu Branch	8/14/2002	37.77125	-81.2675	10324	277
Jehu Branch	9/5/2002	37.77125	-81.2675	10938	290
Jehu Branch	10/31/2002	37.77125	-81.2675	12630	102
Jehu Branch	11/26/2002	37.77125	-81.2675	13323	105
Jehu Branch	12/19/2002	37.77125	-81.2675	13751	106
Jehu Branch	1/15/2003	37.77125	-81.2675	14240	123
Jehu Branch	2/10/2003	37.77125	-81.2675	15159	150
Jehu Branch	3/12/2003	37.77125	-81.2675	15609	145
Jehu Branch	4/21/2003	37.77125	-81.2675	16112	98
Jehu Branch	5/8/2003	37.77125	-81.2675	16562	130
Marsh Fork	10/6/1997	37.77461	-81.3317	416	427
Marsh Fork	7/23/2002	37.80125	-81.4166	10245	327
Marsh Fork	8/1/2002	37.7838	-81.3821	10246	299
Marsh Fork	8/12/2002	37.77733	-81.3356	10247	485
Marsh Fork	8/28/2002	37.80125	-81.4166	10861	515
Marsh Fork	9/4/2002	37.7838	-81.3821	10862	514
Marsh Fork	9/4/2002	37.7838	-81.3821	10863	
Marsh Fork	9/4/2002	37.77733	-81.3356	10864	528

Marsh Fork	7/31/2002	37.80125	-81.4166	11152	286
Marsh Fork	10/17/2002	37.80125	-81.4166	11772	216
Marsh Fork	10/9/2002	37.7838	-81.3821	11773	511
Marsh Fork	10/9/2002	37.77733	-81.3356	11774	511
Marsh Fork	10/23/2002	37.7838	-81.3821	12553	388
Marsh Fork	10/23/2002	37.77733	-81.3356	12554	464
Marsh Fork	12/3/2002	37.80125	-81.4166	13246	212
Marsh Fork	11/21/2002	37.7838	-81.3821	13247	135
Marsh Fork	11/25/2002	37.77733	-81.3356	13248	184
Marsh Fork	12/30/2002	37.80125	-81.4166	13674	273
Marsh Fork	12/12/2002	37.7838	-81.3821	13675	90
Marsh Fork	12/17/2002	37.77733	-81.3356	13676	160
Marsh Fork	1/27/2003	37.80125	-81.4166	14162	368
Marsh Fork	1/13/2003	37.7838	-81.3821	14163	152
Marsh Fork	1/13/2003	37.77733	-81.3356	14164	175
Marsh Fork	2/27/2003	37.80125	-81.4166	15083	139
Marsh Fork	2/11/2003	37.7838	-81.3821	15084	188
Marsh Fork	2/12/2003	37.77733	-81.3356	15085	216
Marsh Fork	3/19/2003	37.80125	-81.4166	15532	214
Marsh Fork	3/10/2003	37.7838	-81.3821	15533	189
Marsh Fork	3/10/2003	37.77733	-81.3356	15534	212
Marsh Fork	4/18/2003	37.80125	-81.4166	16036	132
Marsh Fork	4/16/2003	37.7838	-81.3821	16037	116
Marsh Fork	4/16/2003	37.77733	-81.3356	16038	171
Marsh Fork	5/14/2003	37.80125	-81.4166	16483	145
Marsh Fork	5/14/2003	37.80125	-81.4166	16484	
Marsh Fork	5/7/2003	37.7838	-81.3821	16485	164
Marsh Fork	5/7/2003	37.7838	-81.3821	16486	
Marsh Fork	5/7/2003	37.77733	-81.3356	16487	153
Sandlick Creek	7/25/2002	37.82439	-81.4144	10278	257
Sandlick Creek	7/25/2002	37.82761	-81.3809	10279	335
Sandlick Creek	7/29/2002	37.83103	-81.3451	10280	108
Sandlick Creek	7/29/2002	37.8283	-81.3283	10281	68
Sandlick Creek	9/3/2002	37.82439	-81.4144	10896	633
Sandlick Creek	9/3/2002	37.82761	-81.3809	10897	763
Sandlick Creek	9/3/2002	37.83103	-81.3451	10898	298
Sandlick Creek	9/3/2002	37.8283	-81.3283	10899	171
Sandlick Creek	10/8/2002	37.82439	-81.4144	11805	321
Sandlick Creek	9/26/2002	37.82761	-81.3809	11806	623
Sandlick Creek	9/26/2002	37.83103	-81.3451	11807	353
Sandlick Creek	10/8/2002	37.8283	-81.3283	11808	139
Sandlick Creek	10/30/2002	37.82439	-81.4144	12586	121
Sandlick Creek	10/30/2002	37.82761	-81.3809	12587	120
Sandlick Creek	10/30/2002	37.83103	-81.3451	12588	116

Sandlick Creek	10/23/2002	37.8283	-81.3283	12589	115
Sandlick Creek	11/18/2002	37.82439	-81.4144	13280	92
Sandlick Creek	11/18/2002	37.82761	-81.3809	13281	103
Sandlick Creek	11/20/2002	37.83103	-81.3451	13282	113
Sandlick Creek	11/20/2002	37.8283	-81.3283	13283	79
Sandlick Creek	12/9/2002	37.82439	-81.4144	13708	130
Sandlick Creek	12/9/2002	37.82761	-81.3809	13709	142
Sandlick Creek	12/10/2002	37.83103	-81.3451	13710	117
Sandlick Creek	12/10/2002	37.8283	-81.3283	13711	97
Sandlick Creek	1/8/2003	37.82439	-81.4144	14197	123
Sandlick Creek	1/8/2003	37.82761	-81.3809	14198	130
Sandlick Creek	1/8/2003	37.83103	-81.3451	14199	113
Sandlick Creek	1/8/2003	37.8283	-81.3283	14200	77
Sandlick Creek	2/5/2003	37.82439	-81.4144	15117	88
Sandlick Creek	2/5/2003	37.82761	-81.3809	15118	92
Sandlick Creek	2/6/2003	37.83103	-81.3451	15119	83
Sandlick Creek	2/6/2003	37.8283	-81.3283	15120	89
Sandlick Creek	3/3/2003	37.82439	-81.4144	15567	108
Sandlick Creek	3/3/2003	37.82761	-81.3809	15568	116
Sandlick Creek	3/5/2003	37.83103	-81.3451	15569	115
Sandlick Creek	3/10/2003	37.8283	-81.3283	15570	79
Sandlick Creek	4/14/2003	37.82439	-81.4144	16071	110
Sandlick Creek	4/14/2003	37.82761	-81.3809	16072	118
Sandlick Creek	4/15/2003	37.83103	-81.3451	16073	113
Sandlick Creek	4/16/2003	37.8283	-81.3283	16074	67
Sandlick Creek	5/6/2003	37.82439	-81.4144	16519	111
Sandlick Creek	5/6/2003	37.82761	-81.3809	16520	104
Sandlick Creek	5/6/2003	37.83103	-81.3451	16521	84
Sandlick Creek	5/8/2003	37.8283	-81.3283	16522	77
Bee Branch	9/29/1997	37.83064	-81.3887	426	353
Bee Branch	7/25/2002	37.83064	-81.389	10282	393
Bee Branch	7/25/2002	37.84008	-81.3844	10283	532
Bee Branch	9/3/2002	37.84008	-81.3844	10901	540
Bee Branch	10/8/2002	37.83064	-81.389	11809	400
Bee Branch	9/26/2002	37.84008	-81.3844	11810	348
Bee Branch	10/30/2002	37.83064	-81.389	12590	310
Bee Branch	10/30/2002	37.84008	-81.3844	12591	457
Bee Branch	11/18/2002	37.83064	-81.389	13284	198
Bee Branch	11/18/2002	37.84008	-81.3844	13285	314
Bee Branch	12/10/2002	37.83064	-81.389	13712	184
Bee Branch	12/9/2002	37.84008	-81.3844	13713	314
Bee Branch	1/8/2003	37.83064	-81.389	14201	132
Bee Branch	1/8/2003	37.84008	-81.3844	14202	229
Bee Branch	2/5/2003	37.83064	-81.389	15121	144

Bee Branch	2/5/2003	37.84008	-81.3844	15122	221
Bee Branch	3/3/2003	37.83064	-81.389	15571	175
Bee Branch	3/3/2003	37.84008	-81.3844	15572	270
Bee Branch	4/14/2003	37.83064	-81.389	16075	160
Bee Branch	4/14/2003	37.84008	-81.3844	16076	247
Bee Branch	5/8/2003	37.83064	-81.389	16523	205
Bee Branch	5/29/2003	37.83064	-81.389	16524	202
Bee Branch	5/8/2003	37.84008	-81.3844	16525	354
Bee Branch	5/29/2003	37.84008	-81.3844	16526	285
Right Fork/Sandlick Creek	7/25/2002	37.82539	-81.3689	10284	610
Right Fork/Sandlick Creek	7/25/2002	37.82539	-81.3689	10285	
Right Fork/Sandlick Creek	7/29/2002	37.80539	-81.3397	10286	82
Right Fork/Sandlick Creek	9/3/2002	37.82539	-81.3689	10902	1131
Right Fork/Sandlick Creek	9/3/2002	37.80539	-81.3397	10903	266
Right Fork/Sandlick Creek	10/8/2002	37.82539	-81.3689	11811	370
Right Fork/Sandlick Creek	10/8/2002	37.82539	-81.3689	11812	
Right Fork/Sandlick Creek	9/26/2002	37.80539	-81.3397	11813	127
Right Fork/Sandlick Creek	11/1/2002	37.82539	-81.3689	12592	130
Right Fork/Sandlick Creek	11/1/2002	37.82539	-81.3689	12593	
Right Fork/Sandlick Creek	10/30/2002	37.80539	-81.3397	12594	86
Right Fork/Sandlick Creek	11/19/2002	37.82539	-81.3689	13286	120
Right Fork/Sandlick Creek	11/19/2002	37.82539	-81.3689	13287	
Right Fork/Sandlick Creek	11/19/2002	37.80539	-81.3397	13288	90
Right Fork/Sandlick Creek	12/11/2002	37.82539	-81.3689	13714	69
Right Fork/Sandlick Creek	12/9/2002	37.80539	-81.3397	13715	86
Right Fork/Sandlick Creek	1/9/2003	37.82539	-81.3689	14203	83
Right Fork/Sandlick Creek	1/8/2003	37.80539	-81.3397	14204	127
Right Fork/Sandlick Creek	2/10/2003	37.82539	-81.3689	15123	120
Right Fork/Sandlick Creek	2/5/2003	37.80539	-81.3397	15124	77
Right Fork/Sandlick Creek	3/10/2003	37.82539	-81.3689	15573	182
Right Fork/Sandlick Creek	3/3/2003	37.80539	-81.3397	15574	90
Right Fork/Sandlick Creek	4/17/2003	37.82539	-81.3689	16077	149
Right Fork/Sandlick Creek	4/14/2003	37.80539	-81.3397	16078	69
Right Fork/Sandlick Creek	5/8/2003	37.82539	-81.3689	16527	93
Right Fork/Sandlick Creek	5/6/2003	37.80539	-81.3397	16528	58
Right Fork/Sandlick Creek	1/23/2001	37.79983	-81.337	18896	67
Right Fork/Sandlick Creek	1/23/2001	37.80928	-81.3454	18897	94
Right Fork/Sandlick Creek	1/23/2001	37.8125	-81.3536	18898	91
Right Fork/Sandlick Creek	1/23/2001	37.81869	-81.362	18899	163
Right Fork/Sandlick Creek	1/23/2001	37.82108	-81.3644	18900	167
Right Fork/Sandlick Creek	1/23/2001	37.82539	-81.3689	18901	153
Wingrove Branch	7/29/2002	37.83139	-81.3649	10287	269
Wingrove Branch	9/3/2002	37.83139	-81.3649	10904	320
Wingrove Branch	9/26/2002	37.83139	-81.3649	11814	273

Wingrove Branch	10/30/2002	37.83139	-81.3649	12595	234
Wingrove Branch	11/21/2002	37.83139	-81.3649	13289	197
Wingrove Branch	12/10/2002	37.83139	-81.3649	13716	210
Wingrove Branch	1/8/2003	37.83139	-81.3649	14205	178
Wingrove Branch	2/6/2003	37.83139	-81.3649	15125	180
Wingrove Branch	3/5/2003	37.83139	-81.3649	15575	206
Wingrove Branch	4/14/2003	37.83139	-81.3649	16079	193
Wingrove Branch	5/6/2003	37.83139	-81.3649	16529	204
Harper Branch	7/30/2002	37.82367	-81.3319	10288	120
Harper Branch	9/3/2002	37.82367	-81.3319	10905	883
Harper Branch	10/8/2002	37.82367	-81.3319	11815	695
Harper Branch	10/23/2002	37.82367	-81.3319	12596	420
Harper Branch	11/20/2002	37.82367	-81.3319	13290	96
Harper Branch	12/10/2002	37.82367	-81.3319	13717	141
Harper Branch	3/25/2003	37.82367	-81.3319	15576	220
Harper Branch	4/22/2003	37.82367	-81.3319	16080	105
Harper Branch	5/8/2003	37.82367	-81.3319	16530	114
UMT/Harper Branch RM 0.03	7/29/2002	37.82742	-81.334	10289	181
UNT/Harper Branch RM 0.59	7/29/2002	37.82122	-81.3286	10290	365
Cove Creek	9/29/1997	37.79844	-81.422	427	553
Cove Creek	7/22/2002	37.80039	-81.4184	10291	447
Cove Creek	7/22/2002	37.79155	-81.4274	10292	560
Cove Creek	7/22/2002	37.78969	-81.4359	10293	680
Cove Creek	8/28/2002	37.80039	-81.4184	10906	650
Cove Creek	8/28/2002	37.79155	-81.4274	10907	689
Cove Creek	8/28/2002	37.78969	-81.4359	10908	797
Cove Creek	7/31/2002	37.80039	-81.4184	11168	406
Cove Creek	10/17/2002	37.80039	-81.4184	11816	248
Cove Creek	10/17/2002	37.79155	-81.4274	11817	361
Cove Creek	10/17/2002	37.78969	-81.4359	11818	420
Cove Creek	11/6/2002	37.80039	-81.4184	12597	192
Cove Creek	11/6/2002	37.79155	-81.4274	12598	293
Cove Creek	11/6/2002	37.78969	-81.4359	12599	386
Cove Creek	12/3/2002	37.80039	-81.4184	13291	375
Cove Creek	12/3/2002	37.79155	-81.4274	13292	514
Cove Creek	12/3/2002	37.78969	-81.4359	13293	651
Cove Creek	12/30/2002	37.80039	-81.4184	13718	443
Cove Creek	12/30/2002	37.79155	-81.4274	13719	401
Cove Creek	12/30/2002	37.78969	-81.4359	13720	694
Cove Creek	1/27/2003	37.80039	-81.4184	14207	506
Cove Creek	1/27/2003	37.79155	-81.4274	14208	631
Cove Creek	1/27/2003	37.78969	-81.4359	14209	747
Cove Creek	2/27/2003	37.80039	-81.4184	15127	371
Cove Creek	2/27/2003	37.79155	-81.4274	15128	496

Cove Creek	2/27/2003	37.78969	-81.4359	15129	655
Cove Creek	3/19/2003	37.80039	-81.4184	15577	386
Cove Creek	3/19/2003	37.79155	-81.4274	15578	503
Cove Creek	3/19/2003	37.78969	-81.4359	15579	636
Cove Creek	4/18/2003	37.80039	-81.4184	16081	256
Cove Creek	4/18/2003	37.79155	-81.4274	16082	364
Cove Creek	4/18/2003	37.78969	-81.4359	16083	510
Cove Creek	5/14/2003	37.80039	-81.4184	16531	348
Cove Creek	5/14/2003	37.79155	-81.4274	16532	475
Cove Creek	5/14/2003	37.78969	-81.4359	16533	605
UNT/Cove Creek RM 1.22	7/22/2002	37.79136	-81.4274	10294	158
UNT/Cove Creek RM 1.22	10/17/2002	37.79136	-81.4274	11819	119
UNT/Cove Creek RM 1.22	11/6/2002	37.79136	-81.4274	12600	106
UNT/Cove Creek RM 1.22	12/3/2002	37.79136	-81.4274	13294	136
UNT/Cove Creek RM 1.22	12/30/2002	37.79136	-81.4274	13721	241
UNT/Cove Creek RM 1.22	1/27/2003	37.79136	-81.4274	14210	240
UNT/Cove Creek RM 1.22	2/27/2003	37.79136	-81.4274	15130	93
UNT/Cove Creek RM 1.22	3/19/2003	37.79136	-81.4274	15580	144
UNT/Cove Creek RM 1.22	4/18/2003	37.79136	-81.4274	16084	88
UNT/Cove Creek RM 1.22	5/14/2003	37.79136	-81.4274	16534	124
Breckenridge Creek	8/5/2002	37.79505	-81.4077	10295	144
Breckenridge Creek	7/30/2002	37.77669	-81.4065	10296	130
Breckenridge Creek	7/30/2002	37.76261	-81.4079	10297	161
Breckenridge Creek	9/4/2002	37.79505	-81.4077	10910	185
Breckenridge Creek	9/4/2002	37.77669	-81.4065	10911	307
Breckenridge Creek	9/4/2002	37.76261	-81.4079	10912	444
Breckenridge Creek	10/9/2002	37.79505	-81.4077	11820	234
Breckenridge Creek	9/26/2002	37.77669	-81.4065	11821	180
Breckenridge Creek	9/26/2002	37.76261	-81.4079	11822	174
Breckenridge Creek	10/31/2002	37.79505	-81.4077	12601	133
Breckenridge Creek	10/30/2002	37.77669	-81.4065	12602	160
Breckenridge Creek	10/30/2002	37.76261	-81.4079	12603	215
Breckenridge Creek	11/19/2002	37.79505	-81.4077	13295	165
Breckenridge Creek	11/19/2002	37.77669	-81.4065	13296	131
Breckenridge Creek	11/19/2002	37.76261	-81.4079	13297	149
Breckenridge Creek	12/10/2002	37.77669	-81.4065	13723	121
Breckenridge Creek	12/11/2002	37.76261	-81.4079	13724	148
Breckenridge Creek	1/7/2003	37.77669	-81.4065	14212	154
Breckenridge Creek	1/7/2003	37.76261	-81.4079	14213	254
Breckenridge Creek	2/4/2003	37.77669	-81.4065	15131	127
Breckenridge Creek	2/4/2003	37.76261	-81.4079	15132	132
Breckenridge Creek	3/4/2003	37.77669	-81.4065	15581	99
Breckenridge Creek	3/4/2003	37.76261	-81.4079	15582	130
Breckenridge Creek	4/15/2003	37.77669	-81.4065	16085	92

Breckenridge Creek	4/15/2003	37.76261	-81.4079	16086	119
Breckenridge Creek	5/6/2003	37.77669	-81.4065	16535	120
Breckenridge Creek	5/6/2003	37.76261	-81.4079	16536	147
Shiloh Fork	9/29/1997	37.80154	-81.3926	428	42
Shiloh Fork	8/1/2002	37.79828	-81.3975	10299	62
Shiloh Fork	8/1/2002	37.80383	-81.3914	10300	46
Shiloh Fork	9/4/2002	37.79828	-81.3975	10914	84
Shiloh Fork	9/26/2002	37.80383	-81.3914	11825	51
Shiloh Fork	10/31/2002	37.79828	-81.3975	12605	59
Shiloh Fork	10/31/2002	37.80383	-81.3914	12606	40
Shiloh Fork	11/19/2002	37.79828	-81.3975	13299	49
Shiloh Fork	11/19/2002	37.80383	-81.3914	13300	40
Shiloh Fork	12/12/2002	37.79828	-81.3975	13726	38
Shiloh Fork	12/12/2002	37.80383	-81.3914	13727	31
Shiloh Fork	1/9/2003	37.79828	-81.3975	14215	42
Shiloh Fork	1/9/2003	37.80383	-81.3914	14216	31
Shiloh Fork	2/5/2003	37.79828	-81.3975	15134	39
Shiloh Fork	2/5/2003	37.80383	-81.3914	15135	33
Shiloh Fork	3/4/2003	37.79828	-81.3975	15584	40
Shiloh Fork	3/4/2003	37.80383	-81.3914	15585	36
Shiloh Fork	4/15/2003	37.79828	-81.3975	16088	39
Shiloh Fork	4/15/2003	37.80383	-81.3914	16089	32
Shiloh Fork	5/7/2003	37.79828	-81.3975	16538	40
Shiloh Fork	5/7/2003	37.80383	-81.3914	16539	33
UNT/Breckenridge Creek RM 3.04	7/30/2002	37.76239	-81.4075	10298	85
UNT/Breckenridge Creek RM 3.04	9/4/2002	37.76239	-81.4075	10913	379
UNT/Breckenridge Creek RM 3.04	9/26/2002	37.76239	-81.4075	11823	84
UNT/Breckenridge Creek RM 3.04	10/30/2002	37.76239	-81.4075	12604	103
UNT/Breckenridge Creek RM 3.04	11/19/2002	37.76239	-81.4075	13298	90
UNT/Breckenridge Creek RM 3.04	12/11/2002	37.76239	-81.4075	13725	68
UNT/Breckenridge Creek RM 3.04	1/7/2003	37.76239	-81.4075	14214	76
UNT/Breckenridge Creek RM 3.04	2/4/2003	37.76239	-81.4075	15133	78
UNT/Breckenridge Creek RM 3.04	3/4/2003	37.76239	-81.4075	15583	83
UNT/Breckenridge Creek RM 3.04	4/15/2003	37.76239	-81.4075	16087	78
UNT/Breckenridge Creek RM 3.04	5/6/2003	37.76239	-81.4075	16537	95
Spanker Branch	8/5/2002	37.78147	-81.3735	10301	92
Spanker Branch	8/5/2002	37.79336	-81.3615	10302	101
Spanker Branch	9/4/2002	37.78147	-81.3735	10916	160
Spanker Branch	9/4/2002	37.79336	-81.3615	10917	111
Spanker Branch	10/8/2002	37.78147	-81.3735	11826	232
Spanker Branch	9/26/2002	37.79336	-81.3615	11827	105
Spanker Branch	10/30/2002	37.78147	-81.3735	12607	65
Spanker Branch	10/30/2002	37.79336	-81.3615	12608	65
Spanker Branch	11/21/2002	37.78147	-81.3735	13301	48

Spanker Branch	11/21/2002	37.79336	-81.3615	13302	55
Spanker Branch	12/11/2002	37.78147	-81.3735	13728	39
Spanker Branch	12/11/2002	37.79336	-81.3615	13729	44
Spanker Branch	1/10/2003	37.78147	-81.3735	14217	43
Spanker Branch	1/10/2003	37.79336	-81.3615	14218	43
Spanker Branch	2/5/2003	37.78147	-81.3735	15136	41
Spanker Branch	2/5/2003	37.79336	-81.3615	15137	42
Spanker Branch	3/4/2003	37.78147	-81.3735	15586	47
Spanker Branch	3/4/2003	37.79336	-81.3615	15587	45
Spanker Branch	4/15/2003	37.78147	-81.3735	16090	43
Spanker Branch	4/15/2003	37.79336	-81.3615	16091	42
Spanker Branch	5/7/2003	37.78147	-81.3735	16540	44
Spanker Branch	5/7/2003	37.79336	-81.3615	16541	44
Spanker Branch	5/4/2004	37.78444	-81.3716	20471	36
Spanker Branch	5/14/2009	37.78444	-81.3716	47857	41
Maple Meadow Creek	8/6/2002	37.77739	-81.3749	10303	373
Maple Meadow Creek	8/6/2002	37.74408	-81.37	10304	62
Maple Meadow Creek	9/4/2002	37.77739	-81.3749	10918	826
Maple Meadow Creek	8/14/2002	37.77739	-81.3749	11170	586
Maple Meadow Creek	10/9/2002	37.77739	-81.3749	11828	722
Maple Meadow Creek	10/22/2002	37.77739	-81.3749	12609	334
Maple Meadow Creek	10/22/2002	37.74408	-81.37	12610	63
Maple Meadow Creek	11/20/2002	37.77739	-81.3749	13303	109
Maple Meadow Creek	11/20/2002	37.74408	-81.37	13304	50
Maple Meadow Creek	12/18/2002	37.77739	-81.3749	13730	119
Maple Meadow Creek	12/18/2002	37.74408	-81.37	13731	52
Maple Meadow Creek	1/14/2003	37.77739	-81.3749	14219	55
Maple Meadow Creek	1/14/2003	37.74408	-81.37	14220	142
Maple Meadow Creek	2/11/2003	37.77739	-81.3749	15138	175
Maple Meadow Creek	2/6/2003	37.74408	-81.37	15139	33
Maple Meadow Creek	3/11/2003	37.77739	-81.3749	15588	207
Maple Meadow Creek	3/11/2003	37.74408	-81.37	15589	55
Maple Meadow Creek	4/17/2003	37.77739	-81.3749	16092	165
Maple Meadow Creek	4/16/2003	37.74408	-81.37	16093	59
Maple Meadow Creek	5/8/2003	37.77739	-81.3749	16542	190
Maple Meadow Creek	5/8/2003	37.74408	-81.37	16543	52
Claypool Hollow	8/6/2002	37.77775	-81.3427	10306	156
Claypool Hollow	8/5/2002	37.78897	-81.3495	10307	140
Claypool Hollow	9/4/2002	37.78897	-81.3495	10922	90
Claypool Hollow	9/26/2002	37.78897	-81.3495	11832	80
Claypool Hollow	10/23/2002	37.77775	-81.3427	12612	213
Claypool Hollow	10/21/2002	37.78897	-81.3495	12613	189
Claypool Hollow	11/20/2002	37.77775	-81.3427	13306	115
Claypool Hollow	11/21/2002	37.78897	-81.3495	13307	144

Claypool Hollow	12/17/2002	37.77775	-81.3427	13733	94
Claypool Hollow	12/11/2002	37.78897	-81.3495	13734	79
Claypool Hollow	1/9/2003	37.77775	-81.3427	14222	96
Claypool Hollow	1/7/2003	37.78897	-81.3495	14223	101
Claypool Hollow	2/11/2003	37.77775	-81.3427	15141	287
Claypool Hollow	2/5/2003	37.78897	-81.3495	15142	90
Claypool Hollow	3/5/2003	37.77775	-81.3427	15591	99
Claypool Hollow	3/4/2003	37.78897	-81.3495	15592	97
Claypool Hollow	4/16/2003	37.77775	-81.3427	16095	80
Claypool Hollow	4/14/2003	37.78897	-81.3495	16096	81
Claypool Hollow	5/7/2003	37.77775	-81.3427	16545	98
Claypool Hollow	5/6/2003	37.78897	-81.3495	16546	84
Rockhouse Fork	8/6/2002	37.75947	-81.3638	10305	130
Rockhouse Fork	9/4/2002	37.75947	-81.3638	10920	201
Rockhouse Fork	8/14/2002	37.75964	-81.3637	11172	163
Rockhouse Fork	10/9/2002	37.75947	-81.3638	11830	159
Rockhouse Fork	10/22/2002	37.75947	-81.3638	12611	99
Rockhouse Fork	11/20/2002	37.75947	-81.3638	13305	53
Rockhouse Fork	12/18/2002	37.75947	-81.3638	13732	56
Rockhouse Fork	1/14/2003	37.75947	-81.3638	14221	59
Rockhouse Fork	2/11/2003	37.75947	-81.3638	15140	67
Rockhouse Fork	3/11/2003	37.75947	-81.3638	15590	68
Rockhouse Fork	4/17/2003	37.75947	-81.3638	16094	64
Rockhouse Fork	5/8/2003	37.75947	-81.3638	16544	60
Dingess Branch	8/6/2002	37.77783	-81.3405	10308	196
Dingess Branch	8/5/2002	37.79403	-81.331	10309	115
Dingess Branch	9/3/2002	37.77783	-81.3405	10923	258
Dingess Branch	9/3/2002	37.79403	-81.331	10924	367
Dingess Branch	8/14/2002	37.77783	-81.3405	11173	184
Dingess Branch	10/8/2002	37.77783	-81.3405	11833	302
Dingess Branch	9/26/2002	37.79403	-81.331	11834	100
Dingess Branch	10/23/2002	37.77783	-81.3405	12614	183
Dingess Branch	10/21/2002	37.79403	-81.331	12615	150
Dingess Branch	11/21/2002	37.77783	-81.3405	13308	97
Dingess Branch	11/19/2002	37.79403	-81.331	13309	71
Dingess Branch	12/17/2002	37.77783	-81.3405	13735	69
Dingess Branch	12/11/2002	37.79403	-81.331	13736	52
Dingess Branch	1/13/2003	37.77783	-81.3405	14224	70
Dingess Branch	1/8/2003	37.79403	-81.331	14225	59
Dingess Branch	2/12/2003	37.77783	-81.3405	15143	119
Dingess Branch	2/6/2003	37.79403	-81.331	15144	49
Dingess Branch	3/12/2003	37.77783	-81.3405	15593	77
Dingess Branch	3/3/2003	37.79403	-81.331	15594	51
Dingess Branch	4/17/2003	37.77783	-81.3405	16097	70

Dingess Branch	4/14/2003	37.79403	-81.331	16098	47
Dingess Branch	5/7/2003	37.77783	-81.3405	16547	72
Dingess Branch	5/6/2003	37.79403	-81.331	16548	52
Spruce Laurel Fork	9/25/1997	37.94588	-81.8063	364	1540
Spruce Laurel Fork	9/15/1997	37.8365	-81.7257	365	522
Spruce Laurel Fork	9/25/1997	37.93566	-81.7743	366	1860
Spruce Laurel Fork	7/15/2002	37.94588	-81.8063	10101	824
Spruce Laurel Fork	7/15/2002	37.94441	-81.7736	10102	919
Spruce Laurel Fork	7/9/2002	37.83764	-81.7288	10104	490
Spruce Laurel Fork	8/28/2002	37.94588	-81.8063	10716	1476
Spruce Laurel Fork	8/28/2002	37.94441	-81.7736	10717	1262
Spruce Laurel Fork	8/1/2002	37.91072	-81.7446	11086	280
Spruce Laurel Fork	7/31/2002	37.83764	-81.7288	11087	302
Spruce Laurel Fork	10/9/2002	37.94588	-81.8063	11632	1751
Spruce Laurel Fork	10/9/2002	37.94441	-81.7736	11633	1610
Spruce Laurel Fork	10/30/2002	37.94588	-81.8063	12413	456
Spruce Laurel Fork	10/30/2002	37.94441	-81.7736	12414	489
Spruce Laurel Fork	10/29/2002	37.91072	-81.7446	12415	320
Spruce Laurel Fork	10/28/2002	37.83764	-81.7288	12416	267
Spruce Laurel Fork	11/18/2002	37.94588	-81.8063	13104	353
Spruce Laurel Fork	11/19/2002	37.94441	-81.7736	13105	361
Spruce Laurel Fork	11/18/2002	37.91072	-81.7446	13106	182
Spruce Laurel Fork	11/18/2002	37.83764	-81.7288	13107	139
Spruce Laurel Fork	12/9/2002	37.94588	-81.8063	13537	525
Spruce Laurel Fork	12/9/2002	37.94441	-81.7736	13538	644
Spruce Laurel Fork	12/9/2002	37.91072	-81.7446	13539	243
Spruce Laurel Fork	12/9/2002	37.88125	-81.7543	13540	167
Spruce Laurel Fork	1/30/2003	37.94588	-81.8063	14021	717
Spruce Laurel Fork	1/30/2003	37.94441	-81.7736	14022	652
Spruce Laurel Fork	1/30/2003	37.91072	-81.7446	14023	287
Spruce Laurel Fork	1/30/2003	37.88125	-81.7543	14024	194
Spruce Laurel Fork	2/26/2003	37.94588	-81.8063	14939	349
Spruce Laurel Fork	2/26/2003	37.94588	-81.8063	14940	
Spruce Laurel Fork	2/26/2003	37.94441	-81.7736	14941	488
Spruce Laurel Fork	2/26/2003	37.91072	-81.7446	14942	284
Spruce Laurel Fork	2/26/2003	37.88125	-81.7543	14943	162
Spruce Laurel Fork	3/19/2003	37.94588	-81.8063	15394	583
Spruce Laurel Fork	3/19/2003	37.94441	-81.7736	15395	619
Spruce Laurel Fork	3/20/2003	37.91072	-81.7446	15396	339
Spruce Laurel Fork	3/20/2003	37.88125	-81.7543	15397	199
Spruce Laurel Fork	4/16/2003	37.94588	-81.8063	15896	491
Spruce Laurel Fork	4/16/2003	37.94441	-81.7736	15897	530
Spruce Laurel Fork	4/16/2003	37.91072	-81.7446	15898	306
Spruce Laurel Fork	4/16/2003	37.88125	-81.7543	15899	172

Spruce Laurel Fork	6/2/2003	37.94588	-81.8063	16341	370
Spruce Laurel Fork	6/2/2003	37.94588	-81.8063	16342	
Spruce Laurel Fork	6/2/2003	37.94441	-81.7736	16343	484
Spruce Laurel Fork	6/3/2003	37.91072	-81.7446	16344	298
Spruce Laurel Fork	6/3/2003	37.88125	-81.7543	16345	185
Trace Branch	7/15/2002	37.94838	-81.7756	10105	658
Trace Branch	8/28/2002	37.94838	-81.7756	10720	800
Trace Branch	10/9/2002	37.94838	-81.7756	11636	722
Trace Branch	10/30/2002	37.94838	-81.7756	12417	354
Trace Branch	11/19/2002	37.94838	-81.7756	13109	385
Trace Branch	12/9/2002	37.94838	-81.7756	13541	473
Trace Branch	1/30/2003	37.94838	-81.7756	14025	491
Trace Branch	3/19/2003	37.94838	-81.7756	15398	573
Trace Branch	4/16/2003	37.94838	-81.7756	15900	508
Trace Branch	6/2/2003	37.94838	-81.7756	16346	457
White Oak Branch	7/15/2002	37.93036	-81.7525	10106	545
White Oak Branch	8/28/2002	37.93036	-81.7525	10721	629
White Oak Branch	10/9/2002	37.93036	-81.7525	11637	592
White Oak Branch	10/23/2002	37.93036	-81.7525	12418	596
White Oak Branch	11/19/2002	37.93036	-81.7525	13110	409
White Oak Branch	12/9/2002	37.93036	-81.7525	13542	484
White Oak Branch	1/30/2003	37.93036	-81.7525	14026	484
White Oak Branch	2/26/2003	37.93036	-81.7525	14945	450
White Oak Branch	3/20/2003	37.93036	-81.7525	15399	528
White Oak Branch	4/16/2003	37.93036	-81.7525	15901	437
White Oak Branch	6/2/2003	37.93036	-81.7525	16347	476
Bean Hollow	7/10/2002	37.91653	-81.7446	10107	1236
Bean Hollow	8/28/2002	37.91653	-81.7446	10722	1123
Bean Hollow	10/9/2002	37.91653	-81.7446	11638	907
Bean Hollow	11/18/2002	37.91653	-81.7446	13111	1079
Bean Hollow	12/9/2002	37.91653	-81.7446	13543	1130
Bean Hollow	1/30/2003	37.91653	-81.7446	14027	11.9
Bean Hollow	3/20/2003	37.91653	-81.7446	15400	1372
Bean Hollow	4/16/2003	37.91653	-81.7446	15902	1202
Bean Hollow	6/3/2003	37.91653	-81.7446	16348	1158
Sycamore Fork	7/10/2002	37.91167	-81.7438	10108	2302
Sycamore Fork	8/28/2002	37.91167	-81.7438	10723	2312
Sycamore Fork	7/31/2002	37.91167	-81.7438	11088	2257
Sycamore Fork	10/9/2002	37.91167	-81.7438	11639	2445
Sycamore Fork	10/28/2002	37.91167	-81.7438	12420	2194
Sycamore Fork	11/18/2002	37.91167	-81.7438	13112	1905
Sycamore Fork	12/9/2002	37.91167	-81.7438	13544	1540
Sycamore Fork	1/30/2003	37.91167	-81.7438	14028	1567
Sycamore Fork	2/26/2003	37.91167	-81.7438	14947	1097

Sycamore Fork	3/20/2003	37.91167	-81.7438	15401	928
Sycamore Fork	4/16/2003	37.91167	-81.7438	15903	1311
Sycamore Fork	6/3/2003	37.91167	-81.7438	16349	1313
Sycamore Fork	5/5/2004	37.89624	-81.7357	20549	1450
Skin Poplar Branch	7/10/2002	37.88674	-81.7479	10109	752
Skin Poplar Branch	8/28/2002	37.88674	-81.7479	10724	818
Skin Poplar Branch	7/31/2002	37.88674	-81.7479	11089	704
Skin Poplar Branch	10/9/2002	37.88674	-81.7479	11640	857
Skin Poplar Branch	10/29/2002	37.88674	-81.7479	12421	401
Skin Poplar Branch	11/18/2002	37.88674	-81.7479	13113	364
Skin Poplar Branch	12/9/2002	37.88674	-81.7479	13545	511
Skin Poplar Branch	1/30/2003	37.88674	-81.7479	14029	534
Skin Poplar Branch	2/26/2003	37.88674	-81.7479	14948	426
Skin Poplar Branch	3/20/2003	37.88674	-81.7479	15402	572
Skin Poplar Branch	4/16/2003	37.88674	-81.7479	15904	496
Skin Poplar Branch	6/3/2003	37.88674	-81.7479	16350	595
Tickle Britches Fork	9/15/1997	37.86955	-81.7582	367	90
Spruce Fork	9/25/1997	37.91536	-81.8156	360	883
Spruce Fork	9/25/1997	37.90371	-81.8057	361	913
Spruce Fork	7/9/2002	37.93946	-81.8231	10075	1129
Spruce Fork	7/2/2002	37.90271	-81.8059	10076	824
Spruce Fork	7/1/2002	37.86149	-81.8247	10077	531
Spruce Fork	8/27/2002	37.93946	-81.8231	10693	1152
Spruce Fork	8/27/2002	37.90968	-81.8057	10694	843
Spruce Fork	8/26/2002	37.86149	-81.8247	10695	659
Spruce Fork	8/6/2002	37.93946	-81.8231	11065	938
Spruce Fork	8/6/2002	37.90968	-81.8057	11066	590
Spruce Fork	8/5/2002	37.86149	-81.8247	11067	374
Spruce Fork	10/8/2002	37.93946	-81.8231	11609	1214
Spruce Fork	10/7/2002	37.90968	-81.8057	11610	901
Spruce Fork	10/7/2002	37.86149	-81.8247	11611	537
Spruce Fork	10/22/2002	37.93946	-81.8231	12390	1059
Spruce Fork	10/21/2002	37.90968	-81.8057	12391	694
Spruce Fork	10/21/2002	37.86149	-81.8247	12392	380
Spruce Fork	11/13/2002	37.93946	-81.8231	13079	529
Spruce Fork	11/13/2002	37.90968	-81.8057	13080	302
Spruce Fork	11/12/2002	37.86149	-81.8247	13081	283
Spruce Fork	12/4/2002	37.93946	-81.8231	13513	747
Spruce Fork	12/3/2002	37.90968	-81.8057	13514	426
Spruce Fork	12/3/2002	37.86149	-81.8247	13515	412
Spruce Fork	1/29/2003	37.93946	-81.8231	13997	768
Spruce Fork	1/29/2003	37.90968	-81.8057	13998	495
Spruce Fork	1/27/2003	37.86149	-81.8247	13999	501
Spruce Fork	2/25/2003	37.93946	-81.8231	14915	425

Spruce Fork	2/24/2003	37.90968	-81.8057	14916	202
Spruce Fork	2/24/2003	37.86149	-81.8247	14917	164
Spruce Fork	3/18/2003	37.93946	-81.8231	15370	717
Spruce Fork	3/17/2003	37.90968	-81.8057	15371	420
Spruce Fork	3/17/2003	37.86149	-81.8247	15372	359
Spruce Fork	4/15/2003	37.93946	-81.8231	15872	516
Spruce Fork	4/14/2003	37.90968	-81.8057	15873	276
Spruce Fork	4/14/2003	37.86149	-81.8247	15874	215
Spruce Fork	6/2/2003	37.93946	-81.8231	16317	588
Spruce Fork	5/27/2003	37.90968	-81.8057	16318	387
Spruce Fork	5/27/2003	37.86149	-81.8247	16319	295
Bend Branch	7/16/2002	37.94079	-81.8134	10110	534
Bend Branch	8/28/2002	37.94079	-81.8134	10725	613
Bend Branch	10/30/2002	37.94079	-81.8134	12422	106
Bend Branch	11/13/2002	37.94079	-81.8134	13114	99
Bend Branch	12/9/2002	37.94079	-81.8134	13546	133
Bend Branch	1/30/2003	37.94079	-81.8134	14030	81
Bend Branch	2/26/2003	37.94079	-81.8134	14949	76
Bend Branch	3/19/2003	37.94079	-81.8134	15403	106
Bend Branch	4/16/2003	37.94079	-81.8134	15905	88
Bend Branch	6/2/2003	37.94079	-81.8134	16351	97
Bend Branch	5/8/2007	37.93208	-81.8078	36405	52
Mine Drainage into Bend Branch	7/16/2002	37.94058	-81.8131	10111	728
Rockhouse Creek	7/9/2002	37.93983	-81.8244	10112	821
Rockhouse Creek	7/9/2002	37.9361	-81.8344	10113	1189
Rockhouse Creek	8/27/2002	37.93983	-81.8244	10726	773
Rockhouse Creek	8/27/2002	37.9361	-81.8344	10727	1181
Rockhouse Creek	8/6/2002	37.93983	-81.8244	11091	707
Rockhouse Creek	8/6/2002	37.9361	-81.8344	11092	843
Rockhouse Creek	10/8/2002	37.9361	-81.8344	11643	1268
Rockhouse Creek	10/22/2002	37.93983	-81.8244	12423	860
Rockhouse Creek	10/22/2002	37.9361	-81.8344	12424	1132
Rockhouse Creek	11/13/2002	37.93983	-81.8244	13115	860
Rockhouse Creek	11/13/2002	37.9361	-81.8344	13116	1009
Rockhouse Creek	12/4/2002	37.93983	-81.8244	13547	846
Rockhouse Creek	12/4/2002	37.9361	-81.8344	13548	1072
Rockhouse Creek	1/29/2003	37.93983	-81.8244	14031	636
Rockhouse Creek	1/29/2003	37.9361	-81.8344	14032	929
Rockhouse Creek	2/25/2003	37.93983	-81.8244	14950	638
Rockhouse Creek	2/25/2003	37.9361	-81.8344	14951	799
Rockhouse Creek	3/18/2003	37.93983	-81.8244	15404	591
Rockhouse Creek	3/18/2003	37.9361	-81.8344	15405	952
Rockhouse Creek	4/15/2003	37.93983	-81.8244	15906	392
Rockhouse Creek	4/15/2003	37.9361	-81.8344	15907	790

Rockhouse Creek	6/2/2003	37.93983	-81.8244	16352	580
Rockhouse Creek	6/2/2003	37.9361	-81.8344	16353	980
Beech Creek	7/9/2002	37.92033	-81.8302	10114	1623
Beech Creek	7/9/2002	37.90778	-81.8458	10115	1048
Beech Creek	7/3/2002	37.90703	-81.8752	10116	591
Beech Creek	8/27/2002	37.92033	-81.8302	10728	1687
Beech Creek	8/27/2002	37.90778	-81.8458	10729	1158
Beech Creek	8/27/2002	37.90703	-81.8752	10730	600
Beech Creek	8/6/2002	37.92033	-81.8302	11093	1585
Beech Creek	8/7/2002	37.90778	-81.8458	11094	931
Beech Creek	8/1/2002	37.90703	-81.8752	11095	490
Beech Creek	10/8/2002	37.92033	-81.8302	11644	1776
Beech Creek	10/8/2002	37.90778	-81.8458	11645	1394
Beech Creek	10/8/2002	37.90703	-81.8752	11646	600
Beech Creek	10/22/2002	37.92033	-81.8302	12425	1664
Beech Creek	10/22/2002	37.90778	-81.8458	12426	946
Beech Creek	10/22/2002	37.90703	-81.8752	12427	516
Beech Creek	11/14/2002	37.92033	-81.8302	13117	1378
Beech Creek	11/14/2002	37.90778	-81.8458	13118	674
Beech Creek	11/13/2002	37.90703	-81.8752	13119	376
Beech Creek	12/4/2002	37.92033	-81.8302	13549	1468
Beech Creek	12/4/2002	37.90778	-81.8458	13550	740
Beech Creek	12/4/2002	37.90703	-81.8752	13551	446
Beech Creek	1/29/2003	37.92033	-81.8302	14033	1372
Beech Creek	1/29/2003	37.92033	-81.8302	14034	
Beech Creek	1/29/2003	37.90778	-81.8458	14035	758
Beech Creek	1/29/2003	37.90703	-81.8752	14036	545
Beech Creek	2/25/2003	37.92033	-81.8302	14952	936
Beech Creek	2/25/2003	37.90778	-81.8458	14953	513
Beech Creek	2/25/2003	37.90703	-81.8752	14954	318
Beech Creek	3/18/2003	37.92033	-81.8302	15406	1392
Beech Creek	3/18/2003	37.90778	-81.8458	15407	668
Beech Creek	3/18/2003	37.90703	-81.8752	15410	473
Beech Creek	4/15/2003	37.92033	-81.8302	15908	1101
Beech Creek	4/15/2003	37.90778	-81.8458	15909	555
Beech Creek	4/15/2003	37.90703	-81.8752	15910	385
Beech Creek	6/2/2003	37.92033	-81.8302	16354	1200
Beech Creek	6/2/2003	37.90778	-81.8458	16355	605
Beech Creek	6/2/2003	37.90703	-81.8752	16356	452
Beech Creek	11/30/2005	37.90818	-81.8422	27919	1067
Beech Creek	12/13/2005	37.90818	-81.8422	28276	1560
Beech Creek	1/4/2006	37.90818	-81.8422	28662	1080
Beech Creek	2/8/2006	37.90818	-81.8422	28686	1166
Beech Creek	3/15/2006	37.90818	-81.8422	29280	807

Beech Creek	4/13/2006	37.90818	-81.8422	29609	975
Beech Creek	5/3/2006	37.90818	-81.8422	29930	1110
Beech Creek	6/13/2006	37.90818	-81.8422	30518	1510
Beech Creek	7/12/2006	37.90818	-81.8422	30535	1348
Beech Creek	8/23/2006	37.90818	-81.8422	31069	1670
Beech Creek	9/20/2006	37.90818	-81.8422	31581	1600
Beech Creek	10/17/2006	37.90818	-81.8422	32237	1016
Beech Creek	4/26/2007	37.90818	-81.8422	34057	1277
Mine Drainage into Hurricane Branch	7/9/2002	37.91818	-81.8344	10117	1320
Left Fork/Beech Creek	7/9/2002	37.90763	-81.8457	10118	2992
Left Fork/Beech Creek	8/27/2002	37.90763	-81.8457	10731	3000
Left Fork/Beech Creek	8/7/2002	37.90541	-81.8461	11096	2553
Left Fork/Beech Creek	10/8/2002	37.90763	-81.8457	11647	2992
Left Fork/Beech Creek	10/22/2002	37.90763	-81.8457	12428	2428
Left Fork/Beech Creek	11/13/2002	37.90763	-81.8457	13120	2264
Left Fork/Beech Creek	12/4/2002	37.90763	-81.8457	13552	2368
Left Fork/Beech Creek	1/29/2003	37.90763	-81.8457	14037	2474
Left Fork/Beech Creek	2/25/2003	37.90763	-81.8457	14955	1571
Left Fork/Beech Creek	3/18/2003	37.90763	-81.8457	15408	2600
Left Fork/Beech Creek	4/15/2003	37.90763	-81.8457	15911	1964
Left Fork/Beech Creek	6/2/2003	37.90763	-81.8457	16357	1900
UNT/Beech Creek RM 3.40	7/3/2002	37.91046	-81.8745	10120	644
UNT/Beech Creek RM 3.40	10/22/2002	37.91046	-81.8745	12429	737
UNT/Beech Creek RM 3.40	11/14/2002	37.91046	-81.8745	13121	525
UNT/Beech Creek RM 3.40	12/4/2002	37.91046	-81.8745	13553	514
UNT/Beech Creek RM 3.40	2/25/2003	37.91046	-81.8745	14956	265
UNT/Beech Creek RM 3.40	3/18/2003	37.91046	-81.8745	15409	449
UNT/Beech Creek RM 3.40	4/15/2003	37.91046	-81.8745	15912	344
UNT/Beech Creek RM 3.40	6/2/2003	37.91046	-81.8745	16358	387
UNT/Beech Creek RM 3.63	11/13/2002	37.90708	-81.8752	13122	169
Seng Camp Creek	7/2/2002	37.91038	-81.8054	10122	266
Seng Camp Creek	8/6/2002	37.91038	-81.8054	11097	235
Seng Camp Creek	10/21/2002	37.91038	-81.8054	12431	225
Seng Camp Creek	11/13/2002	37.91038	-81.8054	13123	153
Seng Camp Creek	12/3/2002	37.91038	-81.8054	13555	186
Seng Camp Creek	1/29/2003	37.91038	-81.8054	14040	196
Seng Camp Creek	2/24/2003	37.91038	-81.8054	14958	130
Seng Camp Creek	3/17/2003	37.91038	-81.8054	15411	199
Seng Camp Creek	4/14/2003	37.91038	-81.8054	15913	146
Seng Camp Creek	4/14/2003	37.91038	-81.8054	15914	
Seng Camp Creek	5/27/2003	37.91038	-81.8054	16359	154
Pigeonroost Branch	7/2/2002	37.88514	-81.8247	10123	254
Pigeonroost Branch	7/2/2002	37.88303	-81.8149	10124	264
Pigeonroost Branch	8/26/2002	37.88514	-81.8247	10735	277

Pigeonroost Branch	8/26/2002	37.88303	-81.8149	10736	291
Pigeonroost Branch	8/6/2002	37.88303	-81.8149	11098	251
Pigeonroost Branch	10/7/2002	37.88514	-81.8247	11651	292
Pigeonroost Branch	10/7/2002	37.88303	-81.8149	11652	286
Pigeonroost Branch	10/21/2002	37.88514	-81.8247	12432	232
Pigeonroost Branch	10/21/2002	37.88303	-81.8149	12433	246
Pigeonroost Branch	11/13/2002	37.88514	-81.8247	13124	122
Pigeonroost Branch	11/12/2002	37.88303	-81.8149	13125	136
Pigeonroost Branch	12/3/2002	37.88514	-81.8247	13556	161
Pigeonroost Branch	12/3/2002	37.88303	-81.8149	13557	162
Pigeonroost Branch	1/29/2003	37.88514	-81.8247	14041	145
Pigeonroost Branch	1/29/2003	37.88303	-81.8149	14042	158
Pigeonroost Branch	2/24/2003	37.88514	-81.8247	14959	111
Pigeonroost Branch	2/24/2003	37.88303	-81.8149	14960	123
Pigeonroost Branch	3/17/2003	37.88514	-81.8247	15412	141
Pigeonroost Branch	3/17/2003	37.88303	-81.8149	15413	155
Pigeonroost Branch	4/14/2003	37.88514	-81.8247	15915	123
Pigeonroost Branch	4/14/2003	37.88303	-81.8149	15916	137
Pigeonroost Branch	5/27/2003	37.88514	-81.8247	16360	165
Pigeonroost Branch	5/27/2003	37.88303	-81.8149	16361	178
Oldhouse Branch	7/2/2002	37.87721	-81.8278	10125	113
Oldhouse Branch	8/27/2002	37.87721	-81.8278	10737	128
Oldhouse Branch	10/7/2002	37.87721	-81.8278	11653	159
Oldhouse Branch	10/21/2002	37.87721	-81.8278	12434	105
Oldhouse Branch	11/13/2002	37.87721	-81.8278	13126	69
Oldhouse Branch	12/3/2002	37.87721	-81.8278	13558	72
Oldhouse Branch	1/27/2003	37.87721	-81.8278	14043	79
Oldhouse Branch	2/24/2003	37.87721	-81.8278	14961	52
Oldhouse Branch	3/17/2003	37.87721	-81.8278	15414	74
Oldhouse Branch	4/14/2003	37.87721	-81.8278	15917	61
Oldhouse Branch	5/27/2003	37.87721	-81.8278	16362	75
Trace Branch	7/2/2002	37.87539	-81.8341	10126	1670
Trace Branch	8/27/2002	37.87539	-81.8341	10738	1629
Trace Branch	10/7/2002	37.87539	-81.8341	11654	1593
Trace Branch	10/21/2002	37.87539	-81.8341	12435	1047
Trace Branch	11/13/2002	37.87539	-81.8341	13127	474
Trace Branch	12/3/2002	37.87539	-81.8341	13559	724
Trace Branch	1/27/2003	37.87539	-81.8341	14044	1082
Trace Branch	2/24/2003	37.87539	-81.8341	14962	447
Trace Branch	3/17/2003	37.87539	-81.8341	15415	902
Trace Branch	4/14/2003	37.87539	-81.8341	15918	344
Trace Branch	5/27/2003	37.87539	-81.8341	16363	770
Whites Trace Branch	7/2/2002	37.87466	-81.8328	10127	435
Whites Trace Branch	8/26/2002	37.87466	-81.8328	10739	461

Whites Trace Branch	10/7/2002	37.87466	-81.8328	11655	460
Whites Trace Branch	10/21/2002	37.87466	-81.8328	12436	412
Whites Trace Branch	11/13/2002	37.87466	-81.8328	13128	216
Whites Trace Branch	12/3/2002	37.87466	-81.8328	13560	289
Whites Trace Branch	1/27/2003	37.87466	-81.8328	14045	368
Whites Trace Branch	2/24/2003	37.87466	-81.8328	14963	176
Whites Trace Branch	3/17/2003	37.87466	-81.8328	15416	314
Whites Trace Branch	4/14/2003	37.87466	-81.8328	15919	213
Whites Trace Branch	5/27/2003	37.87466	-81.8328	16364	282
Adkins Fork	9/25/1997	37.86178	-81.8247	369	1054
Adkins Fork	7/1/2002	37.86178	-81.8247	10128	955
Adkins Fork	7/2/2002	37.84833	-81.8424	10129	644
Adkins Fork	8/26/2002	37.86178	-81.8247	10740	959
Adkins Fork	8/26/2002	37.84833	-81.8424	10741	720
Adkins Fork	8/5/2002	37.86178	-81.8247	11099	926
Adkins Fork	8/5/2002	37.84833	-81.8424	11100	734
Adkins Fork	10/7/2002	37.86178	-81.8247	11656	982
Adkins Fork	10/7/2002	37.84833	-81.8424	11657	552
Adkins Fork	10/21/2002	37.86178	-81.8247	12437	958
Adkins Fork	10/21/2002	37.84833	-81.8424	12438	513
Adkins Fork	11/13/2002	37.86178	-81.8247	13129	616
Adkins Fork	11/12/2002	37.84833	-81.8424	13130	295
Adkins Fork	12/3/2002	37.86178	-81.8247	13561	838
Adkins Fork	12/3/2002	37.84833	-81.8424	13562	526
Adkins Fork	1/27/2003	37.86178	-81.8247	14046	888
Adkins Fork	1/27/2003	37.85739	-81.8331	14048	480
Adkins Fork	2/24/2003	37.86178	-81.8247	14964	424
Adkins Fork	2/24/2003	37.85739	-81.8331	14966	288
Adkins Fork	3/17/2003	37.86178	-81.8247	15417	830
Adkins Fork	3/17/2003	37.85739	-81.8331	15419	451
Adkins Fork	4/14/2003	37.86178	-81.8247	15920	621
Adkins Fork	4/14/2003	37.85739	-81.8331	15922	271
Adkins Fork	5/27/2003	37.86178	-81.8247	16365	796
Adkins Fork	5/27/2003	37.85739	-81.8331	16367	483
Mine Discharge into Adkins Fork	1/27/2003	37.86069	-81.8253	14047	981
Mine Discharge into Adkins Fork	2/24/2003	37.86069	-81.8253	14965	813
Mine Discharge into Adkins Fork	3/17/2003	37.86069	-81.8253	15418	965
Mine Discharge into Adkins Fork	4/14/2003	37.86069	-81.8253	15921	912
Mine Discharge into Adkins Fork	5/27/2003	37.86069	-81.8253	16366	939
White Oak Branch	7/10/2000	37.86317	-81.8012	3842	98
White Oak Branch	12/11/2000	37.86317	-81.8012	3843	137.2
Little White Oak Branch	7/1/2002	37.85774	-81.8062	10130	1913
Little White Oak Branch	8/26/2002	37.85774	-81.8062	10742	2188
Little White Oak Branch	10/7/2002	37.85774	-81.8062	11658	1950

Little White Oak Branch	10/21/2002	37.85774	-81.8062	12439	1179
Little White Oak Branch	11/12/2002	37.85774	-81.8062	13131	973
Little White Oak Branch	12/3/2002	37.85774	-81.8062	13563	1430
Little White Oak Branch	1/27/2003	37.85774	-81.8062	14049	1712
Little White Oak Branch	2/24/2003	37.85774	-81.8062	14967	411
Little White Oak Branch	3/17/2003	37.85774	-81.8062	15420	1433
Little White Oak Branch	4/14/2003	37.85774	-81.8062	15923	923
Little White Oak Branch	5/27/2003	37.85774	-81.8062	16368	1353
Garland Fork	7/1/2002	37.84999	-81.8067	10131	331
Garland Fork	7/1/2002	37.84999	-81.8067	10131	
Garland Fork	8/26/2002	37.84999	-81.8067	10743	333
Garland Fork	8/5/2002	37.84999	-81.8067	11101	343
Garland Fork	10/21/2002	37.84999	-81.8067	12440	345
Garland Fork	11/12/2002	37.84999	-81.8067	13132	272
Garland Fork	12/3/2002	37.84999	-81.8067	13564	316
Garland Fork	1/27/2003	37.84999	-81.8067	14050	346
Garland Fork	2/24/2003	37.84999	-81.8067	14968	238
Garland Fork	3/17/2003	37.84999	-81.8067	15421	340
Garland Fork	4/14/2003	37.84999	-81.8067	15924	274
Garland Fork	5/27/2003	37.84999	-81.8067	16369	324
Brushy Fork	10/8/1997	37.84094	-81.7948	370	377
Brushy Fork	7/1/2002	37.84861	-81.798	10132	385
Brushy Fork	8/26/2002	37.84861	-81.798	10744	391
Brushy Fork	8/5/2002	37.84861	-81.798	11102	296
Brushy Fork	10/7/2002	37.84861	-81.798	11660	403
Brushy Fork	10/21/2002	37.84861	-81.798	12441	337
Brushy Fork	11/12/2002	37.84861	-81.798	13133	199
Brushy Fork	12/3/2002	37.84861	-81.798	13565	239
Brushy Fork	1/27/2003	37.84861	-81.798	14051	286
Brushy Fork	2/24/2003	37.84861	-81.798	14969	134
Brushy Fork	3/17/2003	37.84861	-81.798	15422	278
Brushy Fork	4/14/2003	37.84861	-81.798	15925	196
Brushy Fork	5/27/2003	37.84861	-81.798	16370	245
Laurel Fork	7/1/2002	37.84869	-81.7978	10133	154
Laurel Fork	8/26/2002	37.84869	-81.7978	10745	176
Laurel Fork	8/5/2002	37.84869	-81.7978	11103	136
Laurel Fork	10/21/2002	37.84869	-81.7978	12442	180
Laurel Fork	11/12/2002	37.84869	-81.7978	13134	96
Laurel Fork	12/3/2002	37.84869	-81.7978	13566	122
Laurel Fork	1/27/2003	37.84869	-81.7978	14052	127
Laurel Fork	2/24/2003	37.84869	-81.7978	14970	89
Laurel Fork	3/17/2003	37.84869	-81.7978	15423	111
Laurel Fork	4/14/2003	37.84869	-81.7978	15926	98
Laurel Fork	5/27/2003	37.84869	-81.7978	16371	96

Laurel Branch	9/24/1997	38.03368	-81.8333	368	300
Laurel Branch	7/18/2002	38.03368	-81.8333	10079	118
Laurel Branch	10/18/2002	38.03368	-81.8333	11613	292
Laurel Branch	10/30/2002	38.03368	-81.8333	12394	120
Laurel Branch	11/19/2002	38.03368	-81.8333	13083	91
Laurel Branch	12/2/2002	38.03368	-81.8333	13517	101
Laurel Branch	1/7/2003	38.03368	-81.8333	14001	222
Laurel Branch	2/6/2003	38.03368	-81.8333	14919	73
Laurel Branch	3/18/2003	38.03368	-81.8333	15374	89
Laurel Branch	4/18/2003	38.03368	-81.8333	15876	94
Laurel Branch	5/8/2003	38.03368	-81.8333	16321	86
Pond Fork	7/10/2002	37.843	-81.6308	10139	955
Pond Fork	7/8/2002	37.80419	-81.5731	10140	897
Pond Fork	8/30/2002	37.843	-81.6308	10751	986
Pond Fork	8/29/2002	37.80419	-81.5731	10752	927
Pond Fork	8/5/2002	37.843	-81.6308	11108	925
Pond Fork	8/5/2002	37.80419	-81.5731	11109	883
Pond Fork	10/19/2002	37.843	-81.6308	11668	955
Pond Fork	10/19/2002	37.80419	-81.5731	11669	901
Pond Fork	10/29/2002	37.843	-81.6308	12448	655
Pond Fork	10/29/2002	37.80419	-81.5731	12449	729
Pond Fork	11/21/2002	37.843	-81.6308	13140	630
Pond Fork	11/21/2002	37.80419	-81.5731	13141	713
Pond Fork	12/7/2002	37.843	-81.6308	13572	667
Pond Fork	12/7/2002	37.80419	-81.5731	13573	725
Pond Fork	12/7/2002	37.80419	-81.5731	13574	
Pond Fork	1/10/2003	37.843	-81.6308	14058	807
Pond Fork	1/16/2003	37.80419	-81.5731	14059	842
Pond Fork	1/16/2003	37.80419	-81.5731	14060	
Pond Fork	2/14/2003	37.843	-81.6308	14976	831
Pond Fork	2/14/2003	37.80419	-81.5731	14977	795
Pond Fork	3/13/2003	37.843	-81.6308	15429	849
Pond Fork	3/13/2003	37.80419	-81.5731	15430	786
Pond Fork	3/13/2003	37.80419	-81.5731	15431	
Pond Fork	4/19/2003	37.843	-81.6308	15932	731
Pond Fork	4/19/2003	37.80419	-81.5731	15933	708
Pond Fork	5/9/2003	37.843	-81.6308	16378	806
Pond Fork	5/9/2003	37.80419	-81.5731	16379	760
James Branch	7/10/2002	37.87036	-81.6355	10173	972
James Branch	8/29/2002	37.87036	-81.6355	10785	983
James Branch	8/5/2002	37.87036	-81.6355	11122	882
James Branch	10/19/2002	37.87036	-81.6355	11703	74
James Branch	10/29/2002	37.87036	-81.6355	12484	289
James Branch	11/19/2002	37.87036	-81.6355	13176	210

James Branch	12/5/2002	37.87036	-81.6355	13608	251
James Branch	1/16/2003	37.87036	-81.6355	14094	481
James Branch	2/14/2003	37.87036	-81.6355	15012	1281
James Branch	3/13/2003	37.87036	-81.6355	15465	1183
James Branch	4/19/2003	37.87036	-81.6355	15968	1119
James Branch	5/9/2003	37.87036	-81.6355	16413	912
Jasper Workman Branch	9/22/1997	37.864	-81.6388	383	450
Jasper Workman Branch	7/3/2002	37.86464	-81.6389	10174	377
Jasper Workman Branch	8/28/2002	37.86464	-81.6389	10786	470
Jasper Workman Branch	10/16/2002	37.86464	-81.6389	11704	268
Jasper Workman Branch	10/29/2002	37.86464	-81.6389	12485	261
Jasper Workman Branch	11/21/2002	37.86464	-81.6389	13177	239
Jasper Workman Branch	12/4/2002	37.86464	-81.6389	13609	328
Jasper Workman Branch	1/16/2003	37.86464	-81.6389	14095	474
Jasper Workman Branch	2/13/2003	37.86464	-81.6389	15013	331
Jasper Workman Branch	3/15/2003	37.86464	-81.6389	15466	360
Jasper Workman Branch	4/19/2003	37.86464	-81.6389	15969	312
Jasper Workman Branch	5/10/2003	37.86464	-81.6389	16414	325
Skin Fork	7/2/2002	37.80114	-81.5922	10176	1169
Skin Fork	8/26/2002	37.80114	-81.5922	10788	1276
Skin Fork	10/15/2002	37.80114	-81.5922	11706	1262
Skin Fork	10/29/2002	37.80114	-81.5922	12487	420
Skin Fork	11/19/2002	37.80114	-81.5922	13179	505
Skin Fork	12/4/2002	37.80114	-81.5922	13611	1081
Skin Fork	1/16/2003	37.80114	-81.5922	14097	1004
Skin Fork	2/13/2003	37.80114	-81.5922	15015	1027
Skin Fork	3/14/2003	37.80114	-81.5922	15468	1081
Skin Fork	4/17/2003	37.80114	-81.5922	15971	966
Skin Fork	5/9/2003	37.80114	-81.5922	16416	1072
Lacey Branch	9/22/1997	37.80375	-81.5732	384	938
Lacey Branch	7/3/2002	37.80375	-81.5732	10177	896
Lacey Branch	7/8/2002	37.7933	-81.5537	10178	900
Lacey Branch	8/29/2002	37.80375	-81.5732	10789	983
Lacey Branch	8/28/2002	37.7933	-81.5537	10790	1010
Lacey Branch	8/5/2002	37.80375	-81.5732	11124	913
Lacey Branch	8/8/2002	37.7933	-81.5537	11125	974
Lacey Branch	10/16/2002	37.80375	-81.5732	11707	624
Lacey Branch	10/16/2002	37.7933	-81.5537	11708	844
Lacey Branch	10/29/2002	37.80375	-81.5732	12488	657
Lacey Branch	10/29/2002	37.7933	-81.5537	12489	944
Lacey Branch	11/19/2002	37.80375	-81.5732	13180	625
Lacey Branch	11/19/2002	37.7933	-81.5537	13181	882
Lacey Branch	12/4/2002	37.80375	-81.5732	13612	853
Lacey Branch	12/4/2002	37.7933	-81.5537	13613	971

Lacey Branch	1/16/2003	37.80375	-81.5732	14098	887
Lacey Branch	1/16/2003	37.7933	-81.5537	14099	929
Lacey Branch	2/13/2003	37.80375	-81.5732	15016	875
Lacey Branch	2/13/2003	37.7933	-81.5537	15017	938
Lacey Branch	3/15/2003	37.80375	-81.5732	15469	834
Lacey Branch	3/15/2003	37.7933	-81.5537	15470	950
Lacey Branch	4/19/2003	37.80375	-81.5732	15972	731
Lacey Branch	4/19/2003	37.7933	-81.5537	15973	878
Lacey Branch	5/10/2003	37.80375	-81.5732	16417	819
Lacey Branch	5/10/2003	37.7933	-81.5537	16418	936
West Fork/Pond Fork	9/22/1997	37.97204	-81.7054	386	1139
West Fork/Pond Fork	9/18/1997	37.95994	-81.6559	387	1382
West Fork/Pond Fork	9/18/1997	37.92675	-81.6226	388	1312
West Fork/Pond Fork	7/9/2002	37.97036	-81.7025	10150	1670
West Fork/Pond Fork	7/9/2002	37.95994	-81.6559	10151	1750
West Fork/Pond Fork	7/9/2002	37.92675	-81.6226	10152	1700
West Fork/Pond Fork	7/8/2002	37.89847	-81.5967	10153	825
West Fork/Pond Fork	7/8/2002	37.88517	-81.6043	10154	842
West Fork/Pond Fork	8/31/2002	37.97036	-81.7025	10762	1690
West Fork/Pond Fork	8/29/2002	37.95994	-81.6559	10763	1780
West Fork/Pond Fork	8/30/2002	37.92675	-81.6226	10764	1850
West Fork/Pond Fork	8/30/2002	37.89847	-81.5967	10765	866
West Fork/Pond Fork	8/28/2002	37.88517	-81.6043	10766	883
West Fork/Pond Fork	8/7/2002	37.97041	-81.7022	11113	1620
West Fork/Pond Fork	8/6/2002	37.95994	-81.6559	11114	1720
West Fork/Pond Fork	8/6/2002	37.92675	-81.6226	11115	1640
West Fork/Pond Fork	8/6/2002	37.89847	-81.5967	11116	847
West Fork/Pond Fork	10/19/2002	37.97036	-81.7025	11679	1439
West Fork/Pond Fork	10/18/2002	37.95994	-81.6559	11680	1530
West Fork/Pond Fork	10/19/2002	37.92675	-81.6226	11681	1049
West Fork/Pond Fork	10/16/2002	37.88517	-81.6043	11683	380
West Fork/Pond Fork	10/31/2002	37.97036	-81.7025	12460	1244
West Fork/Pond Fork	10/31/2002	37.95994	-81.6559	12461	1413
West Fork/Pond Fork	10/31/2002	37.92675	-81.6226	12462	1271
West Fork/Pond Fork	10/31/2002	37.89847	-81.5967	12463	721
West Fork/Pond Fork	11/4/2002	37.88517	-81.6043	12464	524
West Fork/Pond Fork	11/22/2002	37.97036	-81.7025	13151	946
West Fork/Pond Fork	11/21/2002	37.95994	-81.6559	13152	1321
West Fork/Pond Fork	11/21/2002	37.92675	-81.6226	13153	1110
West Fork/Pond Fork	11/21/2002	37.89847	-81.5967	13154	527
West Fork/Pond Fork	11/21/2002	37.89847	-81.5967	13155	
West Fork/Pond Fork	11/21/2002	37.88517	-81.6043	13156	525
West Fork/Pond Fork	12/6/2002	37.97036	-81.7025	13584	1058
West Fork/Pond Fork	12/5/2002	37.95994	-81.6559	13585	1414

West Fork/Pond Fork	12/6/2002	37.92675	-81.6226	13586	1231
West Fork/Pond Fork	12/6/2002	37.89847	-81.5967	13587	532
West Fork/Pond Fork	12/3/2002	37.88517	-81.6043	13588	664
West Fork/Pond Fork	1/9/2003	37.97036	-81.7025	14070	996
West Fork/Pond Fork	1/9/2003	37.95994	-81.6559	14071	1198
West Fork/Pond Fork	1/9/2003	37.92675	-81.6226	14072	1025
West Fork/Pond Fork	1/9/2003	37.89847	-81.5967	14073	658
West Fork/Pond Fork	1/8/2003	37.88517	-81.6043	14074	564
West Fork/Pond Fork	2/7/2003	37.97036	-81.7025	14987	1006
West Fork/Pond Fork	2/7/2003	37.95994	-81.6559	14988	1243
West Fork/Pond Fork	2/7/2003	37.92675	-81.6226	14989	955
West Fork/Pond Fork	2/7/2003	37.89847	-81.5967	14990	190
West Fork/Pond Fork	2/7/2003	37.88517	-81.6043	14991	171
West Fork/Pond Fork	2/7/2003	37.88517	-81.6043	14992	
West Fork/Pond Fork	3/17/2003	37.97036	-81.7025	15441	1316
West Fork/Pond Fork	3/17/2003	37.95994	-81.6559	15442	1610
West Fork/Pond Fork	3/17/2003	37.92675	-81.6226	15443	1490
West Fork/Pond Fork	4/19/2003	37.97036	-81.7025	15944	1117
West Fork/Pond Fork	4/17/2003	37.95994	-81.6559	15945	1311
West Fork/Pond Fork	4/19/2003	37.92675	-81.6226	15946	1250
West Fork/Pond Fork	4/19/2003	37.89847	-81.5967	15947	311
West Fork/Pond Fork	4/20/2003	37.88517	-81.6043	15948	289
West Fork/Pond Fork	5/9/2003	37.97036	-81.7025	16389	1198
West Fork/Pond Fork	5/9/2003	37.95994	-81.6559	16390	1520
West Fork/Pond Fork	5/10/2003	37.92675	-81.6226	16391	1470
West Fork/Pond Fork	4/30/2003	37.97064	-81.6765	16917	1534
West Fork/Pond Fork	5/3/2004	37.953	-81.6563	20536	1530
West Fork/Pond Fork	10/20/2009	37.953	-81.6563	48237	1678
Roach Branch	9/22/1997	37.96964	-81.701	389	248
Roach Branch	7/9/2002	37.97036	-81.7018	10155	425
Roach Branch	8/28/2002	37.97036	-81.7018	10767	410
Roach Branch	8/7/2002	37.97036	-81.7018	11117	399
Roach Branch	10/16/2002	37.97036	-81.7018	11684	188
Roach Branch	11/4/2002	37.97036	-81.7018	12465	274
Roach Branch	11/20/2002	37.97036	-81.7018	13157	191
Roach Branch	12/3/2002	37.97036	-81.7018	13589	260
Roach Branch	1/18/2003	37.97036	-81.7018	14075	298
Roach Branch	2/5/2003	37.97036	-81.7018	14993	181
Roach Branch	3/15/2003	37.97036	-81.7018	15446	274
Roach Branch	4/20/2003	37.97036	-81.7018	15949	259
Roach Branch	5/10/2003	37.97036	-81.7018	16394	258
Whites Branch	7/9/2002	37.97703	-81.6999	10156	896
Whites Branch	8/31/2002	37.97703	-81.6999	10768	924
Whites Branch	8/7/2002	37.97703	-81.6999	11118	910

Whites Branch	10/18/2002	37.97703	-81.6999	11685	685
Whites Branch	10/30/2002	37.97703	-81.6999	12466	443
Whites Branch	11/19/2002	37.97703	-81.6999	13158	330
Whites Branch	12/5/2002	37.97703	-81.6999	13590	490
Whites Branch	1/9/2003	37.97703	-81.6999	14076	512
Whites Branch	2/7/2003	37.97703	-81.6999	14994	421
Whites Branch	3/17/2003	37.97703	-81.6999	15447	608
Whites Branch	4/17/2003	37.97703	-81.6999	15950	500
Whites Branch	5/9/2003	37.97703	-81.6999	16395	526
Browns Branch	7/9/2002	37.96597	-81.6647	10157	1374
Browns Branch	8/28/2002	37.96597	-81.6647	10769	1248
Browns Branch	10/17/2002	37.96597	-81.6647	11686	917
Browns Branch	11/4/2002	37.96597	-81.6647	12467	1066
Browns Branch	11/20/2002	37.96597	-81.6647	13159	500
Browns Branch	12/3/2002	37.96597	-81.6647	13591	580
Browns Branch	1/8/2003	37.96597	-81.6647	14077	737
Browns Branch	2/5/2003	37.96597	-81.6647	14995	784
Browns Branch	3/15/2003	37.96597	-81.6647	15448	850
Browns Branch	4/20/2003	37.96597	-81.6647	15951	474
Browns Branch	5/10/2003	37.96597	-81.6647	16396	534
Mine Discharge into Browns Branch	10/17/2002	37.96511	-81.6622	11687	994
Mine Discharge into Browns Branch	11/4/2002	37.96511	-81.6622	12468	1146
Mine Discharge into Browns Branch	11/20/2002	37.96511	-81.6622	13160	580
Mine Discharge into Browns Branch	12/3/2002	37.96511	-81.6622	13592	674
Mine Discharge into Browns Branch	1/8/2003	37.96511	-81.6622	14078	863
Mine Discharge into Browns Branch	2/5/2003	37.96511	-81.6622	14996	920
Mine Discharge into Browns Branch	3/15/2003	37.96511	-81.6622	15449	929
Mine Discharge into Browns Branch	4/20/2003	37.96511	-81.6622	15952	512
Mine Discharge into Browns Branch	5/10/2003	37.96511	-81.6622	16397	612
Bandy Branch	7/9/2002	37.94186	-81.6408	10159	1690
Bandy Branch	8/26/2002	37.94186	-81.6408	10771	1680
Bandy Branch	10/15/2002	37.94186	-81.6408	11689	1620
Bandy Branch	11/4/2002	37.94186	-81.6408	12470	1560
Bandy Branch	11/20/2002	37.94186	-81.6408	13162	1460
Bandy Branch	12/3/2002	37.94186	-81.6408	13594	1570
Bandy Branch	1/8/2003	37.94186	-81.6408	14080	1324
Bandy Branch	2/7/2003	37.94186	-81.6408	14998	1432
Bandy Branch	3/14/2003	37.94186	-81.6408	15451	1550
Bandy Branch	4/20/2003	37.94186	-81.6408	15954	1530
Bandy Branch	5/10/2003	37.94186	-81.6408	16399	1620
Mudlick Branch	5/10/2005	37.92658	-81.6342	27141	916
Jarrells Branch	7/9/2002	37.93617	-81.6276	10160	2020
Jarrells Branch	8/27/2002	37.93617	-81.6276	10772	2060
Jarrells Branch	10/15/2002	37.93617	-81.6276	11690	1910

Jarrells Branch	11/4/2002	37.93617	-81.6276	12471	1930
Jarrells Branch	11/20/2002	37.93617	-81.6276	13163	1800
Jarrells Branch	12/3/2002	37.93617	-81.6276	13595	2000
Jarrells Branch	1/8/2003	37.93617	-81.6276	14081	1578
Jarrells Branch	2/5/2003	37.93617	-81.6276	14999	1730
Jarrells Branch	3/15/2003	37.93617	-81.6276	15452	1750
Jarrells Branch	4/20/2003	37.93617	-81.6276	15955	1730
Jarrells Branch	5/10/2003	37.93617	-81.6276	16400	2000
Spruce Lick Fork	7/9/2002	37.92411	-81.6183	10161	2060
Spruce Lick Fork	11/4/2002	37.92411	-81.6183	12472	180
Spruce Lick Fork	11/21/2002	37.92411	-81.6183	13164	1970
Spruce Lick Fork	12/3/2002	37.92411	-81.6183	13596	2070
Spruce Lick Fork	1/8/2003	37.92411	-81.6183	14082	1600
Spruce Lick Fork	2/7/2003	37.92411	-81.6183	15000	1790
Spruce Lick Fork	3/14/2003	37.92411	-81.6183	15453	1830
Spruce Lick Fork	4/20/2003	37.92411	-81.6183	15956	1590
Spruce Lick Fork	5/10/2003	37.92411	-81.6183	16401	1550
James Creek	7/8/2002	37.91994	-81.6026	10162	1065
James Creek	8/28/2002	37.91994	-81.6026	10774	1120
James Creek	10/16/2002	37.91994	-81.6026	11692	1007
James Creek	11/4/2002	37.91994	-81.6026	12473	1006
James Creek	11/21/2002	37.91994	-81.6026	13165	888
James Creek	12/3/2002	37.91994	-81.6026	13597	1115
James Creek	1/8/2003	37.91994	-81.6026	14083	909
James Creek	2/5/2003	37.91994	-81.6026	15001	925
James Creek	3/15/2003	37.91994	-81.6026	15454	1202
James Creek	4/20/2003	37.91994	-81.6026	15957	1014
James Creek	5/10/2003	37.91994	-81.6026	16402	1172
Matts Creek	11/21/2002	37.90083	-81.5969	13166	204
Matts Creek	1/8/2003	37.90083	-81.5969	14084	419
Matts Creek	2/5/2003	37.90083	-81.5969	15002	242
Matts Creek	3/15/2003	37.90083	-81.5969	15455	498
Matts Creek	4/20/2003	37.90083	-81.5969	15958	398
Big Horse Creek	9/22/1997	38.16463	-81.8689	351	1650
Big Horse Creek	9/23/1997	38.11429	-81.8911	352	2410
Big Horse Creek	9/22/1997	38.13895	-81.8954	353	2170
Big Horse Creek	7/30/2002	38.16429	-81.8657	10043	1499
Big Horse Creek	7/30/2002	38.16152	-81.8912	10044	1822
Big Horse Creek	7/30/2002	38.13668	-81.8954	10045	1761
Big Horse Creek	7/30/2002	38.13668	-81.8954	10045	
Big Horse Creek	7/24/2002	38.11429	-81.8911	10046	2160
Big Horse Creek	7/24/2002	38.09891	-81.9041	10047	1970
Big Horse Creek	8/27/2002	38.16429	-81.8657	10663	2015
Big Horse Creek	8/27/2002	38.16152	-81.8912	10664	2160

Big Horse Creek	8/27/2002	38.13668	-81.8954	10665	2464
Big Horse Creek	8/27/2002	38.11429	-81.8911	10666	2454
Big Horse Creek	8/27/2002	38.10252	-81.9003	10667	2293
Big Horse Creek	8/13/2002	38.16429	-81.8657	11044	2006
Big Horse Creek	8/13/2002	38.16152	-81.8912	11045	1896
Big Horse Creek	8/13/2002	38.16152	-81.8912	11046	
Big Horse Creek	8/8/2002	38.13668	-81.8954	11047	1739
Big Horse Creek	10/16/2002	38.16429	-81.8657	11578	902
Big Horse Creek	10/17/2002	38.16152	-81.8912	11579	1168
Big Horse Creek	10/16/2002	38.13668	-81.8954	11580	1532
Big Horse Creek	10/16/2002	38.11429	-81.8911	11581	1394
Big Horse Creek	10/16/2002	38.10252	-81.9003	11582	1297
Big Horse Creek	11/6/2002	38.16429	-81.8657	12358	692
Big Horse Creek	11/6/2002	38.16429	-81.8657	12359	
Big Horse Creek	11/5/2002	38.16152	-81.8912	12360	1371
Big Horse Creek	10/31/2002	38.13668	-81.8954	12361	1595
Big Horse Creek	10/31/2002	38.11429	-81.8911	12362	1639
Big Horse Creek	10/31/2002	38.10252	-81.9003	12363	1326
Big Horse Creek	11/25/2002	38.16429	-81.8657	13047	951
Big Horse Creek	11/25/2002	38.16152	-81.8912	13048	942
Big Horse Creek	11/25/2002	38.13668	-81.8954	13049	1532
Big Horse Creek	11/2/2002	38.11429	-81.8911	13050	1500
Big Horse Creek	11/21/2002	38.10252	-81.9003	13051	1420
Big Horse Creek	12/11/2002	38.16429	-81.8657	13481	776
Big Horse Creek	12/11/2002	38.16152	-81.8912	13482	799
Big Horse Creek	12/11/2002	38.13668	-81.8954	13483	1530
Big Horse Creek	12/11/2002	38.11429	-81.8911	13484	1569
Big Horse Creek	12/11/2002	38.10252	-81.9003	13485	1716
Big Horse Creek	1/8/2003	38.16429	-81.8657	13965	540
Big Horse Creek	1/8/2003	38.16152	-81.8912	13966	578
Big Horse Creek	1/8/2003	38.13668	-81.8954	13967	1407
Big Horse Creek	1/8/2003	38.11429	-81.8911	13968	1512
Big Horse Creek	1/7/2003	38.10252	-81.9003	13969	1310
Big Horse Creek	2/6/2003	38.16429	-81.8657	14883	692
Big Horse Creek	2/6/2003	38.16152	-81.8912	14884	770
Big Horse Creek	2/3/2003	38.13668	-81.8954	14885	1695
Big Horse Creek	2/3/2003	38.11429	-81.8911	14886	1765
Big Horse Creek	2/3/2003	38.10252	-81.9003	14887	1640
Big Horse Creek	3/10/2003	38.16429	-81.8657	15336	1134
Big Horse Creek	3/10/2003	38.16152	-81.8912	15337	1251
Big Horse Creek	3/10/2003	38.13668	-81.8954	15338	2054
Big Horse Creek	3/10/2003	38.11429	-81.8911	15339	2147
Big Horse Creek	3/10/2003	38.10252	-81.9003	15340	1930
Big Horse Creek	4/16/2003	38.16429	-81.8657	15840	719

Big Horse Creek	4/16/2003	38.16152	-81.8912	15841	798
Big Horse Creek	4/14/2003	38.13668	-81.8954	15842	1552
Big Horse Creek	4/14/2003	38.11429	-81.8911	15843	1647
Big Horse Creek	4/14/2003	38.10252	-81.9003	15844	1480
Big Horse Creek	4/30/2003	38.16429	-81.8657	16285	763
Big Horse Creek	4/28/2003	38.16152	-81.8912	16286	862
Big Horse Creek	4/28/2003	38.13668	-81.8954	16287	1895
Big Horse Creek	4/28/2003	38.11429	-81.8911	16288	1982
Big Horse Creek	4/28/2003	38.10252	-81.9003	16289	1831
Big Horse Creek	10/20/2009	38.13668	-81.8954	48235	1982
Spruce Lick	7/24/2002	38.10054	-81.9042	10055	2360
Laurel Fork	7/30/2002	38.16157	-81.8922	10048	214
Laurel Fork	8/27/2002	38.16157	-81.8922	10668	341
Laurel Fork	10/16/2002	38.16157	-81.8922	11583	127
Laurel Fork	11/5/2002	38.16157	-81.8922	12364	160
Laurel Fork	11/25/2002	38.16157	-81.8922	13052	100
Laurel Fork	12/11/2002	38.16157	-81.8922	13486	95
Laurel Fork	1/8/2003	38.16157	-81.8922	13970	72
Laurel Fork	2/6/2003	38.16157	-81.8922	14888	75
Laurel Fork	3/10/2003	38.16157	-81.8922	15341	85
Laurel Fork	4/16/2003	38.16157	-81.8922	15845	79
Laurel Fork	4/28/2003	38.16157	-81.8922	16290	78
Peters Cave Fork	7/30/2002	38.15838	-81.8977	10049	341
Peters Cave Fork	7/30/2002	38.15838	-81.8977	10049	
Peters Cave Fork	8/27/2002	38.16041	-81.9005	10669	402
Peters Cave Fork	10/16/2002	38.15838	-81.8977	11584	221
Peters Cave Fork	11/5/2002	38.15838	-81.8977	12365	269
Peters Cave Fork	11/5/2002	38.15838	-81.8977	12365	
Peters Cave Fork	11/25/2002	38.15838	-81.8977	13053	143
Peters Cave Fork	12/11/2002	38.15838	-81.8977	13487	159
Peters Cave Fork	1/8/2003	38.15838	-81.8977	13971	100
Peters Cave Fork	2/3/2003	38.15838	-81.8977	14889	132
Peters Cave Fork	3/10/2003	38.15838	-81.8977	15342	148
Peters Cave Fork	4/14/2003	38.15838	-81.8977	15846	114
Peters Cave Fork	4/14/2003	38.15838	-81.8977	15847	
Peters Cave Fork	4/28/2003	38.15838	-81.8977	16291	125
Dodson Fork	7/30/2002	38.13674	-81.8955	10050	1065
Dodson Fork	7/30/2002	38.13674	-81.8955	10050	
Dodson Fork	8/27/2002	38.13674	-81.8955	10670	1591
Dodson Fork	8/8/2002	38.13674	-81.8955	11051	1484
Dodson Fork	10/16/2002	38.13674	-81.8955	11585	457
Dodson Fork	10/31/2002	38.13674	-81.8955	12366	600
Dodson Fork	11/25/2002	38.13674	-81.8955	13054	504
Dodson Fork	12/11/2002	38.13674	-81.8955	13488	490

Dodson Fork	1/8/2003	38.13674	-81.8955	13972	272
Dodson Fork	2/3/2003	38.13674	-81.8955	14890	364
Dodson Fork	3/10/2003	38.13674	-81.8955	15343	623
Dodson Fork	4/14/2003	38.13674	-81.8955	15848	316
Dodson Fork	4/28/2003	38.13674	-81.8955	16292	378
Rattlesnake Hollow	9/22/1997	38.13722	-81.9165	354	444
Rattlesnake Hollow	7/23/2002	38.13643	-81.9163	10051	256
Rattlesnake Hollow	10/21/2002	38.13643	-81.9163	11586	249
Rattlesnake Hollow	11/5/2002	38.13643	-81.9163	12367	195
Rattlesnake Hollow	11/25/2002	38.13643	-81.9163	13055	99
Rattlesnake Hollow	12/11/2002	38.13643	-81.9163	13489	80
Rattlesnake Hollow	1/7/2003	38.13643	-81.9163	13973	63
Rattlesnake Hollow	2/6/2003	38.13643	-81.9163	14891	69
Rattlesnake Hollow	3/10/2003	38.13643	-81.9163	15344	78
Rattlesnake Hollow	4/16/2003	38.13643	-81.9163	15849	72
Rattlesnake Hollow	4/28/2003	38.13643	-81.9163	16293	74
Bragg Fork	7/22/2002	38.11299	-81.891	10052	2190
Bragg Fork	8/27/2002	38.11299	-81.891	10672	2392
Bragg Fork	10/16/2002	38.11299	-81.891	11587	1565
Bragg Fork	10/31/2002	38.11299	-81.891	12368	1802
Bragg Fork	11/2/2002	38.11299	-81.891	13056	1341
Bragg Fork	12/11/2002	38.11299	-81.891	13490	1290
Bragg Fork	1/8/2003	38.11299	-81.891	13974	1688
Bragg Fork	2/3/2003	38.11299	-81.891	14892	1869
Bragg Fork	3/10/2003	38.11299	-81.891	15345	2497
Bragg Fork	4/14/2003	38.11299	-81.891	15850	2178
Bragg Fork	4/28/2003	38.11299	-81.891	16294	2263
Mine Seep #1 into Bragg Fork	3/10/2003	38.1126	-81.891	15347	2555
Mine Seep #2 into Bragg Fork	3/10/2003	38.1126	-81.8907	15348	2667
Rich Hollow	7/22/2002	38.10979	-81.8967	10053	2400
Rich Hollow	8/27/2002	38.10979	-81.8967	10673	2577
Rich Hollow	10/16/2002	38.10979	-81.8967	11588	968
Rich Hollow	10/31/2002	38.10979	-81.8967	12369	2030
Rich Hollow	11/21/2002	38.10979	-81.8967	13057	2029
Rich Hollow	12/11/2002	38.10979	-81.8967	13491	1973
Rich Hollow	1/7/2003	38.10979	-81.8967	13975	2154
Rich Hollow	2/3/2003	38.10979	-81.8967	14893	2359
Rich Hollow	3/10/2003	38.10979	-81.8967	15346	2528
Rich Hollow	4/14/2003	38.10979	-81.8967	15851	2397
Rich Hollow	4/28/2003	38.10979	-81.8967	16295	2633
Lavender Fork	7/22/2002	38.10363	-81.8983	10054	2920
Lavender Fork	8/27/2002	38.10363	-81.8983	10674	3202
Lavender Fork	10/16/2002	38.10363	-81.8983	11589	1720
Lavender Fork	10/31/2002	38.10363	-81.8983	12370	1948

Lavender Fork	11/21/2002	38.10363	-81.8983	13058	1606
Lavender Fork	12/10/2002	38.10363	-81.8983	13492	1902
Lavender Fork	1/7/2003	38.10363	-81.8983	13976	1484
Lavender Fork	2/3/2003	38.10363	-81.8983	14894	1782
Lavender Fork	3/10/2003	38.10363	-81.8983	15349	2275
Lavender Fork	4/14/2003	38.10363	-81.8983	15852	1627
Lavender Fork	4/28/2003	38.10363	-81.8983	16296	2025
White Oak Creek	10/8/1997	38.04727	-81.5389	407	661
White Oak Creek	7/22/2002	38.06321	-81.5718	10216	1029
White Oak Creek	7/24/2002	38.04592	-81.5469	10217	1012
White Oak Creek	7/24/2002	38.05011	-81.528	10218	1123
White Oak Creek	7/23/2002	38.02975	-81.5143	10219	1386
White Oak Creek	8/26/2002	38.06321	-81.5718	10831	1022
White Oak Creek	8/26/2002	38.04592	-81.5469	10832	1077
White Oak Creek	8/26/2002	38.05011	-81.528	10833	1258
White Oak Creek	8/29/2002	38.02975	-81.5143	10834	1552
White Oak Creek	10/9/2002	38.06321	-81.5718	11745	1178
White Oak Creek	10/9/2002	38.06321	-81.5718	11746	
White Oak Creek	10/9/2002	38.04592	-81.5469	11747	1263
White Oak Creek	10/9/2002	38.05011	-81.528	11748	1301
White Oak Creek	10/29/2002	38.06321	-81.5718	12527	972
White Oak Creek	10/29/2002	38.04592	-81.5469	12528	1056
White Oak Creek	10/29/2002	38.05011	-81.528	12529	1322
White Oak Creek	10/29/2002	38.02975	-81.5143	12530	1535
White Oak Creek	11/13/2002	38.06321	-81.5718	13218	868
White Oak Creek	11/13/2002	38.06321	-81.5718	13219	
White Oak Creek	11/13/2002	38.04592	-81.5469	13220	924
White Oak Creek	11/13/2002	38.05011	-81.528	13221	1043
White Oak Creek	11/13/2002	38.02975	-81.5143	13222	1448
White Oak Creek	12/20/2002	38.06321	-81.5718	13651	686
White Oak Creek	12/20/2002	38.04592	-81.5469	13652	754
White Oak Creek	12/20/2002	38.05011	-81.528	13653	884
White Oak Creek	12/20/2002	38.02975	-81.5143	13654	1197
White Oak Creek	1/29/2003	38.06321	-81.5718	14137	1010
White Oak Creek	1/29/2003	38.06321	-81.5718	14138	
White Oak Creek	1/29/2003	38.04592	-81.5469	14139	1106
White Oak Creek	1/29/2003	38.05011	-81.528	14140	999
White Oak Creek	3/3/2003	38.06321	-81.5718	15056	723
White Oak Creek	3/3/2003	38.04592	-81.5469	15057	772
White Oak Creek	3/3/2003	38.05011	-81.528	15058	884
White Oak Creek	3/3/2003	38.02975	-81.5143	15059	1094
White Oak Creek	3/19/2003	38.06321	-81.5718	15507	918
White Oak Creek	3/19/2003	38.06321	-81.5718	15508	
White Oak Creek	3/19/2003	38.04592	-81.5469	15509	1005

White Oak Creek	3/19/2003	38.05011	-81.528	15510	975
White Oak Creek	3/19/2003	38.02975	-81.5143	15511	157
White Oak Creek	3/30/2003	38.06321	-81.5718	16010	994
White Oak Creek	3/30/2003	38.06321	-81.5718	16011	
White Oak Creek	3/30/2003	38.04592	-81.5469	16012	1101
White Oak Creek	3/30/2003	38.05011	-81.528	16013	1021
White Oak Creek	3/30/2003	38.02975	-81.5143	16014	890
White Oak Creek	5/29/2003	38.06321	-81.5718	16456	833
White Oak Creek	5/29/2003	38.04592	-81.5469	16457	928
White Oak Creek	5/29/2003	38.05011	-81.528	16458	899
White Oak Creek	5/29/2003	38.02975	-81.5143	16459	1034
White Oak Creek	11/15/2005	38.04592	-81.5469	27921	1720
White Oak Creek	12/13/2005	38.04592	-81.5469	28278	1480
White Oak Creek	1/4/2006	38.04592	-81.5469	28664	1236
White Oak Creek	2/8/2006	38.04592	-81.5469	28688	1073
White Oak Creek	2/8/2006	38.04592	-81.5469	28689	
White Oak Creek	3/15/2006	38.04592	-81.5469	29282	958
White Oak Creek	4/12/2006	38.04592	-81.5469	29611	798
White Oak Creek	5/2/2006	38.04592	-81.5469	29933	1095
White Oak Creek	6/12/2006	38.04592	-81.5469	30520	1610
White Oak Creek	7/12/2006	38.04592	-81.5469	30537	1560
White Oak Creek	8/23/2006	38.04592	-81.5469	31071	1670
White Oak Creek	9/18/2006	38.04592	-81.5469	31583	1800
White Oak Creek	10/17/2006	38.04592	-81.5469	32239	1650
White Oak Creek	4/26/2007	38.04592	-81.5469	34059	1414
Little White Oak Creek	7/24/2002	38.06469	-81.5671	10220	503
Little White Oak Creek	10/30/2002	38.06469	-81.5671	12531	496
Little White Oak Creek	11/13/2002	38.06469	-81.5671	13223	463
Little White Oak Creek	12/20/2002	38.06469	-81.5671	13655	380
Little White Oak Creek	1/29/2003	38.06469	-81.5671	14142	467
Little White Oak Creek	3/3/2003	38.06469	-81.5671	15060	381
Little White Oak Creek	3/19/2003	38.06469	-81.5671	15512	444
Little White Oak Creek	3/30/2003	38.06469	-81.5671	16015	453
Little White Oak Creek	5/29/2003	38.06469	-81.5671	16460	434
Twomile Branch	7/24/2002	38.04658	-81.542	10221	555
Twomile Branch	8/26/2002	38.04658	-81.542	10836	575
Twomile Branch	10/9/2002	38.04658	-81.542	11751	700
Twomile Branch	10/29/2002	38.04658	-81.542	12532	511
Twomile Branch	11/13/2002	38.04658	-81.542	13224	387
Twomile Branch	12/20/2002	38.04658	-81.542	13656	249
Twomile Branch	1/29/2003	38.04658	-81.542	14143	361
Twomile Branch	3/3/2003	38.04658	-81.542	15061	267
Twomile Branch	3/19/2003	38.04658	-81.542	15513	328
Twomile Branch	3/30/2003	38.04658	-81.542	16016	373

Twomile Branch	5/29/2003	38.04658	-81.542	16461	288
Threemile Branch	7/24/2002	38.05036	-81.5319	10222	198
Threemile Branch	10/29/2002	38.05036	-81.5319	12533	153
Threemile Branch	11/13/2002	38.05036	-81.5319	13225	177
Threemile Branch	12/20/2002	38.05036	-81.5319	13657	176
Threemile Branch	1/29/2003	38.05036	-81.5319	14144	203
Threemile Branch	3/3/2003	38.05036	-81.5319	15062	188
Threemile Branch	3/19/2003	38.05036	-81.5319	15514	185
Threemile Branch	3/30/2003	38.05036	-81.5319	16017	196
Threemile Branch	5/29/2003	38.05036	-81.5319	16462	188
Left Fork/White Oak Creek	10/8/1997	38.05022	-81.5279	408	797
Left Fork/White Oak Creek	7/24/2002	38.05022	-81.5279	10223	1049
Left Fork/White Oak Creek	8/26/2002	38.05022	-81.5279	10838	1068
Left Fork/White Oak Creek	8/26/2002	38.04214	-81.4831	10839	1819
Left Fork/White Oak Creek	10/9/2002	38.05022	-81.5279	11753	1389
Left Fork/White Oak Creek	10/29/2002	38.05022	-81.5279	12534	1064
Left Fork/White Oak Creek	11/13/2002	38.05022	-81.5279	13226	1121
Left Fork/White Oak Creek	12/20/2002	38.05022	-81.5279	13658	1019
Left Fork/White Oak Creek	1/29/2003	38.05022	-81.5279	14145	1416
Left Fork/White Oak Creek	3/3/2003	38.05022	-81.5279	15063	1110
Left Fork/White Oak Creek	3/19/2003	38.05022	-81.5279	15515	1333
Left Fork/White Oak Creek	3/30/2003	38.05022	-81.5279	16018	1413
Left Fork/White Oak Creek	5/29/2003	38.05022	-81.5279	16463	1289
Spruce Fork	5/4/2005	38.01889	-81.5068	27055	608
Laurel Creek	10/7/1997	38.10257	-81.6318	403	813
Laurel Creek	7/31/2002	38.10427	-81.6244	10206	798
Laurel Creek	7/30/2002	38.08307	-81.6409	10207	890
Laurel Creek	7/30/2002	38.06043	-81.6608	10208	1294
Laurel Creek	8/27/2002	38.10427	-81.6244	10820	935
Laurel Creek	8/27/2002	38.08307	-81.6409	10821	991
Laurel Creek	8/27/2002	38.06043	-81.6608	10822	1617
Laurel Creek	8/6/2002	38.10388	-81.6241	11138	862
Laurel Creek	10/7/2002	38.10427	-81.6244	11735	979
Laurel Creek	10/7/2002	38.08307	-81.6409	11736	1041
Laurel Creek	10/7/2002	38.06043	-81.6608	11737	1701
Laurel Creek	11/5/2002	38.10427	-81.6244	12515	818
Laurel Creek	10/30/2002	38.08307	-81.6409	12516	641
Laurel Creek	10/30/2002	38.06043	-81.6608	12517	988
Laurel Creek	11/14/2002	38.10427	-81.6244	13207	585
Laurel Creek	11/14/2002	38.08307	-81.6409	13208	652
Laurel Creek	11/14/2002	38.06043	-81.6608	13209	1063
Laurel Creek	12/17/2002	38.10427	-81.6244	13639	405
Laurel Creek	12/17/2002	38.10427	-81.6244	13640	
Laurel Creek	12/17/2002	38.08307	-81.6409	13641	447

Laurel Creek	12/17/2002	38.06043	-81.6608	13642	679
Laurel Creek	1/28/2003	38.10427	-81.6244	14125	699
Laurel Creek	1/28/2003	38.08307	-81.6409	14126	775
Laurel Creek	1/28/2003	38.06043	-81.6608	14127	1309
Laurel Creek	2/28/2003	38.10427	-81.6244	15044	428
Laurel Creek	2/28/2003	38.08307	-81.6409	15045	592
Laurel Creek	2/28/2003	38.06043	-81.6608	15046	990
Laurel Creek	3/18/2003	38.10427	-81.6244	15496	617
Laurel Creek	3/18/2003	38.08307	-81.6409	15497	690
Laurel Creek	3/18/2003	38.06043	-81.6608	15498	1091
Laurel Creek	3/30/2003	38.10427	-81.6244	15999	690
Laurel Creek	3/30/2003	38.08307	-81.6409	16000	720
Laurel Creek	3/30/2003	38.06043	-81.6608	16001	1069
Laurel Creek	5/29/2003	38.10427	-81.6244	16445	617
Laurel Creek	5/29/2003	38.08307	-81.6409	16446	648
Laurel Creek	5/28/2003	38.06043	-81.6608	16447	1118
Sandlick Creek	7/30/2002	38.09346	-81.6395	10209	522
Sandlick Creek	8/27/2002	38.09346	-81.6395	10823	1302
Sandlick Creek	8/27/2002	38.0931	-81.6403	10824	
Sandlick Creek	8/6/2002	38.09346	-81.6395	11139	679
Sandlick Creek	8/6/2002	38.0931	-81.6403	11140	
Sandlick Creek	10/7/2002	38.09346	-81.6395	11738	1205
Sandlick Creek	10/30/2002	38.09346	-81.6395	12518	413
Sandlick Creek	10/30/2002	38.0931	-81.6403	12519	
Sandlick Creek	11/14/2002	38.09346	-81.6395	13210	325
Sandlick Creek	11/14/2002	38.0931	-81.6403	13211	
Sandlick Creek	12/17/2002	38.09346	-81.6395	13643	219
Sandlick Creek	12/17/2002	38.0931	-81.6403	13644	
Sandlick Creek	1/28/2003	38.09346	-81.6395	14128	498
Sandlick Creek	1/28/2003	38.0931	-81.6403	14129	
Sandlick Creek	2/28/2003	38.09346	-81.6395	15047	288
Sandlick Creek	2/28/2003	38.0931	-81.6403	15048	
Sandlick Creek	3/18/2003	38.09346	-81.6395	15499	297
Sandlick Creek	3/18/2003	38.0931	-81.6403	15500	
Sandlick Creek	3/30/2003	38.09346	-81.6395	16002	378
Sandlick Creek	3/30/2003	38.0931	-81.6403	16003	
Sandlick Creek	5/29/2003	38.09346	-81.6395	16448	350
Sandlick Creek	5/29/2003	38.0931	-81.6403	16449	
Hopkins Fork	10/7/1997	38.0771	-81.6349	404	475
Hopkins Fork	10/6/1997	37.96372	-81.5979	405	248
Hopkins Fork	7/30/2002	38.07577	-81.6382	10210	625
Hopkins Fork	7/30/2002	38.01839	-81.6203	10211	443
Hopkins Fork	8/27/2002	38.07577	-81.6382	10825	742
Hopkins Fork	8/28/2002	38.01839	-81.6203	10826	925

Hopkins Fork	8/6/2002	38.07577	-81.6382	11141	684
Hopkins Fork	10/7/2002	38.07577	-81.6382	11739	728
Hopkins Fork	10/9/2002	38.01839	-81.6203	11740	513
Hopkins Fork	10/31/2002	38.07577	-81.6382	12520	468
Hopkins Fork	10/31/2002	38.07577	-81.6382	12521	
Hopkins Fork	10/31/2002	38.01839	-81.6203	12522	304
Hopkins Fork	11/14/2002	38.07577	-81.6382	13212	447
Hopkins Fork	11/14/2002	38.01839	-81.6203	13213	263
Hopkins Fork	12/17/2002	38.07577	-81.6382	13645	353
Hopkins Fork	12/17/2002	38.01839	-81.6203	13646	246
Hopkins Fork	1/28/2003	38.07577	-81.6382	14131	629
Hopkins Fork	1/28/2003	38.01839	-81.6203	14132	474
Hopkins Fork	2/28/2003	38.07577	-81.6382	15050	461
Hopkins Fork	2/28/2003	38.01839	-81.6203	15051	353
Hopkins Fork	3/18/2003	38.07577	-81.6382	15501	578
Hopkins Fork	3/18/2003	38.01839	-81.6203	15502	411
Hopkins Fork	3/30/2003	38.07577	-81.6382	16004	607
Hopkins Fork	3/30/2003	38.01839	-81.6203	16005	412
Hopkins Fork	5/29/2003	38.07577	-81.6382	16450	500
Hopkins Fork	5/28/2003	38.01839	-81.6203	16451	413
Hopkins Fork	4/29/2003	38.01866	-81.6202	16895	406
Hopkins Fork	5/9/2006	38.05829	-81.6156	30899	640
UNT/Laurel Creek RM 3.46	4/24/2003	38.06218	-81.6353	16824	363
Big Jarrells Creek	7/30/2002	38.01849	-81.6208	10212	770
Big Jarrells Creek	8/28/2002	38.01849	-81.6208	10827	511
Big Jarrells Creek	10/9/2002	38.01849	-81.6208	11741	776
Big Jarrells Creek	10/31/2002	38.01849	-81.6208	12523	483
Big Jarrells Creek	11/14/2002	38.01849	-81.6208	13214	494
Big Jarrells Creek	12/17/2002	38.01849	-81.6208	13647	455
Big Jarrells Creek	1/28/2003	38.01849	-81.6208	14133	723
Big Jarrells Creek	2/28/2003	38.01849	-81.6208	15052	527
Big Jarrells Creek	3/18/2003	38.01849	-81.6208	15503	738
Big Jarrells Creek	3/30/2003	38.01849	-81.6208	16006	716
Big Jarrells Creek	5/28/2003	38.01849	-81.6208	16452	656
Cold Fork	10/7/1997	38.06018	-81.6605	406	715
Cold Fork	7/30/2002	38.06018	-81.6605	10213	599
Cold Fork	10/30/2002	38.06018	-81.6605	12524	570
Cold Fork	11/14/2002	38.06018	-81.6605	13215	508
Cold Fork	12/17/2002	38.06018	-81.6605	13648	348
Cold Fork	1/28/2003	38.06018	-81.6605	14134	506
Cold Fork	2/28/2003	38.06018	-81.6605	15053	350
Cold Fork	3/18/2003	38.06018	-81.6605	15504	419
Cold Fork	3/30/2003	38.06018	-81.6605	16007	468
Cold Fork	5/28/2003	38.06018	-81.6605	16453	356

Little Laurel Creek	6/10/2002	38.0251	-81.6979	10566	1006
Brier Creek	8/5/2002	38.23974	-81.7711	10184	250
Brier Creek	8/28/2002	38.23974	-81.7711	10796	263
Brier Creek	8/8/2002	38.23974	-81.7711	11126	259
Brier Creek	10/2/2002	38.23974	-81.7711	11714	266
Brier Creek	10/28/2002	38.23974	-81.7711	12494	227
Brier Creek	11/14/2002	38.23974	-81.7711	13186	131
Brier Creek	12/16/2002	38.23974	-81.7711	13618	92
Brier Creek	1/21/2003	38.23974	-81.7711	14104	131
Brier Creek	3/4/2003	38.23974	-81.7711	15022	124
Brier Creek	3/17/2003	38.23974	-81.7711	15475	93
Brier Creek	3/29/2003	38.23974	-81.7711	15978	127
Brier Creek	5/27/2003	38.23974	-81.7711	16423	138
Brier Creek	5/3/2006	38.23968	-81.713	30931	118
Fork Creek	10/6/1997	38.2265	-81.7763	391	441
Fork Creek	8/5/2002	38.23043	-81.774	10185	1195
Fork Creek	8/28/2002	38.23043	-81.774	10797	1693
Fork Creek	10/2/2002	38.23043	-81.774	11715	1654
Fork Creek	10/28/2002	38.23043	-81.774	12495	710
Fork Creek	11/12/2002	38.23043	-81.774	13187	
Fork Creek	12/16/2002	38.23043	-81.774	13619	304
Fork Creek	1/21/2003	38.23043	-81.774	14105	270
Fork Creek	2/27/2003	38.23043	-81.774	15023	201
Fork Creek	3/17/2003	38.23043	-81.774	15476	137
Fork Creek	3/29/2003	38.23043	-81.774	15979	208
Fork Creek	5/28/2003	38.23043	-81.774	16424	240
Jimmy Fork	10/6/1997	38.1828	-81.7738	392	124
Jimmy Fork	4/22/2002	38.17857	-81.7689	10480	65
Wilderness Fork	10/6/1997	38.17204	-81.7735	393	144
Dave Fork	10/6/1997	38.16428	-81.7723	394	178
Bull Creek	8/5/2002	38.19916	-81.722	10186	536
Bull Creek	8/28/2002	38.19916	-81.722	10798	630
Bull Creek	10/2/2002	38.19916	-81.722	11716	602
Bull Creek	10/28/2002	38.19916	-81.722	12496	593
Bull Creek	11/14/2002	38.19916	-81.722	13188	273
Bull Creek	12/16/2002	38.19916	-81.722	13620	178
Bull Creek	1/21/2003	38.19916	-81.722	14106	287
Bull Creek	3/4/2003	38.19916	-81.722	15024	236
Bull Creek	3/17/2003	38.19916	-81.722	15477	128
Bull Creek	3/29/2003	38.19916	-81.722	15980	292
Bull Creek	5/27/2003	38.19916	-81.722	16425	276
Left Fork/Bull Creek	9/26/1997	38.20487	-81.7124	395	490
White Oak Branch	8/5/2002	38.18474	-81.7159	10187	217
White Oak Branch	8/28/2002	38.18474	-81.7159	10799	237

White Oak Branch	10/3/2002	38.18474	-81.7159	11717	272
White Oak Branch	11/4/2002	38.18474	-81.7159	12497	237
White Oak Branch	11/12/2002	38.18474	-81.7159	13189	155
White Oak Branch	12/19/2002	38.18474	-81.7159	13621	113
White Oak Branch	1/21/2003	38.18474	-81.7159	14107	133
White Oak Branch	2/27/2003	38.18474	-81.7159	15025	93
White Oak Branch	3/17/2003	38.18474	-81.7159	15478	87
White Oak Branch	3/29/2003	38.18474	-81.7159	15981	125
White Oak Branch	5/28/2003	38.18474	-81.7159	16426	121

PH	DO	GLIMPSS	WVSCI	O_E null	O_E	FLOW	ecal Colifor	ecific Cond	Temperatur
7.61	11.71						1100		21.12
8.61	11.42						570		22.93
8.53	11.24						160		23.07
7.73	13.16						42		22.62
8.08	8.2						12		24.37
8.12	9.31						270		22.36
8.38	9.08						160		23.46
7.88	8.78						30		24.93
8.04	9.16	20.88486	54.75	0.32			1300		21.2
8.54	11.9	28.70216	61.62	0.43	0.400328		4400		28.8
8.41	9.56	34.19327	68.74	0.59	0.400466		170		25
8.03	10.31	49.88597	75.04	0.69	0.635532		70		25.39
7.77	10.35								12.29
							850		
7.79	10.12						500		12.22
8.29	10.87						68		12.38
7.74	10.6								12.8
							20		
7.63	11.85						320		12.07
7.53	10.97						1050		12.31
7.15	10.92						360		12.35
7.25	10.66						320		12.41
7.43	11.21						66		10.62
7.32	10.42						240		11.3
7.39	10.51						80		10.46
7.15	10.08						220		10.74
8.58	12.95						6		5.81
8.19	13.52						36		5.03
7.53	11.98						72		5.69
7.08	11.67						54		5.83
7.92	13.27						56		3.66
7.67	13.7						220		2.2
7.93	14.18						14		0.52
7.26	15.6						20		0.34
7.63	11.93						2		4.74
7.47	11.88						2		4.54
7.59	12.37						2		4.07
7.28	11.87						2		4.11
8.47	8.71						140	690	14.29
8.12	9.46						36	500	14.4
8	12.08						6	404	11.07
7.42	11.45						8	190	12.06
7.76	10.4						28		11.65

7.78	10.32						27		13.9
7.86	10.48						26		11.7
7.02	10.21						22		10.68
8.23	10.95						112		15.62
8.02	11.5						550	489	12.05
7.72	10.42						600	416	13.06
7.21	9.57						750	214	12.91
7.02	11.9								19.49
7.13	8.38								22.51
7.36	9.43	35.58141	62.04	0.64	0.320134		3600		19.04
7.47	10.45								12.32
6.36	10.52								12.21
7.03	10.33								11.24
7.13	11.86								7.24
6.92	13.08								3.28
6.95	11.78								5.26
6.83	12.45								9.91
6.87	9.8								15.59
7.23	11.11							588	11.83
6.92	9.68						12		19.31
8.66	9.62					1.45	380		25.23
8.59	7.69					0.67	750		25.54
8.4	9.32	19.38013	57.84	0.43	0.560295		1400		21.27
7.94	10.33					9.51			12.57
						9.51	118		
7.8	11.9					17.5	490		12.32
							390		
7.73	10.32					14.62	260		11.47
8.8	12.46					5.28	64		6.96
7.98	12.91					7.25	76		4.48
7.91	12.31					23.11	20		5.69
							2		
8.74	8.13					7.69	12000	617	15.51
8.12	10.29					9.89	7		13.27
8.14	11.51					6.34	2500	555	11.41
8.67	12.65								5.99
8.22	13.31								3.18
7.8	12.34								4.3
8.41	12.38								12.45
8.33	9.66								16.78
8.27	10.88							404	12.21
6.23	13.47						2		1.21
6.47	14.17						2		4.2
6.41	8.71						2		12.32

6.96	9.9								13.5
7.38	10.81						4		11.41
8.26	9.93								22.31
8.01	10.11								12.565
7.12	10.93								12.32
7.48	10.5								10.36
7.96	11.92								7.08
8.04	12.26								5.51
7.92	12.45								7.04
8.41	8.55							671	15.79
8.17	9.61								16.48
8.2	11.01							608	13.49
6.82	13.43						2		2.51
7.34	12.7						2		4.45
7.75	9.16						210		12.45
6.74	10.44								11.85
7.7	10.51						2		14.19
8.3	10.5		48.27				2800		14.2
8.54	10.91					1.42	420		22
8.36	10.52						350		20.28
8.29	9.49					0.74	210	1489	21.06
8.39	9.69						70		22.45
8.48	12.32	10.11233	23.12	0.37	0.400335		240		22.8
8.34	10.73	18.75225	42.84	0.32	0.480445		15		21.21
8.2	10.9					0.94			12.17
						0.94	230		
8.16	11.37								12.42
							104		
7.86	11.3					11.97	6600		11.99
7.84	11.27						100		11.89
8.01	10.46					11.17	110		10.83
7.83	10.3						76		10.59
7.98	12.04					21.95	112		6.7
7.89	11.92						130		6.96
8.24	13.21					5.17	30		3.67
8.25	13.23						24		4.15
8.03	11.83					27.23	2		5.09
8.06	11.59						2		5.26
8.36	8.42					4.24	8	1170	15.21
8.34	8.41						4	1120	14.47
8.02	10.15					3.66	7		14.87
8.24	10.2								14.16
8.33	11.93					8.96	110	1160	12.49
8.21	12.07						70	1100	11.99

8.6	11.67						210		21.73
8.31	9.43						86		20.92
8.44	11.74	21.22065	48.54	0.43	0.480446		260		22.14
8.09	11.43								12.03
							110		
7.83	11.38						580		11.75
7.94	10.44						140		10.19
8.06	12.15						110		6.49
8.27	13.73						54		3.07
8.04	11.73						2		4.95
8.3	9.48						34	1320	15.09
8.36	10.24						67		14.86
8.28	12.07						84	1330	12.02
7.01	12.96						6		3.33
7.34	13.68						12		4.93
7.46	8.02						24		13.01
7.39	10.09						88		12.74
7.67	10.7						280		11.46
7.7	9		75.91				48		14.6
7.41	8.19					0.09	4500		22.05
7.49	7.67						250		20.42
7.16	7.95	67.59929	76.11	1.02	1.041058		600		19.69
7.74	8.69						1600		13.49
7.13	10.56					3.63	2050		13.52
7.14	10.45					3.12	340		11.87
7.26	11.6					5.28	230		6.66
7.32	12.91					0.89	4800		2.98
7.38	13.48					4.73	570		4.39
7.45	8.06					0.8	650	271	15.13
7.43	10.09					0.71	280		12.45
7.34	10.18					3.3	60000	253	13.3
8.1	8.6		63.04				330		19
7.8	9.8		74.44				72		13.8
8.24	9.32						18		25.91
7.94	9.8								22.23
8.12	7.88						76		24.69
7.94	8.02								22.95
8.08	8.49	32.76947	62.17	0.53	0.640726		60		26.16
8.04	10.01						96		13.39
7.83	9.97								12.6
7.23	11.06						70		11.99
7.19	10.77								12.21
7.61	10.63						200		9.96
7.52	10.48								9.96

7.85	12.77						2		3.38
7.86	12.28								4.92
7.69	13.17						8		2.75
7.81	13.21								2.58
7.53	12.48						2		3.66
7.66	11.23						2	636	13.11
7.77	9.75						4		14.06
7.67	10.39						280	519	14.93
8.14	11.16						4		20.11
7.59	9.2	29.53629	67.33	0.397417	0.534564		4		12.81
8	8.69						20		21.17
7.91	9.77	50.73361	77.67	0.75	0.640988		10		20.86
7.97	10.1						16		13.17
7.5	10.91						68		12.22
7.59	10.13						8		11.06
7.73	11.84						8		5.94
7.8	13.31						4		2.34
7.93	13						2		5.69
7.94	11.43						2	642	11.61
							2	643	
7.94	10.3						2		11.34
7.76	10.32						1050	546	12.64
7.82	7.98	57.17819	88.58	1.043219	0.917211		250	604	12.79
8.39	11.45					0.27	64		22.49
8.29	8.53					0.12	44		24.94
8.54	11.9	26.71905	43.54	0.32	0.556199		40		22.72
8.23	10.53					0.25	12		13.63
7.63	11.34					3.74	80		12.42
7.84	10.49					4.2	600		11.37
7.84	12.01					7.8	104		5.74
8.07	12.64					1.26	16		3.95
7.65	13.2					5.12	2		4.64
8.21	10.39					1.75	2	611	15.16
7.95	10.23					1.9	2		12.32
							2		
7.82	10.53					3.99	850	407	13.65
							950	410	
7.34	4.76								19.78
7.81	9.88								12.42
7.29	10.79								12.52
7.33	10.14								10.66
7.18	11.73								6.36
7.31	14.04								0.11
7.23	11.95								3.87

7.47	11.42								10.48
7.2	10.43								10.44
7.48	10.2								12.16
8.2	9.5		52.82				140		12.5
8.4	9.33					2.96	320		21.53
8.06	10.72						60000		19.56
7.75	8.03						76		18.35
8.24	7.81					1.69	10		21.01
7.9	7.91						170		18.77
7.82	6.85						44		19.25
8.51	9.2	29.2886	62.85	0.48	0.561204		1320		21.38
8.22	9.71	17.8254	45.91	0.37	0.560698		7000		18.21
7.87	2.06	15.75764	31.77	0.37	0.490427		536		15.18
8.16	10.81					1.88	12		16.43
7.91	10.88						420		15.1
7.91	9.77						28		14.72
8.13	13.57					2.16	330		12.29
7.75	11.58						20000		12.16
7.62	11.08						6800		12.33
6.9	6.58					14.77	2100		7.93
6.81	8.65						470		9.27
6.71	6.26						510		10.3
7.26	11.95						540		6.13
6.78	9.77						1960		6.47
7.69	11.05						27		6.09
8.14	13.57					10.17	64		2.48
7.62	12.35						9800		5.05
7.84	11.83						78		6.13
8.27	18.64						420		3.19
7.11	11.36						7300		5.39
7.27	11.02						330		6.61
8.48	19.01					6.39	280	300	5.94
6.85	16.39						240		8.68
7.05	13.71						17		8.1
7.72	10.98						1300		10.92
6.61	10.74						570		14.76
6.67	9.48						19		15.62
8.12	9.79					36.6	103		14.04
7.44	9.2						20000		14.1
7.43	8.46						380		13.78
6.36	2.73						320		22.47
7.5	7.5		41.15				160		13.3
7.76	8.23						21		20.65
7.48	8.47						27		21.89

7.23	7.34						16		24.02
6.74	7.2						35		21.86
7.84	6.81					0.78	200		17.51
7.41	7.51						8		19.19
6.89	5.25						18		19.41
6.83	8.04						6		17.02
8	7.96	39.17218	69.66	0.64	0.701538		2670		21.57
7.53	8.73	22.55844	63.29	0.59	0.700778		196		18.01
6.44	7.18		34.70		0.420399				21.34
7.85	8.86					4.51	10		16.27
7.59	9.67						31		17.33
7.13	9.01						4		16.25
5.91	8.15						1		15.93
7.81	11.41					2.53	17		12.51
7.38	13.51						20		13.78
							21		
6.86	7.41						111		9.66
6.76	7.66						70		9.74
7.17	11.12					22.18	127		7.45
7.15	10.3						6		9.04
6.85	9.97						51		6.63
7.06	10.22						77		7.55
7.35	11.72						42		5.91
7.37	11.63					12.1	4		8.58
							2		
7.26	13.21						2		6.54
7.12	12.82						4		7.16
7.51	18.14					22.07	22		3.12
7.38	10.36						2		6.03
7.34	18.73						82		1.02
7.21	13.8						2		1.7
7.59	18.37						10		3.07
7.28	3.2						1		6.64
7.67	17.65						30		1.74
7.01	21.72						80		2.71
7.44	13.63					16.75	6	229	5.35
7.67	16.96						2	234	8.77
7.21	14.01						10	306	5.77
7.45	17.62						86	264	7.34
7.47	9.67						590		12.51
7.22	10.32						10		13.68
7.14	13.18						310		13.19
7.36	10.02						2000		10.77
7.61	9.26					26.81	57		14.7

7.22	9.31						24		14.73
7.36	9.01						42		18.22
7.17	8.74						94		16.5
6.94	7.01					0.03	2000		18.52
8.39	8.31						16		29.66
7.2	5.54					0.03	92		16.02
7.56	8.56						90		12.18
8.02	8.09					0.01	510		16.62
8.36	10						37		18.35
7.46	12.62						47		10.7
7.31	12.7						39		12.85
7.23	4.36					1.15	180		8.16
6.89	4.76						48		9.35
6.57	12.4					1.89	76		6.05
6.27	11.62						260		6.39
7.04	14.41					1.44	3		6.24
7.77	13.31						10		4.14
6.8	11.87					1.47	54		4.32
6.72							23		4.97
6.87	17.3					0.9	11		5.04
6.93	15.44						54		7.98
6.87	11.65					0.69	19		9.59
7.29	11.79						6		11.02
6.96	9.14					0.57	38		13.87
6.81	9.44						28		16.12
7.21	7.4			73.72		0.13	24		18.5
7.37	7.91					0.03	12		17.14
7.91	9.85					0.02	41		16.47
7.92	13.49					0.03	16		11.81
7.42	10.44					5.61	4		9.32
7.55	12.8					5.65	2		4.96
7.77	11.47					4.05	4		1.64
7.63	12.52					6	4		3.27
7.59	11.28					3.41	4	42	4.62
7.29	9.81					16.5	2		15.34
7.1	8.79					4	13		17.47
6.79	5.63						26		16.48
7.17	10.23						58		7.11
6.38	12.91						13		5.48
7.83	13.27						2		1.32
6.57	20.07						5		2.67
							1		
8.36	18.2						2	63	5.74
5.6	12						31		11.62

6.72	9.32						760		12.77
7.08	7.17						18		20.06
6.92	6.51						6		16.97
7.6	10.9					0.0089	16		15.4
7.46	13.59						61		11.97
6.89	10.34						93		7.36
7.31	12.38						48		6.53
7.83	15.36						12		2.34
							6		
7.29	7.02						46		3.04
7.64	17.08						24	239	6.55
7.29	10.38						30		13.56
7.43	9.51						124		14.4
6.61	6.91					0.03	11		22.35
6.34	6.85					0.02	2		22.24
6.04	7.79					0.01	26		18.52
7.14	12.2					0.06	20		11.99
7.04	10.28					2.21	18		7.51
6.98	12.28					1.81	2		6.48
7.32	6.46					1.97	2		7.3
7.12	6.99					2	1		6.47
7.74	17.26					1.2	2	90	7.09
							2	89	
6.99	10.37					6.37	6		12.87
6.97	8.48					1.73	14		15.16
7.8	10.7								17.4
6.63	8.13					0.001			14.1
6.8	3.59								18.43
7.23	8.06					0.3			9.74
7.36	10.74					0.5			6.29
7.3	13.39					1.43			6.27
7.7	18.09					0.49			1.75
7.68	18.01					1			2.68
7.2	13.83					0.43		120	6.1
7.34	10.77								12.3
7.37	8.82					0.5			16.68
7.9	8.4		43.33				64		14.7
8.12	8.78					17.78	84		22.91
7.38	6.78		63.46				250		23.18
8.09	7.45						560		21.75
8.14	9.02						84		18.68
7.53	5.02						130		20.24
							130		
8.22	8.49						10		22.64

8.18	8.35	37.91938	68.73	0.48			90		24.26
7.64	9.67						1350		11.83
7.62	8.46						170		14.35
7.82	10.59						70		15.36
7.32	11.77						200		12.03
7.7	13						46		13.16
7.21	17.32						66		3.56
7.22	9.51						1710		8.7
7.41	9.92						93		7.67
7.43	11.05						66		3.96
6.69	11.86						187		5.53
7.19	12.48						14		5.75
7.55	14.96						14		0.1
7.36	16.45						580		1.47
7.57	15.98						32		2.23
6.7	9.77						12		3.7
7.81	2.68						53		2.67
7.72	1.13						15		2.82
7.29	10.04						0.59	198	11.69
7.41	14.41						310	193	6.1
7.31	12.05						13	223	6.36
6.87	9.92						580		12.11
6.38	10.73						99		12.76
6.26	11.74						35		12.98
8.16	10.77						98	152	15.21
							116	151	
7.6	9.57						136		15.09
							182		
7.2	8.91						172		14.48
7.59	9.29		73.95			3.78	100		21.8
7.37	8.27						200		22.88
6.93	7.43						1950		22.3
6.78	6.13		50.17				110		22.47
7.95	8.09					1.83	92		19.62
7.64	6.58						20		22.1
7.56	7.81						750		23.35
7.44	6.69						4		20.55
7.86	12.07					0.9	54		13.16
7.36	8.41						1600		16.02
7.58	8.25						1000		16.01
7.11	5.9						11		13.43
6.43	10.48						4000		12
7.12	9.33						4200		12.11
7.15	10.08						2300		12.13

7.45	10.25						9		11.2
7.94	12.34						120		8.3
6	12.28						420		8.52
7.15	7.2						960		8.97
7.24	8.28						61		7.87
7.49	13.5						45		2.89
6.88	12.5						21		2.74
6.73	13.11						530		4.2
6.33	11.41						9		3.1
7.47	15.49						360		4.68
6.92	14.33						300		5.12
7.16	15.8						230		4.93
7.15	11.57						80		4.08
8.24	13.16						410		2.4
6.42	15.24						42		2.65
6.51	15.4						730		3.86
6.5	16.72						16		2.85
7.04	14.08						31		4.63
6.42	13.72						29		5.2
7.35	17.19						51		6.59
6.97	14.09						9	63	6.7
7.23	11.97						53		10.57
6.51	11.46						65		11.51
6.32	11.13						23		15.47
6	7.84						128		15.69
6.96	9.29						260		13.92
6.99	9.06						220		13.79
7.09	9.53						290		13.95
6.7	7.32						106		15.11
7.2	8		50.30				3000		16.9
7.3	9.62					0.1	74		22.07
4.62	9.96						2		18.91
4.64	7.27						2		18.64
7.74	12.02					0.005	33		15.43
7.78	10.15						20000		15.07
5.82	10.51					0.38	89		12.09
4.87	10.49						480		12.21
5.68	12.7					1.26	11		9.4
4.65	12.63						160		10.2
6.55	12.46					0.4	30		4.64
4.56	11.48						530		6.88
6.67	13.5					1.23	42		6.85
5.27	12.5						480		7.73
5.97	15.98					3	4		4.3

5.09	12.56						190		4.93
5.95	13.33					1.2	18		6.1
4.85	13.05						380		6.74
5.94	10.78					1.6	9		13.56
4.77	10.92						37		12.56
6.54	9.4					0.6	76		14.13
7.3	10.21					1.01		204	13.68
4.81	9.22						150		12.61
5.01	10.93							289	12.53
7.34	6.5		42.60			0.97	84		20.62
			57.25				100		
7.3	7.59						170		20.02
7.45	3.65					0.48	32		19.15
7.89	7.79						2		20.93
7.3	4.84					0.34	150		14.41
							230		
7.47	10.08						1200		15.77
6.62	6.07					3.29	320		10.08
							630		
6.65	10.11						370		11.19
6.72	9.36					13.21	600		7.68
							580		
6.95	11.07						59		7.59
6.61	11.99					48.98	1800		5.01
7.13	12.9						44		2.93
7.26	14.52					10.51	120		5.29
7.1	15.05						79		5.31
7.27	15.59					6.43	240		2.73
6.76	16.06						400		3.08
6.91	13.93					7.24	41	211	6.26
6.62	13.47						140		4.97
6.34	10.73					5.65	78		14.94
6.84	10.81						15		14.89
7.03	9.04					8.6	410		14.91
7.12	9.74						33		13.57
6.41	11.6		44.06				410		0.08
11.79	6.5		84.68				1150		2.29
6.64	11.41		73.78				237		3.18
6.95	10.97		18.97				373		3.56
6.66	11.35		21.47				142		2.28
6.69	11.54		38.84				483		0.98
7.26	7.59						110		26.53
7.28	6.36						16		31.67
7.63	9.9						2900		16.5

7.06	10.19						1030		12.86
7.88	10.43						160		9.61
6.79	12.11						36		6.76
7.14	13.09						390		7.37
6.85	18.77						97		4.27
7.06	17.26						32		7.7
6.63	10.32						460		16.36
6.94	9.96						47		14.83
6.76	6.89					0.9	290		20.7
7.47	5.15					0.02	14		22.03
7.48	7.95					0.005	6		15.35
7.04	10.16					0.09	39		13.3
6.88	10.55					2.8	70		8.07
7.43	13.22					1.42	12		3.29
7.26	12.46					0.84	2	241	12.59
7.23	10.77					15.74	16		11.48
6.83	9.03					3.19	34		13.85
7.19	7.07					0.07	250		21.36
7.9	6.11								28.11
7.5	8.8		82.51				2700		13.4
7.74	7.93					1.21	290		22.65
7.87	8.92						400		21.24
7.8	8.09						24		19.81
7.78	9.71					0.45	180		17.55
7.72	10.01						210		17.71
7.65	9.86						60		17.08
7.69	7.89	34.55187	69.01	0.69	0.85906		114		22.64
7.37	9.73					8.91	130		11.7
7.12	9.66						200		11.31
7.32	9.89						26		11.44
6.94	11.05					14.09	270		10.04
6.93	10.82						290		9.62
7.1	11.21						32		9.77
7.23	16.22					4.11	4		4.64
7.33	16.61						8		4.76
7.64	16.13						2		5.48
7.54	10.52					7.43	24		4.96
7.83	10.02						46		6.89
8.15	9.15						6		8.13
7.49	15.88						2		0.07
7.71	15.11						2		0.22
7.86	14.97						2		0.92
7.16	10.89					10.25	4		4.8
7.36	10.57						2		5.86

7.69	10.49						2		6.92
7.78	10.17					3.64	24		11.14
7.95	10.09						44		11.86
8.08	10						2		11.6
7.32	10.39					9.47	2600		10.35
7.52	10.34						6800		10.03
7.87	10.78						78		9.84
7.77	10.22					3.89	1050		15.12
7.82	10.08						550		15.13
7.93	10.31						2		14.63
7.25	7.66						500		28.39
7.25	9.12						240		12.41
6.68	10.58						260		10.16
7.15	16.73						40		5.93
7.11	8.88						2		6.05
7.55	13.94						2		1.37
6.9	9.87						2		4.29
7.47	9.63						4		10.82
7.13	10.05						2950		10.2
7.14	9.83						200		16.72
7.45	7.63		71.94			0.44	2		21.53
7.32	6.48						1550		23.83
6.68	6.18						7000		23.73
7.16	7.09					0.09	40		18.36
7.23	5.86						42		19.48
6.67	4.22						46		22.88
7.87	11.16					0.04	7		13.44
7.43	9.98						1600		15.56
7.23	8.64						20000		15.79
7.1	7.75						430		10.01
6.28	10.06						2400		12.09
6.02	9.6						2700		12.23
6.95	5.23						610		7.97
6.81	9.5						550		8.47
6.68	7.84						3800		9.12
6.97	12.37						62		4.39
6.06	11.35						4600		5.27
7.64	14.09					8.01	28		2.85
6.79	13.91						3400		3.14
7.52	12.18						63		4.76
6.69	11.43						46		4.31
7.43	18.52						20		3.9
6.72	18.23					3.4	440		3.86
6.12	11.72						37		12.46

6.09	10.83					3.1	3		14.23
7.36	9.96						560		15.46
6.91	9.93						540		15.79
7.1	6.4		66.08				4000		14.8
7	6.88					0.1	210		19.85
7.5	5.53						68		20.57
6.88	5.63						14		17.49
6.94	9.71						3800		15.57
6.82	7.3					2.81	189		10.75
5.93	5.65						71		10.6
7.09	9.18					3.09	33		8.41
7.13	8.67						12		8.83
7.02	12.74						64		5.53
6.16	11.83						32		6.01
7.05	14.91					5.67	1		5.13
6.64	13.29						1		6.71
6.85	16.2					4.7	26		3.6
6.47	11.72						3		4.43
6.96	17.33					3.04	8		4.55
6.78	15.73						1		7.28
5.91	11.28					1.4	37		12.5
6.27	9.61						24		16.29
6.6	9.09					14.4	103		13.34
6.28	8.35						20		13.77
6.28	5.07						20000		21.77
6.68	0.82						50		19.76
7.06	7.8						4900		16.35
5.83	8.2						1090		12.48
6.63	6.15						39		9.53
5.87	10.86						870		5.99
7.09	12.83						310		4.09
7.24	11.4						23		4.46
6.84	17.28						42		4.58
6.07	11.27						49		12.71
6.66	9.28						270		14.89
6.68	5.37					0.06	340		23.48
6.66	7.57						48		27
7	4.79						56		21.43
6.44	9.72						4		21.84
7.14	4.51					0.002	20000		15.98
6.29	7.52						4800		16.97
6.27	8.59					2.62	2100		11.69
6.26	8.28						111		12.51
7.49	7.87					4.08	110		8.78

6.71	7.58						45		9.94
5.93	12.68					10.17			5.41
6.22	11.56						1200		6.28
7.03	15.45					2.7	41		4.46
7.04	14.77						20		4.85
6.5	15.94					3.48	70		4.14
6.45	15.74						21		5.38
6.62	16.43					2.49	16		6.79
6.62	15.36						18		8.99
6.08	11.64						22		12.43
7.07	11.53						20		13.25
6.87	9.46					2	1040		14.14
6.61	8.66						30		14.87
6.75	8.37	30.08861	54.20	0.447094	0.565138		116	49	12.65
6.36	9.02	6.309216	29.34	0.298063	0.339851		108	48	13.03
7.37	6.46					2.44	20000		22.61
7	6.59						67		27.35
7.73	6.95					0.19	2750		19.92
7.68	8.11	29.86374	57.68	0.59	0.350888		3000		21.6
7.33	9.39					0.06	3500		15.14
7.15	11.59					0.99	6200		13.62
7.41	11.85						31		16.76
6.98	7.62					19.96	11200		8.51
7.13	9.48						16		9.48
6.63	12.73						23		5.3
6.49	13.07						26		5.22
7.23	17.99						15		0.99
6.94	16.81					9.73	480		1.21
7.18	6.36					9.85	63		2.08
6.53	17.29						13		2.9
7.1	13.01					9.13	19	220	6.02
7.19	12.21						10	59	8.28
6.05	11.41					13.41	141		15.17
5.82	11.95						142		15.76
7.22	8.51					8.03	0		16.52
6.71	9.07						167		16.47
7.1	6.47					0.12	670		20.9
6.17	6.92						70		25.14
9.39	11.52						90		32.31
6.4	9.43						3400		15.63
7.1	12.77					0.02	370		12.22
7.75	11.81						520		12.6
6.65	8.42					0.4	1830		9.86
6.77	7.52						13		10.2

6.9	10.74					0.3	910		6
6.16	11.65						15		8.06
6.78	14.33					0.6	470		5.19
6.94	12.72						2		5.32
7.37	0.72					0.1	230		3.05
6.39	15.98						4		4.94
7.1	15.57					0.4	4200		7.76
6.47	15.15						4		8.79
6.57	11.1					0.2	620		15.6
6.65	9.18						10		17.18
6.9	9.08					0.3	7200		15.24
6.5	9.33						51		14.75
6.84	5.17					0.6	350		20.5
7.07	9.53					0.05	10		19.89
7.21	4.82						179		20.41
7.34	3.49					0.003	29		14.74
7.27	8.98					0.1	34		12.38
7.08	5.13					10.97	5800		9.24
6.29	12.28					7.51	60		5.19
6.88	16					5.41	33		1.24
7.3	8.23					4.77	41		2.14
7.22	10.32					3.2	9	71	6.73
5.7	11.23					5.79	127		14.1
6.75	8.35					3.26	870		15.49
6.88	5.99					0.81	320		21.45
6.72	6.7						5300		21.55
6.62	3.81					0.05	94		22.88
6.79	6.34						2		23.01
6.84	8.39						4800		25.01
6.79	8.91					0.01	31		15.52
6.35	9						20000		16.38
7.02	12.09					0.1	320		11.05
7.3	10.35						420		12.79
6.68	4.27					4.58	1670		9.65
6.87	10.17						64		8.39
6.4	12.16					4.54	630		5.27
6.28	12						590		5.57
7.2	16.58					2.69	28		2.29
6.88	14.27						310		5.88
7.28	2.95					2.17	28		0.45
6.86	16.37						28		3.74
7.51	12.94					1.83	48	83	4.73
6.65	15.52						12		6.42
6.14	11.93					3.39	12000		12.84

6.69	10.04						38		15.69
6.93	10.11					3.18	61		16.13
6.77	9.18						630		15.84
8.7	9.9		57.92				220		16.7
7.7	9.2		68.20				72		14.8
8.7	11.2		60.06				230		17.2
8.51	9.63		58.29			3.17	80		23.19
8.48	10.34		64.53				150		22.86
7.89	8.72								19.1
8.61	10.38					7.59	50		20.21
8.49	10.84								19.06
7.49	9.56		55.64				46		19.95
7.58	9.36	74.37985	84.33	1.18	0.601136		66		18.25
8.53	10.99					5.33	58		16.85
8.48	10.27								16.52
7.93	10.11						250		12.92
7.94	10.24								13.02
7.73	10.3								13.25
7.41	10.21								12.53
7.89	11.38						16		9.23
7.71	11.46								9.06
7.19	11.41								9.22
6.84	11.2								8.93
8.15	15.44						18		3.22
8.38	15.54								4.91
7.23	14.75								3.81
7	14.18								3.6
7.82	12.47						14		4.49
7.93	12.95								5.42
7.22	12.88								3.11
7.13	12.89								3.09
7.62	13.62						2		5.42
							2		
7.74	13.55								5.97
7.16	13.46								5.49
6.48	13.64								4.66
8.03	11.12					22.56	4	615	13.82
7.78	11.95							663	14.24
6.9	10.56							363	12.1
6.1	11.16							212	10.53
8.38	11.68						10		15.53
8.26	11.81								15.18
7.6	11.45								13.74
7.65	11.85								11.96

8.22	10.19						44	447	15.56
							52	446	
8.15	10.94							526	13.53
7.76	9.86							305	14.67
7.59	10.34							194	13.51
7.85	9.53								20.76
7.81	10.3								19.62
7.86	9.5								15.85
7.55	10.65								12.68
7.53	11.23								10.3
7.92	14.78								3.74
7.86	13.23								3.59
7.73	10.88							609	13.07
7.91	11.04								16.33
7.75	10.85							495	13.21
8.15	9.1								20.56
8.09	10.74								20.23
7.93	9.64								15.75
7.97	11.03								11.28
7.52	11.05								9.81
8.14	15.04								4.39
7.62	13.01								3.75
7.71	13.61								5.7
7.71	10.95								12.26
8.25	11.49								14.99
7.75	10.43							517	12.92
6.66	7.39								16.15
7.21	9.95								16.07
7.05	8.84								15.82
6.96	8.62								15.25
7.12	9.61								14.98
6.98	8.38								14.93
6.64	8.07							1470	15.32
6.77	11.67								15.34
6.8	7.86							1240	15.71
8.82	8.98								18.74
8.91	9.8								17.22
8.87	10.58	15.30641	45.53	0.53	0.528717		18		19.33
8.55	10.24								15.87
8.38	10.21								14.26
8.23	10.92								11.71
8.42	13.99								6.48
7.99	11.32								10.4
7.97	12.79								9.22

7.79	11.31							1010	13.03
8.43	12.32								15.97
8.37	9.94							1380	15.62
8.79	8.46	4.190144	19.50	0.198708	0.33336		10	1500	15.19
7.61	7.97					0.08			20.39
7.59	9.05					0.08			17.53
7.71	8.85	61.59482	69.29	0.86	1.055568				22.2
7.44	7.97					0.01			14.65
7.79	10.49					20.91			12.54
7.38	11.39					7.05			9.08
7.44	15.32								3.92
7.02	12.51					1.27			4.08
7.06	12.98					19.7			6.63
6.67	10.89					1.87		651	11.48
7.9	12.21					7.07			12.15
7.98	9.93							577	14.27
7.2	8.4		54.54				120		15.3
8.5	9.7		66.81				3000		15.5
8.5	9.6		53.76				2000		15.1
8.18	7.89						112		23.13
8.16	9.27						76		23.59
7.42	8.43						80		22.09
8.2	12.32						56		20.32
8.33	11.31						64		20.03
7.74	10.19						70		20.5
8.13	10.42	42.38227	69.45	0.64					23.18
7.98	9.45	38.61304	67.08	0.64	0.523717				21.04
7.6	8.53	44.66174	68.79	0.75	0.746953				24.28
8.19	11.31						42		16.04
8.41	9.1						88		18.47
7.61	7.57						6		17.53
8.14	10.671						42		14.77
8.2	10.38						4		13.92
7.48	10.05						14		13.48
7.74	10.76						180		11.69
7.52	10.96						400		11.17
7.43	9.56						64		12.44
7.89	13.58						160		4.32
7.82	12.76						10		6.19
7.67	11.28						20		7.68
7.8	12.29						750		5.31
7.58	11.91						44		4.83
7.96	12.23						4		4.13
7.56	13.1						2		6.24

7.06	12.66						8		7.98
6.88	12.59						10		7.47
7.73	10.84						260	759	14.18
7.59	9.97						40	463	14.68
6.95	9.63						26	386	12.96
7.99	11.3						38		15.88
7.87	9.55						20		16.43
7.51	9.34						8		15.49
8.03	10.29						490	630	16.12
7.83	10.1						500	406	15.49
7.61	9.81						200	248	14.43
8.17	8.99		81.88				118		19.87
8.22	10.59								18.57
7.5	10.5								12.98
7.63	10.97								11.24
8.01	13.92								5.25
7.98	12.98								3.62
7.77	13.85								4.94
7.94	10.45							95	13.38
7.48	10.68								16.79
7.62	10.09							103	15.97
6.1	9.42	84.00733	89.55	1.19225	0.992524		5	55	16.82
8.3	9.08								17.5
8.15	7.52					0.18	260		25.14
8.18	8.49						12		19.3
8.15	11.79					0.05	170		22.24
8.16	12.5						12		18.32
8.07	9.38	19.80245	53.30	0.37	0.524755				24.83
8.11	11.23	25.24835	51.65	0.48	0.674519				19.96
8.14	10.56						10		14.59
8.08	10.15						32		16.67
8.13	10.13						42		15.01
8.1	10.9					2.52	8000		12.23
7.94	10.39						6		12.55
8.16	13.66					3.09	420		6
8.12	12.08						12		9.25
7.85	12.57					1.64	34		4.97
7.86	11.56						6		7.67
7.73	12.96					12.81	2		7.03
7.75	12.7						2		8.18
8.04	11.23					2.51	74	617	13.66
7.85	10.82						60	987	12.48
8.17	10.81						112		16.79
8.16	11.27						2		15.01

8.13	9.03					2.37	380	591	19.87
8.14	10.22						16	989	15.9
7.84	9.15					6.16	170		19.99
8.23	8.52								22.07
8.04	10.37								22.02
7.83	12.83					4.9	22		17.74
8.13	10.88							2660	20.53
8.22	11.5							2660	21.93
7.74	10.98	22.60129	54.10	0.53	0.748686				19.31
8.15	11.71	27.75961	63.61	0.53	0.672287		24		19.7
8.14	9.32	41.23113	74.34	0.48	0.60307		18		23.45
7.86	10.79					4.49	12		15.27
8.32	12.04								15.42
8.18	10.25								15.82
7.84	10.49						16		14.7
8.2	10.8								13.96
8.05	10.29								13.73
7.7	11.55					14.99	2		12.08
7.89	11.62								10.12
7.74	11.23								10.63
7.5	12.58					10.72	4		8.06
8.07	14.13								4.22
7.63	13.65								4.52
7.5	11.1					11.35	4		7.72
							4		
7.7	12.18								4.48
7.42	11.76								5.49
7.28	12.57						2		8.65
7.3	12.63								7.11
6.78	12.66								6.95
7.42	10.64					18.67	8	1440	13.8
7.76	10.93							697	12.44
7.16	10.24							500	12.14
7.67	11.5					30.25	16		15.49
8.16	11.21								14.26
7.6	11.06								13.3
7.69	10.32					21.23	16	1200	16.15
8.12	10.24							650	15.77
7.87	10.1							485	16.08
8.02	10.16					3.4134		1070	8.04
7.99	12.27					2.49		1600	4.4
7.87	10.83					6.1		1060	9.39
8.31	11.31					7.35		1150	7.5
7.75	10.36					13.25		835	11.39

7.16	9.53					21.34		975	16.75
7.48	9.87					12.76		1130	15.98
7.61	7.76					3.65		1470	17.56
7.51	8.57					8.75		1310	19.68
7.61	8.96					4.26		1630	19.53
7.77	8.1					4.36		2290	15.93
7.74	9.46					10.95		998	14.24
7.03	10.89					17.36		1250	14.52
6.98	6.45								14.02
7.6	7.49					0.56			21.62
7.62	10.48					0.5			20.33
7.01	9.99	10.93667	23.37	0.26	0.29875		14		18.99
7.68	10.22					0.41			16.38
7.54	9.71								15.1
7.37	10.26					3.23			13.71
7.56	11.57					2.7			10.16
7.35	10.47					1.47			9.91
6.48	11.23								11.74
6.79	9.91					5.16		3940	14.39
7.11	18.63					6.23			15.15
7.09	9.83					3.37		2120	16.21
6.96	9.73								16.32
7.27	8.95								14.73
7.31	10.07								11.65
7.38	11.68								7.33
6.89	13.12								5.82
6.99	10.19							475	11.28
7.47	10.37								15.13
7.28	8.46							408	18.94
7.5	11.49								8.54
7.17	7.82					0.07	12		26.19
6.69	8.16		71.88						22.62
7.43	9.87						6		16.1
7.18	10.99					8.86	44		11.34
7.2	13.39					2.24	2		4.87
7.45	12.78					3.39	6		2.62
6.92	12.85						2		6.98
6.92	9.86					7.74	2	212	14.71
7.18	9.81					10.23	2		15.38
							2		
7.2	9.51						10	190	16.21
7.63	8.11						4500		26.15
7.12	9.15						6		23.08
7.82	9.27						88		22.62

7.78	9.76						16		21.29
7.35	9.63	46.00054	62.34	0.64	0.746892				21.44
7.8	8.79						24		19.02
7.62	8.96						4		17.83
7.74	10.46						26		13.83
7.53	10.42						6		13.14
7.38	11.15						8		10.58
7.3	10.37						4		11.78
7.6	13.98						52		3.74
7.68	13.66						2		3.95
7.72	13.39						30		0.75
8.13	12.92						2		2.13
7.02	12.74						4		7.69
7.2	12.83						2		7.58
7.05	9.84						20	151	14.4
7.49	10.05						2		13.79
7.4	9.56						96		16.37
7.34	9.56						2		10.1
7.57	10.32						10	168	14.83
7.54	10.48						100		13.94
7.47	8.99								21.25
8.17	10.65								20.03
7.94	8.83								18.16
8	10.12								13.78
7.54	10.97								10.74
8.03	13.5								4.26
7.96	15.02								0.3
7.38	12.97								7.03
7.81	10.28							75	12.88
7.16	9.91								13.95
7.56	10.56							74	13.57
7.53	7.97								22.33
7.9	9.84								20.96
7.78	8.01								17.67
7.79	9.92								13.42
7.59	10.88								11.06
7.64	13.43								4.09
7.65	15.24						110		0.09
7.26	12.96						6		7.37
7.58	10.61						170		13.34
7.58	9.84						120		14.31
7.83	10.24						2100		14.79
7.5	10.13								18.05
8	12.32								17.08

8.02	9.76								16.3
7.96	10.48								13.92
7.71	11.16								11.01
7.84	12.65								7.07
7.93	13.1								5.42
7.45	12.45								8.25
7.49	10.22							333	13.87
7.72	9.63								15.24
7.87	10.44							287	14.07
7.8	8.5		56.90				30		15.1
7.56	9.3					6.9			17.84
7.28	9.12								18.81
7.98	11.96					4.4			17.23
7.72	10.97								19.11
7.94	9.32	63.41756	77.85	0.91	1.045752		26		19.12
7.59	9.74		65.67				26		19.91
7.99	9.55					5.51			16.41
7.49	8.66								16.48
7.96	9.81								14.68
7.27	9.96								11.59
7.88	10.14					9.13			12.15
7.3	10.24								12.02
8.06	11.13					6.06			9.96
7.7	12.55								5.74
8.02	12.06					7.21			8.93
7.76	14.76								0.83
7.57	12.11								9.13
6.94	12.53								7.99
7.7	9.66					9.19		896	15.49
6.85	10.49							483	11.36
7.99	9.87					13.15			14.79
7.47	12.33								11.54
7.97	10.1					11.67		826	15.37
7.39	10.61							514	13.3
8.03	11.49								10.44
7.7	11.08								11.63
9.68	9.8					6.17		1020	15.85
7.97	9.83					7.56			15.25
7.91	9.55					8.13		987	16.1
7.35	8.58	61.69302	77.82	0.69	0.717755				17.5
6.78	12.23	73.87556	86.43	0.992063					5.25
7.29	6.96								25.52
7.07	8.37								23.47
7.27	7.52								19.87

7.37	9.53								13.35
7.34	9.54								13.04
8.49	13.03								4.17
9.02	13.9								2.41
8.66	13.21								5.45
5.75	9.58							1520	14.48
7.64	9.54								15.89
9.37	9.08							1420	18.46
6.91	8.95								18
							300		
6.89	10.39						240		19.88
7.53	9.35		71.38		0.671772				20.43
7.48	10.17								13.13
7.38	10.25								12.08
7.4	13.11								5.75
7.02	14.69						64		1.59
7.65	12.65						2		7.88
6.72	10.59						76	369	12.71
7.86	10.11						58		14.15
7.85	10.71						2100	330	13.39
6.3	5.2		66.07				20		14.9
6.82	8.41						35		20.45
7.36	9.61						56		20.59
7.17	9.11	54.25017	75.39	0.8	0.671714				19.76
6.21	2.02						2		16.5
7.43	10.02						18		13.28
7.36	10.36						76		12.18
7.18	12.69						34		5.7
6.65	14.54						2		0.13
6.57	12.58						4		7.42
6.48	10.25						2	293	12.25
7.43	9.73						2		15.08
7.51	10.49						10	247	13.78
6.55	8.48						8		22.66
5.71	9.94						2		21.43
6.74	9.03	60.81486	77.77	0.91	0.820988				21.73
6.6	10.22						2		13.24
7.08	10.39						18		12.08
7.05	13						4		5.34
6.68	14.75						2		0.1
6.67	12.69						8		7.25
6.46	10.39						1	120	12.26
6.99	9.89						2		14.1
7.41	10.59						20	108	13.06

7.9	8.1		70.49				26		15.8
7.47	8.31						140		21.87
6.98	9.05						14		13.82
7.18	10.08						950		11.85
6.9	9.8						105		10.81
6.99	10.73						82		5.68
7.48	10.24						2250		5.19
6.99	12.66						70		4.59
7.32	10.25						1200		13.58
6.67	9.13						220		14.13
6.81	9.81						1100		16.96
8.15	8.79						28		20.09
7.89	8.9						6		22.5
8.31	8.38						10		21.51
7.63	8.31						2		19.67
8.44	8.07	38.6328	72.16	0.59	0.67148				25.4
7.67	8.18	21.4327	57.46	0.48	0.430492				22.19
8.3	9.57						6		13.4
7.62	9.43						6		13.01
7.8	9.23						116		13.38
7.42	9.28						90		12.82
7.91	9.49						12		10.88
7.48	9.3						4		10.24
7.87	11.1						6		5.45
7.37	11.01						2		5.08
							2		
8.38	12.46						10		5.61
7.51	12.5						20		4.68
							30		
8.52	10.31						2		5.3
7.75	11.35						2		4.17
8.09	9.12						2	901	13.19
7.49	8.81						2	835	12.65
							2	840	
8.14	8.71						2		15.36
7.71	8.62						2		15.51
7.93	8.3						40	864	17.78
7.58	8.29						108	820	18.13
8.57	10.38						380		20.77
8.57	9.91						46		20.69
8.59	9.24	17.71693	52.27	0.37	0.523161				23.53
8.51	9.91						36		14.73
7.81	9.28						100		14.39
7.93	10.67						36		10.27

7.69	11.85						72		5.27
8.86	13.65						10		4.66
9.28	9.73						4		11.29
8.65	9.89						34		14.96
8.54	8.66						110		16.63
8.31	8.49						300		11.59
7.5	9.1		67.17				170		15.4
7.66	7.8								19.37
7.55	7.96								18.38
7.54	9.25								14.12
7.28	9.24								13.6
7.26	10.27								10.11
7.39	11.31								4.01
8.02	12.89								4.33
7.81	10.83								3.83
7.65	9.54							380	11.01
7.62	9.2								13.33
7.44	9.11							344	14.89
7.25	9.02								15.87
7.42	8.62								15.21
7.57	9.7								13.72
7.41	9.36								12.99
7.19	10.45								10.28
7.44	9.57								10.73
7.61	10.92								11.11
7.85	9.73								10.71
7.39	8.97								13.37
7.06	8.82								14.09
6.97	8.92								14.48
7.7	9.6		59.15				80		13.3
7.78	8.32					1.89			17.88
7.63	9.98								15.94
7.83	8.67					1.41			16.92
7.32	9.09								14.24
7.76	8.34	36.11107	73.36	0.53	0.573971		26		17.87
7.36	8.91	52.75776	71.48	0.53	0.499466		10		15.74
7.61	9.48					4.23			12.8
7.25	9.02								12.62
7.47	9.3					3.52			12.3
7.04	8.72								12.24
7.49	10.3					6.14			9.39
7.19	9.38								10.85
7.77	10.74					4.16			5.19
7.36	9.55								8.81

8.17	11.94					3.74			6.45
7.16	11.25								8.66
8.33	10.9					4.79			6.02
7.51	10.81								7.23
8.03	9.23					4.9		891	12.85
7.17	9.16							1010	10.87
7.8	9.03					4.25			12.24
7.29	9.07								12.27
7.7	8.97					5.03		877	15.11
7.17	9.43							994	13.68
8.4	9.7		57.86				1800		14.8
8.5	7.9		50.98				320		23.6
8.6	9.3		51.45				600		20.1
8.33	9.3					60.6	88		20.18
8.43	9.58						70		21.4
8.4	8.71					12.25	28		22.42
8.83	9.16						28		23.81
8.72	9.97					4.79			22.45
8.5	8.92					33.75	10		22.15
8.5	8.9						12		20.39
8.46	8.36					8.38	56		20.78
8.73	8.29						8		21.11
8.48	9.06								17.83
8.48	8.65	35.991	59.01	0.59					19.03
8.57	8.44	11.13943	50.34	0.32	0.300265				23
8.46	8.81	18.04932	54.20	0.21	0.524301				22.51
8.64	8.43	29.47641	54.45	0.64	0.598101				20.88
8.42	9.85					57.19	78		13.13
8.42	9.2						20		15.06
7.94	9.64					3.14	2		13.57
8	9.31								13.46
8.4	9.88					46.7	200		11.54
8.42	9.94						54		12.39
8.28	9.72					17.58	36		12.85
8.4	10.87						18		9.34
8.38	11.13								9.16
8.27	9.93					67.85	68		8.78
8.36	9.46						4		12.99
8.24	9.71					23.21	8		12.74
8.28	10.41						4		10.1
							8		
8.24	10.52								10.57
8.38	11.15					65.65	40		6.19
8.27	10.44						4		8.49

8.36	10.77					17.17	66		8.34
8.65	12.51						2		4.54
8.59	11.59								6.76
8.52	10.7					104.22	72		9.32
8.58	10.08						16		11.12
8.37	10.32					45.97	50		10.84
7.62	10.7						2		7.9
8.29	11.7								8.45
8.34	10.18					70.43	12		6.53
8.42	10.09						4		8.32
8.21	10.5					35.69	2		7.3
7.93	12.02						2		2.9
7.67	11.73						2		3.13
							2		
8.32	8.8					88.71	30	1400	16.41
8.46	8.8						12		17.41
8.17	9.06					19.74	2	1570	17.66
8.47	8.57					80.51	42		18.77
8.15	9.59						8		17.71
8.27	8.99					27.06	6		18.91
8.72	8.62						2		18.72
8.51	8.05								18.42
8.26	7.86					83.44	110	1250	19.78
8.23	8.69						116		19.53
8.06	8.14					29.37	550	1500	18.33
8.53	9.51	29.90047	66.23	0.34774			2		19.05
8.62	9.14	25.93128	58.89	0.198708	0.239434		28	1550	14.15
8.37	9.18								14.01
7	9.4		64.94				400		12.7
7.41	7.03								20.14
7.32	7.54								19.57
7.33	8.76	50.65964	70.33	0.8	0.825046		22		17.02
7.32	9.43								13.78
7.17	10.08								9.58
6.71	10.02								9.69
6.93	11.17								4.12
8.12	12.56								7.07
7.2	10.98								3.78
6.72	8.9							291	13.57
7.4	8.14								16.84
7.1	8.71							268	16.54
8.58	9.62					1.17	3100		23.54
6.21	8					0.89	100		23.76
8.39	9.66	31.58772	63.14	0.59	0.600303				19.85

8.07	9.15					1.74	950		14.2
7.78	9.72					6.89	2050		12.21
7.77	10.37					9	220		10.75
7.68	11.89					10.32	210		4.51
8.64	11.59					18.19	210		7.87
7.78	12.71					11.07	32		4.37
8.42	9.97					9.01	350		15.28
7.89	9.53					14.06	450		15.38
8.06	9.3					15.52	530		17.77
7.71	8.24								19.87
7.43	5.8								20.69
7.6	9.46								14.03
7.78	9.81								11.35
6.84	9.81								9.33
7.35	11.57								3.32
7.69	12.35								7.56
7.57	10.26								6.95
7.55	9.97							902	9.66
4.89	8.41								17.33
7.12	8.08							561	20.55
7.4	9.26								14.32
7.57	9.79								11.57
6.82	10.42								8.1
7.51	11.7								2.75
7.72	11.68								7.56
7.45	9.99								7.91
7.42	9.95							983	10.02
4.74	8.64								16.81
7.19	8							650	21.06
8.55	8.91								19.35
8.65	8.36								18.71
8.62	9.72								15.62
8.73	9.62								13.84
8.69	9.32								14.83
8.69	9.6								11.32
8.89	11.56								12.4
8.64	9.62								10.86
8.66	8.87								17.95
8.59	7.92								18.57
8.34	8.46							1660	17.86
8.27	10.34	18.41893	63.12	0.298063	0.532851		190	937	13.67
8.36	8.82								20.65
8.36	8.51								18.71
8.37	9.41								15.62

8.42	9.3					14.6
8.32	8.92					15.14
8.43	9.07					13.63
8.52	10.89					11.95
8.36	9.29					12.43
8.21	9.27				1830	13.89
8.3	8.28					18.6
8.14	8.26				2050	18.31
7.95	7.41					27.75
7.93	9.41					9.46
8.78	9.27					10.74
8.68	10.19					7.37
8.87	12.21					6.84
10.03	10.78					5.66
8.42	8.59					15.4
8.78	8.1					17.4
8.18	7.69				1580	21.36
8.15	8.51					26.37
7.97	7.84					20.92
8.04	9.09					15.02
8.08	10.18					11.79
8.03	9.94					11.34
8.12	11.74					5.16
8.24	12.49					7.09
8.04	11.29					5.21
8.02	10.16				1280	10.28
7.92	8.39					17.44
7.96	8.3				1220	20.33
7.39	10.32					9.51
7.72	13.43					5.38
7.56	12.05					3.24
7.48	11.1				536	6.96
7.84	8.77					15.06
8	9.8	51.64		520		15.1
8.2	8.9	51.10		35		16.3
8.2	9.7	45.53		27		13.4
7.83	7.08		11.41	4000		25.53
8.01	5.31			1100		24.78
7.93	6.91					23.04
				1500		
8.05	7.43	61.84		116		24.45
7.92	7.36	63.72		10		23.32
8.01	9.35		2.14	74		22.84
7.83	9.21			200		22.68

8.06	9.17						58		22.19
8	9.06								21.98
7.91	8.87								21.96
7.76	8.6	43.06458	56.68	0.59	0.677746		82		22.22
7.74	8.52	30.92949	52.35	0.37	0.527033		210		22.06
			56.38	0.48	0.602324		150		
7.93	16.02	20.18793	56.13	0.37	0.378837		86		20.25
7.61	9.54						4000		14.17
7.73	9.83						200		13.39
7.74	9.49						410		15.03
7.69	9.49								15.37
7.81	9.84								14.12
7.59	10.1						220		10.96
							750		
7.79	15.03						1050		9.5
7.71	11.18						220		11.26
7.9	11.05								11.46
7.66	11.03								11.01
7.76	12.38						10		7.93
7.75	12.4						44		9.13
7.75	12.7						10		9.49
7.66	10.48								12.35
7.8	11.13								10.21
7.58	10.39						180		5.19
7.51	10.44						230		5.66
7.66	9.99						16		6.62
7.6	9.63								6.58
7.88	10.41								3.94
7.42	14.02						70		5.5
7.33	14.09						60		6.02
7.5	13.05						12		5.57
7.79	12.61								5.44
7.38	14.49								4.76
7.16	13.72						22		2.76
6.71	13.61						140		3.4
7.61	11.33						10		7.96
7.88	11.84								7.66
7.59	12.54								6.43
7.82	14.15					28.78	20	1180	6.69
7.91	13.43						4	1300	8.33
8.11	13.54						6	3170	8.72
8.21	13.79							3420	8.43
8.2	14.62							2960	5.37
6.36	10.5					39.11	230		13.27

7.2	10.94						500		12.08
7.89	10.59						2		14.73
8.06									13.05
7.58									11.1
7.76	10.02					38.78	320		16.86
7.99	10.33						110		18.35
8.01	10.3						750		18.32
8.11	10.07								17.19
8.07	10.75								14.26
8.04	9.05								12.17
8	7.61								25.92
7.4	6.03						10000		25.53
6.82	1.4						11000		21.37
7.52	9.72						1650		13.8
7.67	12						550		9.5
7.3	11.46						36		8.43
7.38	10.32						270		4.45
7.11	13.29						200		5.66
6.82	13.52						560		2.9
7.29	13.56						10	86	6.23
6.28	10.79						20		12.38
7.23	9.67						330		18.18
8.15	8.88								27.08
							20000		
8.18	9.3					0.01	110		26.71
7.71	9.8						2000		14.21
7.8	12.42								10.07
							230		
7.66	12.87						8		8.56
7.47	10.34						835		5.1
7.43	14.18						84		5.92
7.88	12.37						100		8.01
7.55	13.65						4	148	8.13
8.28	11.24						6		16.75
							10		
7.87	10.19						450		20.51
7.55	7.18								23.65
							1350		
7.6	7.78						800		21.55
7.7	15.26	27.43636	52.90	0.53	0.68191		370		18.22
7.62	9.66						2050		13.76
7.57	11.26						300		10.44
6.98	12.75						210		7.36
7.46	10.12						160		5.11

7.7	13.39				200		5.44
7.73	11.52				3450		8.12
7.66	14.4				8	646	5.24
8.09	11.18				44		11.73
7.47	10.53				250		15.5
7	9.3	62.58			520		13.6
7.33	6.64			0.01	1050		27.41
7.79	9.45			0.2	14		14.2
7.42	11.37			0.5	60		9.89
6.94	11.12			0.58	2		9.03
7.88	10.28			2.14	18		4.48
6.49	13.7			2.28	370		4.91
7.01	13.14			1.38	2		3.17
7.73	12.81			0.61	2		8.95
5.36	10.6			1.15	4		11.05
6.34	9.64				108		17.64
7.77	7.69						24.85
7.91	8.64						22.06
7.36	8.52						18.76
7.66	10.12						14.21
7.21	9.74						13.83
7.58	8.57						8.97
7.36	11.91						8.08
7.24	11.44						7.49
7.79	13.14					4010	7.71
7.82	10.27						13.58
7.8	10.08						16.19
7.41	10.54					4210	13.99
6.39	4.44					4340	7.59
8.28	7.3						26.91
7.89	8.33						23.9
8.72	10.21						13.61
8.48	11.09						11.53
8.66	10.83						12.1
9.04	9.87						6.26
8.71	13.25						5.7
8.43	11.4						8.86
8.41	13.46					4210	8.34
8.77							14.71
8.74	9.53						19.8
8.1	8.32						25.03
8.08	9.35						20.84
7.97	9.9						13.73
7.98	11.39						10.38

8.03	11.11					10.88
7.92	10.29					4.83
7.74	14.66					4.81
7.98	12.44					7.38
8.33	14.82				3530	5.15
8.11						10.9
8.22	10.37					15.18
7.8	9.2	51.08		180		15
7.91	7.13	71.91	7.69	14		28.38
7.81	7.51					25.41
7.99	7.18	76.29		54		23.96
7.97	7.5	60.61		26		26.96
8.02	8.88		2.28	30		22.35
7.82	9.06					21.93
7.84	8.96					21.17
8.12	8.44					23.31
8.03	10.59		2.66	2		17.63
				2		
7.79	10.14					18.48
7.64	9.92					17.85
7.74	10.42		36.27	12000		14.25
7.52	10.5					14.26
7.82	10.5					13.74
7.85	10.55					14
7.71	10.02		22.31	30		12.07
				20		
7.63	10.1					11.93
7.69	10.03					11.81
7.74	10.47					11.06
7.8	12.23		27.52	10		8.53
7.76	12.31					8.26
8.13	12.49					7.65
8.05	12.43					7.15
8.03	15.11		15.23	4		3.52
				2		
7.95	15					3.42
8.09	15.03					3.03
7.78	14.81		57.14	2		6.16
7.69	14.52					6.26
8.07	13				970	6.15
8.11	12.98				1170	6.53
7.89	9.24		35.25	2	948	13.31
				2	943	
7.98	9.8				1040	13.07

7.99	9.82							1000	12.6
7.13	9.97							178	12.15
8.01	12.87					22.37	22	1090	7.46
							20	1090	
8.05	13.09							1190	7.63
8.1	12.89							1120	8.03
7.9	13							692	6.95
7.87	8.79					32.35	44	860	16.86
7.89	9.22							966	15.34
7.99	9.28							934	15.5
8.05	9.27							1090	15.88
7.9	9.63					4.4049		1590	15.97
7.97	13.2					7.61		1520	2
7.88	11.12					12.66		1210	9.03
8.29	11.72					19.64		1070	5.05
								1070	
7.79	11.39					42.3		1010	8.78
7.74	10.09					33.53		804	14.74
8.13	9.49					14.23		1100	17.31
8.02	7.51					7.43		1560	20.18
8.07	7.67					10.35		1540	24.7
7.89	8.17					2.47		1650	26.19
7.98	8					3.44		2790	23.23
7.98	10.63					22.61		2530	12.85
7.93	10.18					28.67		1370	17.54
7.42	4.88								22.1
7.1	11.82								12.36
6.45	8.58								11.8
6.79	10.64								8.3
7.12	13.22								5.26
7.35	14.85								5.93
7.1	9.89								9.08
7.64	12.37								8.23
7.35	9.49								13.34
6.79	6.91								25.77
6.24	7.8								16.55
6.75	6.62								16.95
7.04	10.82								13.78
6.87	10.15								11.21
6.89	12.24								8.38
6.49	15.07								3.01
6.85	14.52								5.25
6.27	9.98								11.33
7.21	13.02								6.65

6.96	9.38								13.98
5.42	6.89								21.04
6.42	10.94								12.99
5.49	10.02								11.18
5.46	12.05								8.54
5.54	15.48								1.81
5.12	13.02								5.05
4.65	10.32							203	11.66
5.05	12.98								5.8
5.05	9.62								12.98
7.6	8.6		64.09				10		15.2
7.58	7.8		61.21				20		22.35
7.64	8.65								20.85
8.13	9.76								17.35
7.64	9.74								17.82
7.62	10.51								13.3
7.66	9.98								11.49
8.07	12.24								8.31
8.13	14.71								3.6
8.09	12.98							1210	5.86
8.16	9.81							1360	12.78
8.22	12.9							1580	7.53
8.1	9.07							1330	15.53
8.06	10.96	34.21829	69.01	0.695479	0.762092		28	664	12.42
7.9	9.3		64.44				5800		19.2
8.03	9.78					20.63	1450		23.19
7.97	9.31						330		24.36
7.85	9.05						44		24.57
7.91	9.22					3.9	180		21.72
7.96	9.29						290		21.71
7.72	9.14						46		21.75
8.19	8.99	31.61371	71.05	0.43			500		23.35
7.95	10.21					5.65	20		18.71
7.88	9.93						42		18.73
7.65	9.52						2		18.43
7.52	16.28					27.4	210		9.75
7.43	12.06						290		12.3
7.44	12						90		12.32
7	9.93					48.19	96		7.9
7.35	10.31						12		9.65
7.35	11.06						4		9.58
7.4	12.28					90.84	74		6.6
							84		
7.4	12.28						4		6.56

7.26	12.39						2		6.24
7.62	16.57						40		0.16
7.59	16.56						30		0.67
7.81	16.49						16		1.02
7.33	13.12						2	596	6.46
7.21	13.17						2		6.61
7.78	13.46						2	1080	5.98
7.39	9.22					67.53	70	637	11.55
7.39	9.36						116		11.39
7.57	9.44						4	1100	11
7.7	13.49					51.51	1100	753	7.04
7.39	13.06						350		7.49
7.81	12.79						8	1270	7.52
7.66	9.25						1000	647	15.23
7.75	9.85						380		15.07
7.78	9.47						24	1160	16.96
7.84	9.2						10000		24.29
7.83	10.41						4000000		22.45
							180		
7.75	8.91	30.50648	60.52	0.43	0.757785		19000		22.26
							1500		
7.45	7.67						5400		18.69
7.26	12.39						180		12.07
							250		
7.11	10.3						68		10.02
							12		
7.27	12.32						106		6.96
							34		
7.21	16.61						500		0.14
							18		
7.11	13.39						10		6.03
							62		
7.19	9.54						110		11.04
							210		
7.32	13.54						5600		7.35
							560		
7.63	9.7						23000		15.63
							410		
7.9	8.7		74.05						17.5
7	8.1		85.28				52		15.7
7.99	9.48					9.4	1750		23.39
8.01	9.53								21.52
7.89	8.82					2.65	240		21.37
7.91	9.73						1100		19.56

7.99	8.96	31.22895	70.90	0.37	0.529766		260		22.68
7.92	9.73					2.69	20		18.5
7.74	11.03								14.64
7.44	14.37					21.81	64		10.59
							100		
7.49	14.61						110		10.2
7.17	10.53						22		8.14
7.4	10.35						120		9.22
7.48	12.6					51.71	8		6.47
7.68	12.46						2		6.81
7.89	16.09					16.32	50		0.8
8.07	16.22						34		1.32
7.59	12.95					88.71	2	503	6.79
7.84	12.74						2		7.38
7.52	9.09					34.09	76	618	11.13
7.77	9.49						4	451	10.63
7.83	12.89					29.43	180	669	7.31
7.95	13.29						40	454	6.17
7.71	9.65						550	525	14.66
7.86	9.59						20	440	14.14
7.95	9.72	46.25425	67.21	0.496771	0.640122		120		14.94
7.68	9.7	23.80866	47.84	0.447094	0.527608		19	654	13.15
4.34	7.06	31.95995	71.16	0.298063	0.418954		2		10.51
8.04	9.81						11000		21.59
7.92	9.75								19.1
7.89	11.9								15.35
7.54	14.11						4000		11.04
7.52	10.35								9.98
7.79	12.3								7.98
7.74	14.53								5.2
7.62	12.19							581	8.59
7.76	9.42							783	12.53
7.7	12.71							785	8.91
7.75	9.43							699	15.74
7.2	8.5		71.15				900		14.4
7	9.52					0.47	30		21.62
6.41	12.22					3.03	10		11.77
5.84	10.11					1.2	2		9.92
6.49	12.46					3.14	2		6.39
6.77	15.98					0.54	2		0.96
5.75	12.91					4.31	2		5.68
5.29	9.45					2	2		10
5.78	12.94					1.59	2		6.42
5.78	9.71					2.12	2		14.01

6.92	9.34	48.12226	66.81	0.8	0.921454		40		19.73
8.33	9.83					0.23	116		27.91
8.06	9.25					0.24	29000		22.29
8.08	7.02	46.10337	67.38	0.64	0.714303		42		19.5
7.79	8.48					0.27	22		21.5
7.41	10.59					1.52	62		13.08
7.06	10.14					6.23	320		9.98
7.02	12					51.06	100		7.85
7.49	16.09					6.5	900		2.7
7.35	13.74					31.95	2		7.19
7.05	9.67					22.6	90		13.14
7.51	11.68					12.94	290		10.88
7.08	8.99					19.4	3200		15.55
6.95	8.02	40.08395	58.01	0.794834	0.824762		16	126	12.46
8.3	8.9		71.72				260		16.3
7.95	8.64					0.64	200		30.5
8.01	10.54					0.41	62		23.77
7.9	8.36					0.49	22		23.13
7.32	10.06					1.56	30		13.99
6.55							24		12.12
7.32	12.56						6		7.74
6.89	14.79					9.47	2		1.97
7.03	12.95						2		3.82
6.76	10.27						2		10.19
7.39	10.39						22		12.84
7.21	8.01					9.37	26		14.29
6.9	4.4						24		15.8
6.88	9.26	82.9263	96.98	1.142573	0.996269		50		13.34
7.5	7.6						200		13.8
6.7	0.8						120		15.6
7.6	9.08					0.1	36		26.25
7.53	8.66					0.07	100		22.16
7.41	7.33					0.1	8		22.03
7.44	9.82					1.55	28		13.75
7.23	10.13						28		9.62
7.21	11.84						6		7.83
7.52	15.74					3.6	2		2.5
6.59	13.79						2		7.41
6.92	8.49					13.8	2		14.43
7.45	12.5					6.98	4		11.57
7.22	8.76					4.93	10		16.52
7.7	8.5		67.55				280		16.7
7.17	7.97								24.77
7.32	8.2								22.79

7.17	8.27							21.22
6.36	11.14							9.97
6.78	10							12.35
7.26	12.1							8.52
6.74	14.57							2.15
7.14	13.65							4.28
6.72	10.76						105	10.1
7.33	11.06						134	11.95
7.33	8.78						133	15.76

Sulfate	Alkalinity	hloride Tot	Al Total	Fe Total	Mn Total	Se Total	TSS	NO2-NO3-N
394	86.4		0.05	0.1	0.02	0.005	3	
322	58.6		0.05	0.12	0.04	0.005	3	
292	105		0.05	0.12	0.02	0.005	3	
283	60.7		0.05	0.78	0.25	0.005	3.2	
433	98.6		0.05	0.1	0.02	0.005	5	
348	77.9		0.05	0.14	0.06	0.005	3	
264	99.7		0.05	0.16	0.04	0.005	5.2	
368	58.7		0.07	0.55	0.24	0.005	3.2	
184	53.2		0.36	0.5	0.12	0.005	31	
158	40.4		0.46	0.43	0.26	0.005	12	
241	83.5		0.05	0.21	0.03	0.005	3	
242	54		0.1	0.26	0.65	0.005	3	
125	39.7		0.58	1.29	0.12	0.005	28	
111	33.3		0.27	0.59	0.16	0.005	9	
92	39.8		0.32	0.62	0.11	0.005	10	
56	23.4		0.21	0.35	0.09	0.005	3	
129	41.4		0.11	0.24	0.03	0.005	4	
88	28.5		0.19	0.44	0.1	0.005	6	
70	29.2		0.22	0.52	0.08	0.005	8	
38	16.9		0.18	0.38	0.05	0.005	5	
172	49.7		0.05	0.09	0.03	0.005	3	
119	34		0.05	0.13	0.11	0.005	3	
77	31.4		1.43	3.36	0.3	0.005	68	
29	13.4		0.97	2.35	0.13	0.005	37	
251	56.6		0.06	0.14	0.15	0.005	3	
193	43.6		0.24	0.61	0.26	0.005	11	
180	59.4		0.06	0.24	0.12	0.005	3	
106	25.6		0.09	0.35	0.13	0.005	3	
161	41		0.5	0.89	0.12	0.005	19	
123	25.5		0.38	0.84	0.18	0.005	13	
137	35.5		0.13	0.32	0.08	0.005	15	
56	15.7		0.22	0.45	0.03	0.005	9	
263	65.2		0.04	0.16	0.076	0.005	3	
178	38.3		0.1	0.28	0.251	0.005	5	
124	43.5		0.06	0.21	0.066	0.005	3	
49.5	16.1		0.49	0.92	0.109	0.005	8	
184	52.2		0.05	0.18	0.048	0.005	3	

138	35.5	0.09	0.25	0.151	0.005	3
135	44.8	0.09	0.2	0.057	0.005	3
60.7	20.3	0.16	0.31	0.052	0.005	3
216	67.8	0.06	0.2	0.03	0.005	3
172	48.9	0.04	0.19	0.103	0.005	3
130	52.8	0.62	1.09	0.128	0.005	25
59.5	26.7	1.19	3.03	0.326	0.005	64
340	11.8	0.07	0.04	0.07	0.005	3
345	11.3	0.07	0.09	0.05	0.005	5
203	16.2	0.37	0.29	0.19	0.005	18
133	13.5	3.71	6.33	0.43	0.005	186
166	14.9	0.26	0.33	0.18	0.005	8
117	9.3	1.64	2.02	0.18	0.005	67
264	10.4	1.21	0.37	0.16	0.005	14
213	8.2	1.75	0.77	0.25	0.005	3
237	9.3	0.55	0.19	0.114	0.005	3.6
216	5.5	1.47	0.38	0.246	0.005	13.2
253	12.3	0.6	0.21	0.145	0.005	6
256	103	0.05	0.06	0.02	0.005	3
275	116	0.05	0.09	0.02	0.005	5.2
113	63.4	0.34	0.83	0.11	0.005	85
72	39.1	0.91	1.74	0.09	0.005	47
72	39	0.92	1.67	0.88	0.005	51
71	37.8	0.25	0.44	0.03	0.005	10
137	68.5	0.05	0.08	0.02	0.005	3
153	68.9	0.1	0.15	0.03	0.005	4
134	55.9	0.28	0.49	0.03	0.005	12
133	54.3	0.26	0.46	0.04	0.005	10
216.8	87.6	0.05	0.14	0.007	0.005	3
137	66	0.09	0.15	0.013	0.005	3.2
173	87.2	0.07	0.19	0.012	0.005	3
52	58	0.05	0.14	0.06	0.005	3
61	113	0.24	0.5	0.1	0.005	6
53	44.3	0.05	0.18	0.06	0.005	5
64	111	0.08	0.26	0.05	0.005	3
55.4	60.4	0.11	0.36	0.042	0.005	5.2
66.9	127	0.11	0.32	0.05	0.005	3

250	97.8		1.35	2.07	0.25	0.005	280	
100	47.9		1.79	3.56	0.2	0.005	96	
85	36.6		0.32	0.6	0.08	0.005	17	
135	54.1		1.13	2.14	0.15	0.005	50	
195	85.5		1.02	1.47	0.08	0.005	34	
159	53		0.58	1	0.06	0.005	24	
226	94.6		0.19	0.38	0.023	0.005	6	
160	63.2		0.47	0.8	0.046	0.005	24	
216	88.7		0.27	0.55	0.038	0.005	13	
530	100	3	0.8	1.3	0.29		63	0.22
678	128		0.05	0.06	0.02	0.005	3	
731	137		0.05	0.08	0.02	0.01	3	
697	141		0.2	0.44	0.03	0.005	11.6	
723	142		0.05	0.12	0.02	0.005	6.4	
675	121		0.05	0.05	0.02	0.005	3	
653	125		0.05	0.03	0.02	0.005	3	
314	73.7		0.42	0.85	0.05	0.005	14	
270	67.5		0.38	0.66	0.04	0.005	12	
266	64.4		0.18	0.3	0.02	0.005	6	
239	63.6		0.17	0.29	0.02	0.005	6	
291	63		0.9	1.75	0.11	0.005	47	
236	55.7		0.85	1.63	0.09	0.005	42	
486	91.7		0.05	0.07	0.02	0.005	3	
490	93.9		0.05	0.07	0.02	0.005	3	
318	79		0.28	0.5	0.04	0.005	11	
315	84.5		0.37	0.66	0.04	0.005	10	
529	94.7		0.06	0.17	0.006	0.005	4	
497	98.6		0.12	0.24	0.008	0.005	4	
356	86.4		0.27	0.43	0.025	0.005	9.6	
359	93.2		1.94	2.89	0.08	0.005	57	
515	114		0.07	0.2	0.01	0.005	3	
485	124		0.15	0.32	0.014	0.005	6	

798	129		0.05	0.08	0.02	0.01	3	
855	136		0.17	0.36	0.02	0.005	3	
871	123		0.05	0.03	0.02	0.005	3	
426	87.8		0.37	0.76	0.05	0.005	20	
349	76.2		0.18	0.34	0.03	0.005	8	
422	77.2		0.72	1.44	0.09	0.005	40	
602	91.6		0.05	0.07	0.02	0.006	3	
393	77.7		0.2	0.37	0.03	0.005	9	
621	0.02		0.02	0.14	0.008	0.005	3	
434	81.3		0.04	0.1	0.009	0.005	3	
605	123		0.06	0.2	0.016	0.005	3	
310	56	2	0.085	0.067	0.02		7	0.55
123	40.3		0.05	0.11	0.04	0.005	3	
126	46.8		0.05	0.24	0.16	0.005	3.2	

128	40.8		0.06	0.14	0.04	0.005	4	
60.4	23.7		0.23	0.43	0.03	0.005	10	
57	21.2		0.11	0.18	0.02	0.005	4	
66	17.5		0.58	1.07	0.07	0.005	28	
89	20.6		0.8	1.63	0.08	0.005	62	
72	18.2		0.11	0.2	0.02	0.005	5	
92.8	19.8		0.06	0.13	0.012	0.005	4	
77.8	21.3		0.08	0.11	0.01	0.005	3	
81.4	26.1		1.44	2.01	0.095	0.005	37	
860	59		0.05	0.05	0.031			
430	73	1	0.05	0.05	0.046		5	0.18
341	37.6		0.09	0.05	0.03	0.005	3	
421	65.6		0.05	0.16	0.03	0.005	3	
581	51.8		0.05	0.06	0.02	0.005	3	
420	65.7		0.05	0.15	0.03	0.005	4	
445	48.9		0.05	0.05	0.02	0.005	3	
383	59.8		0.05	0.18	0.04	0.005	4	
233	29.4		0.28	0.45	0.43	0.005	8	
196	40.8		0.22	0.64	0.07	0.005	7	
198	30.5		0.16	0.3	0.26	0.005	4	
166	37.3		0.12	0.34	0.03	0.005	8	

238	36.5		0.05	0.15	0.34	0.005	3	
243	46.4		0.05	0.1	0.02	0.005	3	
258	29.9		0.27	0.75	0.55	0.005	8	
266	53.4		0.12	0.28	0.03	0.005	5	
197	22		0.24	0.43	0.51	0.005	8	
264	24.5		0.25	0.62	0.743	0.005	4	
214	29.9		0.19	0.39	0.416	0.005	4	
193	28.8		1.56	3.29	0.986	0.005	50	
347	89.8		0.05	0.07	0.02	0.005	3	
154	44.4	2.39	0.39	0.67	0.06	0.005	20.8	0.62
398	101		0.05	0.12	0.05	0.005	3	
328	92.3		0.05	0.07	0.03	0.005	3	
162	63.6		0.16	0.41	0.08	0.005	5	
125	51.3		0.12	0.28	0.04	0.005	4	
152	50.8		0.54	1.31	0.12	0.005	20	
261	61.4		0.26	0.38	0.03	0.005	5	
269	65.7		0.82	1.37	0.07	0.005	35	
249	59.3		0.04	0.18	0.016	0.005	3	
249	61.9		0.04	0.16	0.017	0.005	3	
239	72.7		0.09	0.15	0.019	0.005	3	
191	61.1		3.08	5.67	0.439	0.005	143	
238	79.4	3	0.36	0.5	0.035	0.001	14	0.5
223	180		0.06	0.14	0.1	0.005	3	
182	159		0.06	0.16	0.13	0.005	4.4	
137	143		0.05	0.09	0.07	0.005	4	
73	52.8		0.47	0.75	0.15	0.005	16	
70	42.3		0.29	0.48	0.17	0.005	7	
88	59.9		1.74	3.52	0.78	0.005	77	
76	122		0.25	0.83	0.6	0.005	7	
99	37.8		0.24	0.47	0.32	0.005	8	
173	108		0.11	0.3	0.411	0.005	3	
118	66.8		0.12	0.22	0.32	0.005	3	
119	65.8		0.13	0.23	0.333	0.005	3	
103	80.8		9.86	19.2	2.09	0.005	520	
106	80.7		10.2	19.7	2.11	0.005	528	

5	255	0.16	0.76	0.03	0.005	3.2
5.25	278	0.12	0.65	0.03	0.005	5
5	257	0.091	0.676	0.022	0.003	5
9.2	195	0.104	0.924	0.023	0.003	2
10.8	44.4	0.169	0.56	0.042	0.003	3
8.59	23.4	0.381	0.764	0.07	0.003	13
9.61	82.6	0.068	0.45	0.044	0.003	1
9.27	85.5	0.111	0.492	0.044	0.003	4
11	121	0.05	0.55	0.032	0.005	3
9.2	43.9	0.8	0.97	0.064	0.005	15
9.04	73.9	0.3	0.73	0.06	0.005	11
64.9	113	0.313	0.391	0.121	0.003	4
60.1	95	0.107	0.242	0.177	0.003	3

235	52	0.182	0.403	1.06	0.003	4	
261	51	1.23	0.305	2.07	0.003		
94.9	163	0.21	0.31	0.08	0.005	5	
65.7	84.2	0.1	0.31	0.28	0.005	5	
533	34.4	0.08	0.56	1.31	0.005	4	
432	11.5	0.84	0.32	3.04	0.005	6.8	
107	173	0.202	0.226	0.042	0.003	5	
84.7	67.6	0.08	0.614	0.376	0.003	3	
412	25.2	0.129	0.529	2.47	0.003	10	
481	3.2	2.2	0.657	4.41	0.003	10	
93.5	127	0.198	0.148	0.042	0.003	2	
101	53.8	0.088	0.369	0.318	0.003	2	
101	56.3	0.09	0.371	0.318	0.003	2	
103	43.9	0.293	0.373	0.51	0.003	2	
112	53	1.03	0.446	0.72	0.003	8	
32.5	49.1	0.09	0.323	0.119	0.003	2	
39.5	62.4	0.179	0.346	0.137	0.003	1	
63.7	47.5	0.148	0.142	0.302	0.003	2	
72.4	50.9	0.83	0.332	0.466	0.003	7	
28.2	38.3	0.084	0.195	0.103	0.003	3	
41	65.6	0.09	0.18	0.09	0.005	3	
46	63.8	0.09	0.19	0.1	0.005	3	
53	44.8	0.11	0.14	0.27	0.005	3	
63	49.1	0.55	0.24	0.32	0.005	3	
30.8	38.9	0.088	0.233	0.125	0.003	2	
42	64.7	0.08	0.14	0.09	0.005	3	
55	47.5	0.1	0.16	0.33	0.005	3	
62	50	0.76	0.4	0.47	0.005	7.2	
26.7	32	0.084	0.141	0.088	0.003	1	
38.7	60.1	0.106	0.134	0.077	0.003	1	
47.3	45.6	0.115	0.127	0.23	0.003	1	
40.5	36.5	0.575	0.254	0.232	0.003	5	
43.4	40.5	0.07	0.29	0.134	0.005	3	
41	50.2	0.09	0.18	0.085	0.005	3	
58.8	49	0.08	0.17	0.349	0.005	3	
48	40.6	0.35	0.24	0.249	0.005	4	
21.1	28.6	1.17	1.1	0.104	0.005	15	
29.9	42.8	0.22	0.26	0.069	0.005	5	
33.4	38.6	0.45	0.39	0.175	0.005	6	
29.4	36.5	0.55	0.48	0.165	0.005	5	
28.2	35.5	0.11	0.28	0.065	0.005	4	

34.7	51.2
51.3	56
66.8	60.4

0.12	0.27	0.067	0.005	3
0.18	0.31	0.26	0.005	3
0.7	0.47	0.524	0.005	15

6.6	7.9
4.4	15
5.3	17.5
6.9	10.9
6.6	7.9
6	8.9
6	8.6
7.09	7.6
6.39	7.8
6.31	7.3
6.4	7.3
7	24.5
9.4	3.9
10.8	3.9
13	5
9.79	3
9.76	3
13	5.8
13.4	6.3

0.068	0.264	0.033	0.003	2
0.27	0.62	0.14	0.005	8.4
0.071	0.239	0.039	0.003	4
0.061	0.238	0.018	0.003	1
0.041	0.167	0.092	0.003	3
0.05	0.25	0.14	0.005	3
0.05	0.1	0.05	0.005	3
0.034	0.07	0.072	0.003	3
0.04	0.13	0.054	0.005	3
0.1	0.13	0.037	0.005	4
0.09	0.19	0.07	0.005	6
0.206	0.938	0.124	0.003	27
0.087	0.127	0.011	0.003	1
0.063	0.093	0.009	0.003	10
0.05	0.09	0.02	0.005	3
0.089	0.092	0.011	0.003	1
0.087	0.097	0.012	0.003	1
0.09	0.14	0.022	0.005	3
0.14	0.28	0.017	0.005	3

10.5	6.8		0.17	0.44	0.022	0.005	4	
50.7	56		0.099	0.809	0.508	0.003	10	
81.4	50.8		0.05	0.19	0.3	0.005	5	
74.8	46.2		0.074	0.284	0.404	0.003	2	
52.1	39.5		0.07	0.262	0.29	0.003	3	
35.2	32.9		0.094	0.275	0.144	0.003	4	
43	32.4		0.08	0.36	0.19	0.005	3	
55	34.5		0.05	0.63	0.38	0.005	3	
54	35.1		0.05	0.63	0.4	0.005	3	
36.8	31.9		0.094	0.339	0.182	0.003	4	
50.3	32.1		0.07	0.42	0.244	0.005	3.6	
29.8	28.3		0.2	0.38	0.124	0.005	7	
31.5	34.1		0.21	0.6	0.205	0.005	9	
24.3	38		0.143	1.52	0.422	0.003	37	
64.4	36.5		0.05	2.2	1.29	0.005	6	
48.6	34.9		0.078	1.81	1.09	0.003	1	
19.4	22.7		0.104	1.07	0.247	0.003	4	
14.3	10.9		0.114	0.321	0.069	0.003		
22	14.6		0.11	0.24	0.07	0.005	3	
31	19.9		0.11	0.2	0.09	0.005	3	
18.4	12.1		0.113	0.23	0.076	0.003	3	
18.6	14.5		0.06	0.29	0.095	0.005	3	
18.4	14.4		0.06	0.27	0.096	0.005	3	
13.4	11.8		0.22	0.31	0.04	0.005	4	
15.6	15.1		0.18	0.43	0.061	0.005	9	
5	134		0.104	2.21	1.44	0.003	8	
8.26	143		0.07	3.46	1.09	0.005	11	
16.6	28.7		0.515	0.842	0.054	0.003	10	
16.6	26.2		0.133	0.297	0.033	0.003		
18	25.2		0.1	0.27	0.04	0.005	3	
20	31.3		0.16	1.58	0.13	0.005	3.6	
17.2	25.5		0.093	0.242	0.04	0.003	2	
19.5	24.4		0.05	0.5	0.077	0.005	3	
16.5	24.9		0.35	0.36	0.037	0.005	3	
18.7	33.5		0.16	0.43	0.074	0.005	3	
47	200	7	0.051	0.37	0.039		5	0.1
80.9	73.3		0.12	0.72	0.07	0.005	5.6	
36.3	100		0.12	1.06	0.2	0.005	8.4	
49.7	181		0.33	0.69	0.12	0.005	14	
60.4	164		0.21	0.71	0.12	0.005	7	
55.4	188		0.25	1.06	0.25	0.005	14.8	
55.2	187		0.23	1.1	0.27	0.005	10	
52.3	206		0.17	0.41	0.06	0.005	5	

59	31.9	0.45	0.85	0.12	0.005	12
59.4	176	0.194	1.36	0.239	0.003	9
50.1	192	0.148	0.41	0.048	0.003	3
50.5	113	0.126	1.23	0.203	0.003	7
58.8	142	0.165	0.51	0.056	0.003	2
26	43.7	0.09	0.54	0.11	0.005	3
20.5	28.4	0.202	0.678	0.12	0.003	6
25.3	49.2	0.114	0.391	0.09	0.003	4
21	28.6	0.15	0.4	0.4	0.005	3
12.6	15	0.676	1.16	0.122	0.003	28
23	39.4	0.088	0.263	0.078	0.003	5
51	64.6	0.05	0.38	0.11	0.005	3
31.6	36	0.56	0.987	0.156	0.003	15
22.9	45.6	0.153	0.385	0.096	0.003	4
24	24.2	0.12	0.35	0.1	0.005	8
21.4	38.1	0.123	0.49	0.124	0.003	2
22	51	0.106	0.343	0.08	0.003	3
29.8	46.5	0.12	0.59	0.072	0.005	5.2
36.7	43.2	0.1	0.57	0.15	0.005	4
32	53.3	0.07	0.32	0.089	0.005	4.8
20.2	31.24	0.88	1.19	0.11	0.005	25
25.4	37.5	0.19	0.57	0.104	0.005	6
25.3	45.4	0.14	0.32	0.061	0.005	4
23.1	37.7	0.19	0.71	0.074	0.005	4
21.2	39.9	0.63	0.13	0.998	0.005	5
21.4	46	0.25	0.55	0.06	0.005	9
21.7	46.2	0.25	0.54	0.06	0.005	8
21.17	41.7	0.33	0.88	0.097	0.005	10
7.8	19.3	0.24	1.71	0.36	0.005	6
10.5	75.8	0.05	1.18	0.29	0.005	3.6
8.4	50.6	0.07	2.84	0.749	0.01	4

12	29.9	0.121	2.13	0.403	0.003	2
12	8.4	0.106	0.554	0.112	0.003	9
12.2	99.7	0.142	0.716	0.136	0.003	2
10.7	6.8	0.12	0.37	0.088	0.003	2
9.59	5	0.244	0.532	0.066	0.003	4
9.87	10.5	0.09	0.73	0.203	0.005	4
9.22	10.5	0.25	0.87	0.177	0.005	6
9.13	13.7	0.14	0.67	0.121	0.005	5
189	5	2.84	0.15	2	0.005	3
264	5	1.2	0.18	1.39	0.005	4

75	5.9		0.98	0.76	0.345		15	
125	5		1.77	0.41	0.771		6	
91.8	177		0.05	1.11	0.3	0.005	3	
85.8	175		0.05	1.1	0.3	0.005	3	
173	315		0.05	0.78	0.15	0.005	3	
18	137		0.078	0.861	0.275	0.01	2	
18.4	126		0.073	0.908	0.288	0.01	1	
10	11.8		0.122	0.343	0.083	0.003	2	
9.9	14.4		0.176	0.459	0.082	0.003	8	
14.4	21.2		0.302	0.67	0.092	0.003	5	
14.6	21		0.238	0.652	0.091	0.003	3	
13.2	13.9		2.34	5.41	0.208	0.003	54	
17.6	32.8		0.05	0.661	0.124	0.003	2	
23.3	45.7		0.166	0.879	0.161	0.003	4	
28.2	51.5		0.04	0.7	0.163	0.005	3	
22	41.9		0.12	0.74	0.146	0.005	3	
20.1	39.7		0.14	0.74	0.173	0.005	3	
6	13	6.8	0.17	0.16	0.03		3	0.01
6	18	11.5	0.19	0.3	0.06		3	0.01
7	19	8.7	0.53	1.33	0.15		8	0.01
14	38	10.6	0.3	1.13	0.18		2	0.01
15	40	10.5	0.33	1.12	0.18		9	0.01
14	37	10.5	0.3	1.04	0.2		3	0.01

24	33	0.18	1.21	0.36	0.005	7.6
185	231	0.16	1.52	0.55	0.005	8.4
131	218	0.09	1.7	0.673	0.01	4
72.8	121	0.095	1.39	0.423	0.003	4
19.4	17.1	0.076	0.268	0.075		
32.6	27.5	0.052	0.315	0.117	0.003	1
59.3	41.1	0.09	0.63	0.219	0.005	4
22.8	21.1	0.22	0.5	0.107	0.005	3
25.3	23.3	0.14	0.52	0.119	0.005	3
9.17	82.8	1.18	1.43	0.34	0.005	14.4

5.99	12.3	2.16	0.14	0.67	0.11	0.001	3	0.254
5	11	2	0.14	0.88	0.111	0.001	6	0.249
65.8	102		0.822	2.31	0.34	0.003	20	0.31
21.4	24.9		0.816	2.94	0.138	0.003	16	0.1
231	226		0.11	1.64	0.24	0.005	8	
198	122		0.09	0.964	0.253	0.003	4	
89.9	45.6		0.11	1.35	0.373	0.003	3	
12.9	5.5		0.102	0.35	0.032	0.003	1	
23.1	13.8		0.186	0.703	0.173	0.003	4	
9.8	5.8		0.156	0.29	0.033	0.003	2	
25.3	18.7		0.155	0.609	0.142	0.003	3	
11	7.6		0.136	0.319	0.045	0.003	1	
10.3	8.4		0.13	0.346	0.06	0.003	2	
31.3	24.9		0.151	0.66	0.195	0.003	3	
30.6	27.1		0.166	0.665	0.178	0.003	4	
9.56	5.8		0.234	0.39	0.033	0.003	3	
53.7	33.8		0.11	0.68	0.253	0.005	4.4	
10.9	9		0.24	0.75	0.109	0.005	12	
38	31.2		0.2	0.88	0.201	0.005	4	
10.6	12.9		0.44	0.9	0.12	0.005	8	
39.2	41.5		0.21	1.12	0.188	0.005	4	
8.54	12		0.33	1.09	0.149	0.005	6	
								0.28

14.1	47.2	1.33	6.47	0.512	0.003	18	0.16
19.7	89.4	0.08	2.42	0.45	0.005	6	
9.6	62.5	0.091	5.25	0.97	0.003	11	
12.8	24	0.207	2.72	0.277	0.003	7	
9.8	6.3	0.21	0.605	0.076	0.003	3	
10.9	7.9	0.24	0.663	0.083	0.003	3	
10.4	8.8	0.255	0.858	0.1	0.003	6	
11.3	8.5	0.184	0.682	0.093	0.003	2	
12.1	12.2	0.13	0.69	0.135	0.005	4.4	
11.8	12.5	0.55	1.01	0.139	0.005	6	
9.78	14.6	0.36	1.15	0.129	0.005	8	
11.2	31.7	4	4.51	0.196	0.003	58	0.6
							0.27
15.8	63.1	0.13	2.59	0.36	0.005	12.8	
10.1	61.9	0.123	2.52	0.27	0.01	3	
12.4	35	0.165	1.57	0.155	0.003	3	
9	16.4	0.344	0.871	0.094	0.003	7	
8.59	10.7	0.261	0.588	0.089	0.003	5	
9.08	11.2	0.301	0.632	0.103	0.003	3	
9.24	11.8	0.231	0.579	0.109	0.003	2	
8.22	12.5	0.14	0.57	0.098	0.005	3.6	
7.45	12.9	0.35	0.75	0.079	0.005	7	

7.12	15.5			0.39	0.95	0.095	0.005	12	
620	500		30	0.05	0.23	0.02		5	1.1
248	164			0.06	0.08	0.02	0.005	3	
260	192			0.07	0.1	0.02	0.005	3	
177	83.8			0.06	0.09	0.02	0.005	3	
260	493			0.05	0.08	0.02	0.005	3	
193	499			0.05	0.13	0.02	0.005	3	
93	33			0.36	1.09	0.13	0.005	5.6	
392	486			0.05	0.09	0.02	0.005	3	
308	510			0.05	0.13	0.02	0.005	3	
100	121			1.23	1.77	0.08	0.005	44	
107	133			0.8	1.8	0.12	0.005	44	
73	54.3			28.9	67.8	1.39	0.005	2312	
80.5	43.5			0.26	0.42	0.03	0.005	8	
89	71.9			0.66	1.38	0.09	0.005	30	
103	77.7			0.4	0.9	0.09	0.005	18	
51	25.5			0.76	1.61	0.08	0.005	36	
42	19.9			0.07	0.11	0.02	0.005	4	
137	174			0.12	0.2	0.06	0.005	3	
149	198			0.24	0.5	0.09	0.005	6	
73	47.9			0.5	1.38	0.1	0.005	6	
45	27.6			0.05	0.06	0.02	0.005	3	
160	201			0.12	0.28	0.15	0.005	3	
146	173			0.13	0.23	0.15	0.005	3	
91	41.7			0.59	1.46	0.12	0.005	9	
55	31.3			0.06	0.11	0.02	0.005	3	
105	64.6			0.38	0.94	0.07	0.005	10	
105	64.3			0.35	0.89	0.07	0.005	11	
127	112			0.37	1.14	0.11	0.005	10	
91	40.7			0.49	1.59	0.08	0.005	9	
50	21.9			0.05	0.06	0.02	0.005	3	
162	120			0.11	0.18	0.058	0.005	3	
177	125			0.16	0.28	0.085	0.005	3	
109	50.1			0.72	1.79	0.15	0.005	5	
56.3	32.6			0.04	0.07	0.004	0.005	3	
109	122			0.28	0.67	0.07	0.005	5.2	
120	136			0.47	1.2	0.087	0.005	5.6	
88.3	51.4			0.59	1.64	0.1	0.005	4.4	
47.2	27.9			0.1	0.1	0.016	0.005	3	

114	96.6	0.26	0.56	0.059	0.005	3
115	94.6	0.27	0.59	0.061	0.005	8
119	116	0.31	0.69	0.084	0.005	8
88.2	52.4	0.68	1.69	0.107	0.005	6
48.4	33.5	0.07	0.15	0.007	0.005	3
300	46.2	0.08	0.09	0.02	0.005	3
369	53.4	0.05	0.06	0.02	0.005	3
133	48	0.05	0.05	0.02	0.005	3
136	24.3	0.36	0.5	0.03	0.005	12
151	22.8	0.15	0.2	0.02	0.005	6
195	31.7	0.13	0.19	0.02	0.005	5
211	30.7	0.17	0.23	0.02	0.005	6
238	34.9	0.05	0.12	0.008	0.005	3
202	39.4	0.1	0.3	0.338	0.005	4.4
180	35.9	0.1	0.23	0.03	0.005	4
211	80.6	0.16	0.16	0.02	0.005	3
255	92.8	0.05	0.04	0.02	0.005	3
233	95	0.05	0.07	0.02	0.005	3
237	83.2	0.05	0.05	0.02	0.005	3
135	54.7	0.14	0.24	0.02	0.005	6
174	61.4	0.05	0.07	0.02	0.005	3
176	56.6	0.14	0.19	0.02	0.005	3
166	53.8	0.05	0.02	0.02	0.005	10
207	59.2	0.03	0.11	0.004	0.007	3
151	58	0.1	0.21	0.008	0.005	3
166	65.3	0.69	1.31	0.053	0.005	38
534	136	0.08	0.21	0.09	0.005	5.6
423	160	0.05	0.13	0.09	0.005	6.4
393	172	0.05	0.11	0.08	0.005	4
409	160	0.18	0.51	0.12	0.005	13
448	154	0.05	0.07	0.07	0.005	3
498	131	0.05	0.03	0.09	0.005	3
649	103	0.02	0.15	0.128	0.005	3
527	115	0.04	0.27	0.11	0.005	3
496	120	0.02	0.18	0.108	0.005	3
624	696	0.05	0.42	0.29	0.005	5.2
456	710	0.05	0.48	0.17	0.005	6
707	525	0.05	0.05	0.02	0.005	3
606	533	0.15	0.95	1.34	0.005	12
539	446	0.08	0.68	1.06	0.005	7
450	334	0.05	0.09	0.02	0.005	3
348	487	0.08	0.99	0.5	0.005	8
244	327	0.06	0.51	0.37	0.005	4

221	243		0.02	0.05	0.067	0.005	3	
280	412		0.03	0.51	0.364	0.005	3	
285	402		0.06	0.66	0.377	0.005	7	
368	365	19.7	0.21	0.19	0.009	0.001	3	0.1
249	158		0.22	0.63	0.47	0.005	5.6	
232	192		0.05	0.27	0.18	0.005	3	
243	189		0.05	0.14	0.15	0.005	3	
88.1	88.5		21	39	1.39	0.005	1504	
96	63.6		0.34	0.56	0.06	0.005	22	
156	87.2		0.45	0.75	0.14	0.005	17	
171	92.9		0.16	0.38	0.25	0.005	4	
129	102		0.11	0.13	0.06	0.005	6	
165	140		0.16	0.27	0.161	0.005	3	
136	136		0.13	0.25	0.049	0.005	3	
149	116		0.14	0.29	0.096	0.005	3	
170	290	11	0.05	0.21	0.022		5	0.51
170	300	13	0.05	0.17	0.02		5	0.53
357	259		0.05	0.1	0.02	0.005	3.6	
168	240		0.05	0.15	0.02	0.005	3	
134	116		0.07	0.15	0.07	0.005	3	
388	263		0.05	0.12	0.03	0.005	5	
318	255		0.05	0.1	0.02	0.005	5	
356	169		0.05	0.17	0.06	0.005	5	

402	278	0.05	0.09	0.02	0.005	3	
225	288	0.05	0.13	0.02	0.005	3	
190	231	0.05	0.17	0.06	0.005	3	
346	234	0.05	0.15	0.04	0.005	3	
53.1	168	0.05	0.28	0.02	0.005	3	
124	66.7	0.08	0.15	0.14	0.005	3	
150	102	0.08	0.2	0.03	0.005	3	
70	67.8	0.11	0.25	0.03	0.005	3	
58	60.7	0.98	1.21	0.07	0.005	12	
238	154	0.05	0.17	0.04	0.005	3	
102	103	0.11	0.22	0.04	0.005	3	
74	41.7	0.29	0.38	0.1	0.005	4	
249	155	0.07	0.22	0.04	0.005	3	
124	124	0.12	0.33	0.04	0.005	3	
99	136	0.38	0.62	0.1	0.005	5	
138	72.4	0.34	0.56	0.06	0.005	12	

55	32.5		0.71	1.2	0.8	0.005	30		
45	23.9		1.01	1.56	0.09	0.005	36		
239	135		0.1	0.27	0.054	0.005	3		
105.5	95.8		0.34	0.29	0.049	0.005	3		
83.4	80.1		0.41	0.79	0.154	0.005	4.4		
160	96.8		0.11	0.28	0.038	0.005	3		
67.7	58.3		0.19	0.32	0.038	0.005	4		
55	40.1		0.3	0.47	0.055	0.005	4		
188	123		0.06	0.24	0.033	0.005	3		
91.7	90.2		0.19	0.42	0.044	0.005	3		
65.8	42.4		0.39	0.74	0.078	0.005	3		
53.8	219		0.07	0.19	0.02	0.005	3		
67.9	256		0.05	0.14	0.02	0.005	3		
25	14.3		0.15	0.21	0.04	0.005	3		
27	13.6		0.05	0.11	0.04	0.005	3		
29	14.8		0.05	0.11	0.06	0.005	3		
22	10		0.15	0.26	0.04	0.005	4		
24	7		0.16	0.44	0.03	0.005	10		
26.1	12.4		0.05	0.15	0.051	0.005	3		
24.4	14.2		0.21	0.41	0.045	0.005	8.4		
25.9	15.7		0.05	0.16	0.057	0.005	3		
13	7.2	1	0.04	0.1	0.027	0.001	2	0.3	
297	149		0.05	0.03	0.02	0.005	4		
430	260		0.05	0.05	0.02	0.005	3		
263	160		0.05	0.03	0.02	0.005	5		
400	266		0.05	0.06	0.02	0.005	5		
954	279		0.07	0.2	0.03	0.005	3		
301	175		0.05	0.03	0.02	0.005	3		
410	250		0.05	0.06	0.02	0.005	3		
289	183		0.05	0.04	0.02	0.005	3		
329	239		0.45	1.08	0.06	0.005	35		
290	189		0.05	0.05	0.02	0.005	3		
388	247		0.05	0.09	0.02	0.005	3		
223	132		0.05	0.09	0.02	0.005	4		
327	194		0.15	0.28	0.02	0.005	8		
216	129		0.36	0.43	0.06	0.005	5		
276	166		0.17	0.31	0.02	0.005	3.2		
200	110		0.04	0.14	0.19	0.005	3		
360	194		0.04	0.15	0.01	0.005	0.3		
123	67.7		0.13	0.23	0.026	0.005	3		
269	164		0.12	0.29	0.017	0.005	3		

189	111		0.03	0.15	0.009	0.005	3	
332	226		0.04	0.2	0.012	0.005	9	
642	306		0.05	0.14	0.1	0.005	3	
404	183		0.05	0.07	0.02	0.005	3	
154	139		0.05	0.15	0.05	0.005	3	
661	322		0.05	0.13	0.12	0.005	5	
1498	565		0.05	0.03	0.02	0.006	12	
298	165		0.05	0.15	0.05	0.005	5	
774	336		0.05	0.09	0.13	0.005	4	
722	233		0.05	0.06	0.02	0.005	3	
183	173		0.05	0.04	0.02	0.005	3	
647	331		0.05	0.14	0.13	0.005	3	
335	186		0.05	0.07	0.02	0.005	3	
125	142		0.05	0.07	0.02	0.005	3	
420	273		0.05	0.18	0.11	0.009	3	
213	132		0.05	0.1	0.02	0.005	3	
38	38.8		0.05	0.12	0.02	0.005	3	
602	284		0.05	0.11	0.09	0.007	3	
250	141		0.05	0.05	0.02	0.005	3	
128	105		0.05	0.06	0.02	0.005	3	
555	257		0.22	1.12	0.34	0.005	4	
555	255		0.16	0.81	0.27	0.005	8	
264	142		0.05	0.09	0.02	0.005	3	
161	127		0.18	0.28	0.03	0.005	5	
342	177		0.25	0.54	0.07	0.006	11	
171	92.5		0.38	0.52	0.04	0.005	10	
100	54.9		0.27	0.36	0.03	0.005	18	
579	250		0.02	0.24	0.084	0.007	3	
233	122		0.04	0.16	0.017	0.005	3	
145	100		0.12	0.31	0.052	0.005	7.2	
441	213		0.05	0.31	0.073	0.005	3	
176	105		0.06	0.26	0.024	0.005	3.2	
122	84.5		0.12	0.28	0.041	0.005	5	
464	231		0.04	0.29	0.087	0.005	3	
193	126		0.08	0.27	0.04	0.005	3	
121	107		0.11	0.3	0.049	0.005	5	
385	213				0.038	0.007	12	
683	294					0.012	3	
405	217					0.007	3	
466	229					0.018	3	
288	154					0.007	6	

341	209					0.01	6
427	227					0.016	3
614	291					0.008	3
506	271					0.022	3
731	337					0.018	3
662	326					0.009	3
352	213					0.006	5
484	256					0.019	2
1570	583		0.05	0.03	0.02	0.007	3
440	210		0.05	0.06	0.02	0.005	5
1456	582		0.05	0.02	0.02	0.009	4
867	541		0.05	0.03	0.02	0.018	3
914	507		0.05	0.1	0.02	0.014	3
1118	501		0.05	0.04	0.02	0.015	3
1212	481		0.05	0.02	0.02	0.009	3
631	326		0.09	0.18	0.02	0.035	3
1260	480		0.02	0.11	0.004	0.053	3
859	404		0.02	0.18	0.006	0.037	3
881	420		0.02	0.15	0.003	0.038	3
215	107		0.05	0.6	0.19	0.005	3
273	117		0.05	0.3	0.05	0.005	3
165	92.6		0.05	0.23	0.02	0.005	3
170	83		0.05	0.23	0.03	0.005	3
75	44.5		2.24	1.78	0.05	0.005	20
144	75.5		0.06	0.4	0.103	0.005	3
97.2	63.1		0.16	0.33	0.066	0.005	3
110	76.1		0.31	0.78	0.079	0.005	16
95	88.3		0.05	0.06	0.02	0.005	3
95	24.8		0.05	0.02	0.02	0.005	3
75.7	30.8		0.05	0.02	0.02	0.005	3
42	20.2		0.05	0.07	0.02	0.005	3
60	20.1		0.28	0.03	0.02	0.005	3
65	18.7		0.5	0.59	0.03	0.005	10
43	10.9		0.16	0.2	0.02	0.005	3
65.66	18.1		0.09	0.13	0.017	0.005	3
46	16.2		0.08	0.12	0.014	0.005	3
45.4	16.4		0.07	0.12	0.013	0.005	3
56.1	20.7		0.04	0.09	0.015	0.005	3
84	35		0.05	0.05	0.02	0.005	3
92	32		0.05	0.06	0.02	0.005	3
190	40.4		0.05	0.03	0.02	0.005	5

191	35.9	0.05	0.07	0.04	0.005	5
113	44.7	0.05	0.03	0.02	0.005	3
127	39.4	0.05	0.05	0.03	0.005	3
72.2	31.2	0.05	0.04	0.02	0.005	3
82	29.2	0.05	0.04	0.02	0.005	3
35	15.2	0.05	0.07	0.02	0.005	3
40	17.3	0.07	0.11	0.02	0.005	3
52	16.3	0.22	0.04	0.02	0.005	3
59	17.1	0.05	0.05	0.02	0.005	3
46	15.7	0.1	0.18	0.02	0.005	4
36	10.2	0.25	0.44	0.02	0.005	14
44.66	14.8	0.38	0.16	0.008	0.005	3.6
38.1	13.9	0.13	0.19	0.01	0.005	3
46.9	20.5	0.08	0.14	0.006	0.005	3
44	23.8	0.05	0.09	0.02	0.005	4.8
66	34.7	0.05	0.06	0.02	0.005	5
37.3	42.2	0.05	0.08	0.02	0.005	3
26.8	24.6	0.05	0.04	0.02	0.005	3
19	10.7	0.05	0.07	0.02	0.005	3
20	9.7	0.05	0.05	0.02	0.005	3
22	9.9	0.05	0.03	0.02	0.005	3
19	5	0.14	0.23	0.02	0.005	7
19.32	9.3	0.09	0.17	0.008	0.005	3.2
16.8	7	0.14	0.16	0.008	0.005	3
18.7	10.3	0.11	0.19		0.005	3
781	131	0.13	0.25	0.02	0.008	3
754	133	0.13	0.24	0.02	0.0053	15
932	152	0.05	0.04	0.02		3
447	116	0.05	0.04	0.02	0.01	3
181	39.1	0.05	0.11	0.02	0.005	3
321	43.2	0.05	0.05	0.02	0.006	3
108	114	0.05	0.05	0.02	0.01	3
208	122	0.05	0.02	0.02	0.005	7

134	120		0.05	0.03	0.02	0.005	3	
84.2	108		0.05	0.02	0.02	0.005	3	
34	54.9		0.05	0.05	0.02	0.005	3	
59	70.7		0.05	0.04	0.02	0.005	3	
76	81.6		0.05	0.02	0.02	0.005	3	
37	25.7		0.1	0.15	0.02	0.005	5	
67.72	66.2		0.29	0.09	0.004	0.005	3	
46	44.2		0.53	0.65	0.032	0.005	26	
57.2	66.9		0.05	0.1	0.005	0.005	3	
142	343		0.05	0.56	0.04	0.005	3	
231	81.1		0.17	0.11	0.03	0.005	3	
275	350		0.05	0.43	0.03	0.005	5	
264	88.9		0.08	0.06	0.02	0.005	16	
185	353		0.05	0.39	0.02	0.005	3	
282	62.2		0.05	0.03	0.02	0.005	3	
138	344		0.05	0.37	0.02	0.005	3	
200	43.9		0.05	0.05	0.02	0.005	4	
100	200		0.05	0.44	0.03	0.005	6	
102	16.2		0.16	0.15	0.24	0.005	3	
141	286		0.11	0.43	0.02	0.005	3	
237	63.3		1.04	0.17	0.3	0.005	4	
147	311		0.05	0.44	0.02	0.005	3	
177	91.2		0.13	0.05	0.03	0.005	3	
101	96.1		0.37	0.41	0.16	0.005	11	
106	15.3		0.81	0.51	0.36	0.005	20	
146	282		0.55	0.88	0.051	0.005	8	
170	40.4		0.65	0.39	0.088	0.005	8.4	
115	209		0.14	0.47	0.058	0.005	4	
89.3	21.3		0.43	0.24	0.167	0.005	5	
143	259		0.1	0.51	0.06	0.005	3	
176	34.2		0.63	0.26	0.279	0.005	5	
145	409		0.05	0.46	0.02	0.005	3	
127	285		0.05	0.49	0.03	0.005	3	
140.4	344		0.02	0.64	0.033	0.005	3	
138	335		0.02	0.64	0.04	0.005	3	
137	334		0.02	0.6	0.038	0.005	3	
20	34	1.2	0.1	0.02	0.02		5	0.11
28	62	1.4	0.1	0.02	0.02		5	0.15
949	39.5		0.05	0.05	0.02	0.005	3	
1133	31.2		0.05	0.06	0.02	0.005	9	
1190	32.8		0.05	0.05	0.03	0.005	4	

607	28.3		0.06	0.1	0.11	0.005	3	
491	23.2		0.1	0.35	0.44	0.005	3	
707	32.6		0.08	0.11	0.05	0.005	3	
910	51.6		0.09	0.28	0.08	0.005	3	
161	24.2		0.21	0.33	0.11	0.005	4	
842	5		0.17	18.1	7.85	0.005	6.8	
459	24.4		0.09	0.37	0.443	0.005	3	
620	38.9		0.03	0.16	0.04	0.005	3	
90	66.4		0.05	0.04	0.02	0.005	3	
90	66.2		0.05	0.04	0.02	0.005	5	
95	70.4		0.2	0.13	0.02	0.005	5	
64	60.2		1.17	1.36	0.04	0.005	35	
89	63.3		0.08	0.08	0.02	0.005	4	
95	67.8		0.05	0.06	0.02	0.005	3	
65	41.9		1.27	2.22	0.1	0.005	74	
96	63		0.06	0.09	0.014	0.005	3	
75.6	53.5		0.14	0.29	0.04	0.005	5	
84.4	68.3		0.24	0.41	0.033	0.005	7	
59	120	1	0.082	0.069	0.02		15	0.05
133	55.9		0.86	4.29	0.26	0.005	9.2	
217	79.2		0.24	1.76	0.16	0.005	8	
179	53.9		0.06	0.97	0.22	0.005	3	
82.4	79.3		0.23	1.32	0.07	0.005	6	
41	47		1.44	2.08	0.05	0.005	23	
58	47.9		0.35	1.01	0.05	0.005	7	
81	50		0.9	2.77	0.11	0.005	13	
40	15.5		0.94	1.26	0.06	0.005	45	
79.1	44.9		0.69	1.38	0.073	0.005	10.4	
49.2	35.5		0.44	1.08	0.056	0.005	8	
62.5	46.9		0.8	2.44	0.095	0.005	19	
59	5		0.9	0.93	0.17	0.005	3	
121	5		1.27	1.24	0.24	0.005	13	
70.5	5		1.47	1.06	0.22	0.005	7	
22	13.9		0.49	0.4	0.04	0.005	6	
40	9.5		1.02	0.87	0.08	0.005	6	
43	8.6		1.2	1.06	0.09	0.005	7	
31	5		1.62	2.51	0.13	0.005	10	
37	7.8		1.1	0.88	0.062	0.005	7.2	
29.6	8.6		0.76	0.73	0.052	0.005	6	
30.6	10.9		0.92	0.84	0.064	0.005	8	

342	152		0.1	0.1	0.03		3
393	45.1		0.52	0.32	0.33		5.2
342	157		0.05	0.08	0.02	0.005	4.4
410	48.4		0.18	0.3	0.26	0.005	3
322	136		0.07	0.09	0.1	0.005	3
371	45.7		0.24	0.27	0.36	0.005	4
204	102		0.62	0.85	0.14	0.005	39
295	49.9		0.79	1.19	0.34	0.005	29
192	97.1		0.19	0.3	0.06	0.005	4
278	49.7		0.45	0.52	0.28	0.005	5
202	117		0.09	0.1	0.06	0.005	3
282	49.2		0.35	0.25	0.24	0.005	4
283	50.7		0.35	0.25	0.25	0.005	4
249	146		0.15	0.14	0.1	0.005	3
315	47.1		1.39	0.6	0.35	0.005	10
315	47.8		1.41	0.65	0.34	0.005	12
244	145		0.14	0.09	0.1	0.005	3
302	51.8		1.21	0.42	0.35	0.005	10
262	144		0.27	0.2	0.12	0.005	3
313	44.3		1.53	0.51	0.358	0.005	10.8
310	42.1		1.6	0.6	0.361	0.005	9.2
214	131		0.12	0.11	0.061	0.005	3
280	56		0.96	0.38	0.238	0.005	3
245	142		0.38	0.4	0.1	0.005	8
296	49.8		1.08	0.56	0.289	0.005	10

105	72.7		0.05	0.11	0.03		3	
145	89.3		0.05	0.14	0.05	0.005	3	
60.3	60.6		0.12	0.31	0.06	0.005	14	
60.5	59.9		0.2	0.5	0.06	0.005	18	
61	49.4		0.05	0.11	0.02	0.005	3	
91	63.3		0.05	0.07	0.04	0.005	3	
99	56.2		0.05	0.08	0.02	0.005	3	
95	58.8		0.05	0.13	0.03	0.005	3	
110	55.4		0.04	0.13	0.019	0.005	3	
89.1	57.9		0.03	0.12	0.017	0.005	3	
89	64.3		0.08	0.23	0.027	0.005	14	
352	66.1		0.15	0.4	0.05		5.2	
371	43.5		0.21	1.43	0.5		7.6	
410	73.7		0.05	0.18	0.02	0.005	3	
446	41.3		0.08	0.06	0.08	0.005	3	
219	55.2		0.99	1.93	0.32	0.005	186	
306	47.7		0.5	0.12	0.12	0.005	6	
232	63.2		2.16	3.46	0.2	0.005	254	
429	49.6		0.08	0.07	0.08	0.005	3	
211	62.4		2.19	3.87	0.16	0.005	60	
309	52.4		0.07	0.04	0.06	0.005	3	
305	87.5		0.05	0.08	0.02	0.005	3	
371	51.2		0.07	0.04	0.06	0.005	3	

307	84.4		0.1	0.17	0.06	0.005	3	
334	51.8		0.05	0.03	0.11	0.005	3	
298	90		0.09	0.2	0.05	0.005	3	
313	48.9		0.2	0.04	0.1	0.005	3	
288	75.3		0.14	0.23	0.069	0.005	4.8	
293	46.5		0.21	0.08	0.13	0.005	3	
234	79.3		0.21	0.39	0.065	0.005	3	
261	56.7		0.18	0.11	0.12	0.005	3	
281	74.8		0.158	0.323	0.077	0.005	4	
303	52.7		0.2	0.1	0.12	0.005	3	
160	500	28	0.38	0.093	0.022		5	0.24
140	510	23	0.11	0.15	0.074		5	0.22
278	576		0.17	0.1	0.05		3	
264	591		0.05	0.09	0.03		3	
93	364		0.05	0.32	0.02		3	
97.8	381		0.05	0.48	0.05		3	
175	631		0.17	0.09	0.02	0.005	3.2	
244	685		0.05	0.1	0.02	0.005	4.8	
98	386		0.05	0.21	0.02	0.005	3	
96.2	396		0.05	0.08	0.02	0.005	3	
385	496		0.11	0.1	0.05	0.005	3	
284	237		0.08	0.25	0.11	0.006	3	
36.7	144		0.31	0.49	0.06	0.005	10	
188	417		0.13	0.16	0.04	0.005	3	
216	433		0.09	0.18	0.06	0.005	3	
75	303		0.05	0.14	0.02	0.005	3	
54	215		0.05	0.33	0.13	0.005	3	
160	310		0.16	0.12	0.11	0.005	3	
201	364		0.05	0.12	0.03	0.005	3	
67	207		0.05	0.12	0.02	0.005	3	
63	210		0.05	0.13	0.02	0.005	3	
61	212		0.06	0.18	0.02	0.005	3	
196	321		0.15	0.2	0.1	0.005	4	

240	393		0.05	0.13	0.04	0.005	3	
64	214		0.05	0.1	0.02	0.005	3	
78	284		0.05	0.12	0.02	0.005	3	
186	319		0.19	0.23	0.12	0.005	5.2	
195	362		0.08	0.17	0.04	0.005	4	
61	255		0.05	0.15	0.03	0.005	3	
56	247		0.05	0.14	0.04	0.005	3	
180	312		0.13	0.11	0.1	0.005	3	
188	303		0.05	0.09	0.03	0.005	3	
36	56.3		0.05	0.06	0.02	0.005	3	
33	52.2		0.07	0.12	0.03	0.005	3	
33	52.6		0.06	0.12	0.03	0.005	3	
274	359		0.47	0.22	0.246	0.005	4.8	
355	419		0.06	0.25	0.075	0.005	3	
228	328		0.37	0.17	0.158	0.005	3	
286	369		0.05	0.22	0.053	0.005	3	
59.6	93.4		0.03	0.07	0.007	0.005	3	
54.3	87.1		0.05	0.11	0.025	0.005	3	
222	363		0.19	0.15	0.107	0.005	3	
313	456		0.25	0.55	0.079	0.005	5	
291	501	31.1	0.22	0.17	0.14	0.005	3	1.56
230	560	25.4	0.04	0.08	0.015	0.001	3	0.1
217		25						
176	29.8		0.23	0.02	0.17		3	
157	37.1		0.1	0.04	0.05	0.005	3	
55.4	15.9		0.73	0.53	0.2	0.005	79	
91	21.7		0.57	0.12	0.5	0.005	3	
63	12		0.38	0.12	0.22	0.005	3	
92	12.9		0.54	0.11	0.31	0.005	4	
65	12		0.41	0.13	0.2	0.005	4	
65	13.5		0.35	0.11	0.18	0.005	3	
102	13.3		0.78	0.12	0.323	0.005	6.4	
92.9	14.9		0.62	0.14	0.289	0.005	5	
89.7	19.8		0.54	0.16	0.273	0.005	4	

284	430			0.07	0.02	0.17		3	
387	162			0.09	0.16	0.17	0.005	3.6	
258	345			0.2	0.2	1.4	0.005	4	
240	276			0.25	0.4	0.35	0.005	3	
208	11			0.49	0.33	1.29	0.005	3	
232	28.5			0.26	0.09	0.43	0.005	3	
189	152			0.36	0.56	0.72	0.005	3	
221	167			0.37	0.23	0.88	0.005	3	
280	117			0.61	0.15	1.24	0.005	5.2	
209	5			2.49	0.52	1.65	0.005	3	
227	13.3			0.22	0.21	1.44	0.005	3	
267	32.7			0.4	0.08	0.58	0.005	3	
219	201			0.42	0.76	0.94	0.005	3	
247	213			0.43	0.28	1.1	0.005	3	
298	135			0.55	0.15	1.46	0.005	4.8	
230	5			3.06	0.62	2	0.005	3	
261	14.3			0.25	0.25	1.85	0.005	3	
118	687			0.05	0.03	0.02	0.005	3	
125	568			0.05	0.04	0.02	0.005	3	
162	631			0.06	0.12	0.007	0.005	5	
162	644			0.08	0.17	0.02	0.005	10	
269	189		8	0.44	0.68	0.036	0.009	27	5.2

359	532		0.06	0.1	0.02	0.005	3	
371	593		0.05	0.06	0.02	0.005	3	
373	459		0.05	0.05	0.02	0.005	3	
380	459		0.05	0.04	0.02	0.005	3	
445	412		0.02	0.12	0.008	0.005	3	
440	408		0.02	0.1	0.011	0.005	3	
466	507		0.02	0.09	0.007	0.005	3	
1208	45.9		0.05	0.36	0.23	0.005	3	
926	47.6		0.05	0.58	0.5	0.005	3	
896	27.4		0.02	0.53	0.13	0.005	3	
832	34.3		0.05	0.81	0.629	0.005	4	
379	170		0.05	0.03	0.02		3	
394	196		0.05	0.05	0.02	0.006	3	
298	210		0.6	0.78	0.22	0.008	88	
271	234		0.05	0.09	0.03	0.008	3	
283	163		0.05	0.1	0.02	0.008	3	
379	214		0.05	0.04	0.02	0.011	3	
309	216		0.05	0.07	0.04	0.006	3	
316	183		0.05	0.03	0.02	0.006	3	
430	208		0.05	0.14	0.032	0.007	3	
381	192		0.03	0.14	0.01	0.005	3	
415	215		0.37	0.71	0.048	0.005	39	
47	40.2		0.05	0.04	0.02	0.005	3	
98	59.7		0.05	0.02	0.02	0.005	3	
70	49.9		0.05	0.02	0.02	0.005	3	
149	93		0.02	0.08	0.008	0.005	3	
114	85.2		0.02	0.09	0.004	0.005	3	
1500	220	26	0.96	0.09	0.045		5	1
1300	168	22	0.77	0.13	0.046		5	0.88
770	106.8		0.3	0.39	0.19	0.005	10.8	
1030	128		0.07	0.17	0.08	0.005	3	
932	119		0.18	0.34	0.13	0.005	6.4	
1280	153		0.05	0.12	0.05	0.005	3	
1260	136		0.05	0.19	0.09	0.005	3	
995	127		0.05	0.1	0.16	0.005	5	
1243	137		0.05	0.15	0.07	0.005	7	

1249	152	0.05	0.11	0.07	0.005	4.8
1250	160	0.05	0.1	0.05	0.005	4.8
1093	168	0.05	0.07	0.02	0.005	3
358	61.7	0.77	1.36	0.4	0.005	77
488	81.4	0.09	0.2	0.09	0.005	3
698	96.9	0.79	1.52	0.97	0.005	79
638	92.4	0.55	1.04	0.54	0.005	46
635	110	1.51	1.77	0.27	0.005	101
283	55.9	0.11	0.22	0.09	0.005	10
281	55.7	0.13	0.26	0.1	0.005	8
631	109	0.09	0.25	0.24	0.005	3
842	117	0.07	0.24	0.46	0.005	4
835	128	0.08	0.32	0.96	0.005	6
647	105	0.13	0.34	0.19	0.005	8
416	71.6	0.06	0.23	0.24	0.005	3
445	69.7	0.07	0.21	0.18	0.005	3
764	104	0.05	0.17	0.31	0.005	3
744	105	0.05	0.18	0.41	0.005	3
716	131	0.05	0.09	0.12	0.005	3
294	51.5	0.22	0.52	0.15	0.005	6
316	55	0.52	1.15	0.14	0.005	18
703	102	0.07	0.22	0.16	0.005	5
702	114	0.07	0.26	0.22	0.005	5
837	174	0.16	0.44	0.26	0.005	8
218	38.9	0.09	0.18	0.18	0.005	3
247	41.9	0.13	0.16	0.17	0.005	3
705	108	0.07	0.15	0.37	0.005	3
763	123	0.05	0.08	0.46	0.005	3.2
653	113	0.05	0.1	0.22	0.005	3
255	34.6	0.09	0.15	0.17	0.005	3
288	37.7	0.08	0.33	0.14	0.005	3
860	109	0.05	0.14	0.3	0.005	3
921	123	0.05	0.1	0.4	0.005	3
866	142	0.05	0.08	0.12	0.005	3
544	72.5	0.08	0.22	0.44	0.005	3
604	83.2	0.12	0.24	0.456	0.005	3
1165	144	0.03	0.24	0.67	0.005	3
1179	169	0.02	0.18	0.861	0.005	3
1031	258	0.04	0.19	0.251	0.005	3
298	43.8	0.05	0.25	0.131	0.005	3

344	48.9		0.06	0.23	0.129	0.005	3
834	101		0.04	0.26	0.344	0.005	3
875	121		0.03	0.23	0.322	0.005	3
776	116		0.06	0.24	0.147	0.005	3
316	45.8		0.13	0.28	0.062	0.005	3
397	54.7		0.06	0.24	0.055	0.005	3
1106	121		0.02	0.23	0.114	0.005	3
1067	141		0.02	0.21	0.233	0.005	3
1038	152		0.02	0.18	0.031	0.005	3
1090		34					
1270	217		0.12	0.37	0.2	0.007	9.2
13	56.4		0.14	0.85	0.09	0.005	3.6
14.4	144		0.05	4.05	2.11	0.005	6
19	22.9		1	1.2	0.16	0.005	44
20	32.1		0.05	0.39	0.05	0.005	3
18	14.3		0.05	0.26	0.05	0.005	3
17	13.4		1	3.22	0.19	0.005	45
15	10.1		0.08	0.17	0.03	0.005	3.6
17	9.7		0.13	0.2	0.03	0.005	3
18.8	11.9		0.06	0.22	0.04	0.005	3
14.7	12.6		0.08	0.24	0.032	0.005	3
17	13.4		0.08	0.29	0.028	0.005	3
20.2	83.8		0.13	0.43	0.05	0.005	3
21	42.9		0.9	0.95	0.11	0.005	62
20	43.5		0.16	0.41	0.05	0.005	6
17	24.4		0.08	0.25	0.05	0.005	5
18	23.5		1.38	3.04	0.12	0.005	52
18	14.5		0.11	0.23	0.03	0.005	3.6
18	15.7		0.12	0.26	0.03	0.005	4
17.1	21		0.05	0.17	0.029	0.005	3
15.9	17.4		0.07	0.17	0.017	0.005	3
15.5	17.1		0.1	0.21	0.021	0.005	3
22	21.8		0.06	0.2	0.019	0.005	4
537	83.1		0.09	0.15	0.13	0.005	3
806	99.3		0.05	0.16	0.11	0.005	6.4
180	35.5		1.5	1.32	0.64	0.005	42
216	58.9		0.16	0.18	0.13	0.005	4
202	44.8		0.22	0.25	0.29	0.005	5
189	32.2		0.64	0.56	0.2	0.005	13

103	27.8		0.21	0.1	0.2	0.005	3
143	20.2		0.23	0.17	0.17	0.005	7
264	33.4		0.46	0.19	0.72	0.005	3
120	20.7		0.15	0.16	0.173	0.005	3
148	25.8		0.15	0.16	0.073	0.005	3
		11	0.05				5
541	69.5		0.06	0.23	0.05	0.006	3
472	62.3		0.05	0.14	0.04	0.005	3
1047	293		0.05	0.08	0.06	0.005	3
819	97.4		0.05	0.08	0.07	0.005	3
1407	160		0.02	0.21	0.205	0.005	3
1201	155		0.02	0.24	0.134	0.005	3
1193	137		0.02	0.21	0.054	0.005	3
1593	145		0.02	16.5	14.5	0.005	21
1706	50.6		0.09	0.18	0.181	0.005	7
1490	61.2		0.05	0.05	0.7	0.005	3
1479	54		0.05	0.04	0.14	0.005	4
130	36.5		0.5	0.48	1.48	0.005	13
1180	119		0.05	0.25	6.65	0.005	6
1196	110		0.05	0.12	3.42	0.005	9
1309	95.5		0.16	0.4	2.08	0.005	27
1339	133		0.05	0.1	3.78	0.005	4
1513	103		0.05	0.14	4.77	0.005	3
1586	122		0.03	0.22	5.55	0.005	3
1518	90.5		0.05	0.22	3.35	0.005	43.2
1619	84.9		0.02	0.16	3.39	0.005	4
945	157		0.55	2.09	0.64	0.005	46
1060	173		0.05	0.24	0.05	0.005	4

1000	169		0.05	0.13	0.03	0.005	3		
1037	175		0.07	0.32	0.08	0.005	4		
766	132		0.05	0.1	0.04	0.005	3		
989	151		0.05	0.12	0.04	0.005	3		
1279	212		0.02	0.18	0.075	0.005	3		
873	141		0.02	0.31	0.034	0.005	3		
1182	176		0.02	0.27	0.016	0.005	3		
310	68	7	0.26	0.05	0.35		5	3.8	
440	94.1		0.08	0.19	0.02	0.005	3		
429	89.3		0.14	0.12	0.16	0.005	3		
462	105		0.05	0.07	0.02	0.007	3		
675	141		0.06	0.07	0.03	0.007	3.2		
404	84.8		0.05	0.07	0.02	0.005	10		
459	88		0.12	0.19	0.08	0.005	5		
444	102		0.05	0.03	0.02	0.006	10		
740	14		0.05	0.05	0.02	0.007	3		
558	98.9		0.05	0.09	0.02	0.005	3		
533	100		0.05	0.09	0.02	0.005	3		
603	111		0.1	0.06	0.06	0.005	3		
610	97.9		0.05	0.06	0.02	0.008	4		
409	88.5		3.88	6.7	0.35	0.005	275		
463	89.9		22	33.4	0.64	0.005	1320		
567	128		0.89	1.41	0.19	0.008	69		
702	157		0.12	0.25	0.07	0.009	6		
355	79.1		0.11	0.11	0.14	0.005	3		
347	80.2		0.11	0.11	0.14	0.005	3		
376	89		0.14	0.17	0.19	0.005	4		
428	104		0.06	0.12	0.02	0.005	3		
628	153		0.06	0.17	0.08	0.007	4		
267	58		0.22	0.19	0.29	0.005	3		
296	66.9		0.21	0.17	0.28	0.005	3		
360	86.2		0.11	0.12	0.04	0.005	3		
530	125		0.08	0.17	0.13	0.007	3		
437	91.2		0.16	0.16	0.31	0.005	3		
437	94.7		0.19	0.18	0.36	0.005	3		
469	106		0.28	0.13	0.43	0.007	3		
428	93.3		0.05	0.05	0.02	0.006	3		
294	63.7		0.57	0.7	0.348	0.005	28		
325	71.5		0.8	1.02	0.436	0.005	30		
371	84.1		0.22	0.3	0.061	0.007	14		
484	108		0.24	0.32	0.1	0.009	10		
372	82.7		0.18	0.2	0.283	0.005	3		
378	82.7		0.18	0.27	0.282	0.005	3		
403	93.6		0.27	0.16	0.349	0.008	3.6		

395	89.6
59.7	9.7
437	96.1
438	96.1
512	109
457	96.2
319	5.9
340	86.6
361	99.1
346	94.7
445	113
829	128
716	127
580	108
506	101
504	99.9
428	90.8
342	73.5
505	109
800	146
774	143
891	125
904	135
733	133
633	140

0.09	0.2	0.025	0.02	6.4
0.02	0.06	0.003	0.005	3
0.17	0.22	0.201	0.005	3
0.15	0.23	0.198	0.005	3
0.24	0.24	0.196	0.006	4
0.17	0.23	0.021	0.007	4
0.51	0.74	0.03	0.005	22
0.81	0.75	0.183	0.005	30
0.79	0.77	0.184	0.005	23
1.65	1.75	0.065	0.005	87
0.14	0.22	0.035	0.007	3
			0.016	3
			0.016	3
			0.008	3
			0.019	3
			0.0177	3
			0.013	3
			0.008	3
			0.014	3
			0.019	3
			0.024	3
			0.017	3
			0.014	3
			0.01	22
			0.027	2

77	5		0.53	0.06	0.45	0.005	3	
444	103		0.05	0.09	0.02	0.006	3	
444	101		0.05	0.04	0.02	0.005	5	
720	226		0.05	0.15	0.02	0.007	15	
654	146		0.05	0.05	0.02	0.006	3	
430	113		1.17	2.39	0.61	0.005	76	
446	117		0.12	0.22	0.35	0.005	4	
416	96.9		0.24	0.41	0.53	0.005	3	
614	146		0.38	0.22	0.81	0.006	6	
465	111		0.47	0.48	0.55	0.007	21	
546	141		0.36	0.17	0.42	0.02	5.2	
673	163		0.33	0.31	0.247	0.02	5	
533	154		0.21	0.19	0.192	0.006	3	
234	73.2	4	0.54	0.7	0.027	0.012	29	3.9
490	56	7	0.05	0.05	0.027		5	0.36
362	60.9		0.14	0.15	0.29	0.005	3.2	
544	76.8		0.22	0.1	3.51	0.005	3	
234	65.6		0.05	0.05	0.03	0.005	5	
820	42.8		0.05	0.08	0.29	0.005	5	
556	61.9		0.05	0.05	0.02	0.005	3	
371	56.6		0.07	0.14	0.52	0.005	3	
466	53.2		0.95	0.73	2.98	0.005	23	
233	38.1		0.14	0.13	0.72	0.005	3	
484	62.6		0.28	0.25	2.8	0.005	5	
153	25.5		0.3	0.17	0.84	0.005	4	
155	25.4		0.27	0.18	0.77	0.005	4	

288	35.7		0.63	0.29	0.27	0.005	9	
308	47.9		0.23	0.14	1.16	0.005	3	
651	61.9		0.36	0.23	4.07	0.005	5	
222	37.2		0.56	0.49	1.34	0.005	16	
446	60.2		0.63	0.35	3.92	0.005	14	
264	36.3		0.24	0.18	1.36	0.005	3.2	
520	52.2		0.48	0.31	4.29	0.005	8.8	
309	40.9		0.26	0.28	1.26	0.005	3	
599	54.5		0.667	0.44	3.73	0.005	18	
248	50.5		0.29	0.26	0.929	0.005	3	
527	69.2		0.4	0.3	3.3	0.005	6	
230	65	7	0.13	0.31	0.054		5	0.15
120	12	1	0.1	0.15	0.032		6	0.11
254	59.9		0.18	0.16	0.12	0.005	3	
159	64.3		0.05	0.1	0.02	0.005	3	
295	68.2		0.05	0.06	0.03	0.005	5	
418	77.3		0.05	0.14	0.05	0.005	4	

362	66.7		0.05	0.08	0.03	0.005	3	
184	64.7		0.05	0.04	0.02	0.005	3	
177	40.1		0.13	0.16	0.32	0.005	3	
177	39.7		0.14	0.16	0.35	0.005	3	
94	40.2		0.05	0.1	0.02	0.005	3	
170	35.8		0.12	0.11	0.38	0.005	3	
81	38		0.05	0.07	0.02	0.005	3	
124	27.9		0.15	0.13	0.39	0.005	3	
75	31.7		0.05	0.11	0.02	0.005	3	
256	54.8		0.13	0.05	0.5	0.005	3	
164	67.5		0.05	0.02	0.02	0.005	3	
175	38.1		0.57	0.46	0.719	0.005	15	
232	42		0.22	0.13	0.665	0.005	3	
148.5	53.1		0.03	0.11	0.011	0.005	3	
249	46.3		0.21	0.16	0.647	0.005	3	
150	54.6		0.03	0.19	0.01		3	
185	50.3		0.23	0.18	0.515	0.005	3	
132	71.1		0.04	0.13	0.01	0.005	3	
169	57.4	6.23	0.07	0.16	0.033	0.005	3	0.844
259	62.7	7	0.32	0.04	0.712	0.003	3	0.7
176	5	2.12	1.88	0.09	1.86	0.005	3	0.98
312	85.4		0.06	0.15	0.05	0.005	3	
189	68.8		0.05	0.06	0.02	0.005	3	
301	85.4		0.05	0.09	0.02	0.005	3	
167	50.9		0.07	0.2	0.06	0.005	3	
175	49.4		0.05	0.15	0.06	0.005	3	
158	45.4		0.07	0.16	0.08	0.005	3	
284	85.9		0.05	0.09	0.09	0.005	3	
199	43.4		2.2	3.57	0.231	0.005	142	
294	62.1		0.08	0.22	0.077	0.005	3.6	
300	62.6		0.17	0.27	0.091	0.005	5	
242	64.6		0.16	0.28	0.119	0.005	4	
450	16	1	0.05	0.05	0.02		5	

541	14.3	11	0.09	0.11	0.06	0.005	3	0.1
34	17.2	2	0.06	0.25	0.047	0.001	3	0.2
31	240	4	0.074	0.56	0.02		5	0.05
184	105		0.27	1.01	0.22	0.005	6.4	
			0.05				5	
17.5	9.59	1.47	1.35	2.26	0.12	0.005	59.2	0.18
			0.05				5	
			0.05				5	
221	113		0.06	0.75	0.29	0.005	6	
21.2	67.9		0.13	0.54	0.24	0.005	5.2	
39.3	55.8		0.07	0.52	0.25	0.005	4.4	

76.1	60		0.07	0.53	0.17	0.005	4	
43	49.1		0.28	0.13	0.03	0.005	3	
32	24.3		0.12	0.19	0.02	0.005	3	
25	15.3		0.06	0.12	0.12	0.005	3	
28	35.7		0.05	0.1	0.03	0.005	3	
25	14.8		0.16	0.37	0.03	0.005	3	
26.1	13.1		0.33	0.22	0.024	0.005	4	
26	21.4		0.06	0.23	0.034	0.005	3	
22.3	28.6		0.11	0.31	0.048	0.005	4	

UBSTRATE	ESS_POO	ENTDEPO	NELALTER	BANKSTA	EGETATIVE	UNDISTUR	L_RBP_SC	RRATIVE_
17	16	15	15	14	14	12	155	Optimal
18	14	14	15	16	13	13	150	Optimal
16	13	13	15	13	12	10	133	Optimal
10	5	5	14	10	14	12	105	Marginal

16	13	12	12	11	13	13	132	Optimal
15	16	14	10	13	12	9	137	Optimal

16	18	16	11	16	12	1	137	Optimal
15	13	16	14	11	10	3	124	Optimal
18	14	16	15	12	5	5	129	Optimal

13	15	14	13	13	13	12	135	Optimal
14	13	15	19	17	18	20	151	Optimal
15	14	12	17	15	15	14	140	Optimal
16	17	16	13	14	10	3	131	Optimal
18	16	15	18	12	12	6	136	Optimal
17	16	15	13	12	13	9	139	Optimal

13	14	8	17	2	11	13	128	Optimal
16	14	14	15	12	14	11	137	Optimal
12	10	9	14	17	19	15	141	Optimal
10	5	2	7	12	8	6	85	Marginal

14	16	12	16	9	9	4	118	Optimal
18	13	7	14	18	18	16	151	Optimal
10	14	2	18	8	13	5	105	Marginal
7	15	3	11	15	6	2	96	Marginal
9	11	8	12	8	10	8	100	Marginal

16	14	6	13	12	15	16	131	Optimal
10	12	4	5	10	9	4	94	Marginal
12	10	13	12	11	11	10	111	Optimal

15	13	13	13	16	14	9	128	Optimal

10	16	8	15	10	8	1	95	Marginal
18	12	14	16	14	17	8	155	Optimal

17	13	11	18	15	18	19	159	Optimal
16	9	10	19	14	13	10	131	Optimal
15	5	5	16	18	17	15	134	Optimal

10	11	10	14	15	12	3	114	Optimal

10	6	5	11	8	6	7	92	Marginal
13	7	5	13	14	12	11	116	Optimal
17	13	12	14	11	9	10	132	Optimal
9	8	7	14	10	8	6	99	Marginal
7	14	6	13	8	9	8	105	Marginal
6	3	4	12	8	3	1	77	Marginal
5	4	3	14	12	4	4	88	Marginal
13	13	9	15	16	10	6	131	Optimal

14	13	13	15	12	14	6	134	Optimal
18	11	14	13	17	18	16	148	Optimal

16	16	14	19	20	14	16	156	Optimal

12	16	14	11	16	13	3	112	Optimal

9	2	2	18	4	2	18	78	Marginal
5	2	2	16	9	14	14	98	Marginal
6	11	2	13	10	12	17	108	Marginal

15	9	8	15	14	15	12	132	Optimal
16	15	13	19	15	20	18	154	Optimal
16	11	14	14	19	18	10	140	Optimal
14	11	11	13	17	13	7	127	Optimal
13	15	9	17	14	15	7	130	Optimal
10	6	11	15	18	14	13	130	Optimal
17	17	10	18	8	14	14	143	Optimal

14	13	9	14	4	14	14	134	Optimal

15	11	10	15	16	16	12	142	Optimal
12	2	1	14	15	16	14	110	Optimal
16	19	15	20	16	20	17	158	Optimal
16	15	14	18	13	14	18	149	Optimal
16	15	15	19	17	14	19	153	Optimal
17	10	12	18	15	17	17	154	Optimal
17	14	4	17	12	14	14	138	Optimal
14	15	10	17	12	16	14	144	Optimal

13	12	9	14	11	15	10	120	Optimal
14	14	14	13	14	14	2	129	Optimal
12	9	7	17	6	13	10	116	Optimal
15	13	10	16	14	14	13	136	Optimal

15	14	10	10	14	9	6	118	Optimal
12	5	7	12	14	8	4	105	Marginal
5	8	12	9	16	15	11	124	Optimal

7	9	11	2	16	12	10	112	Optimal
10	9	10	3	8	7	6	83	Marginal

14	12	10	11	13	13	11	122	Optimal

14	11	13	14	18	18	18	153	Optimal
17	8	9	17	16	16	16	142	Optimal
13	14	12	17	15	18	18	151	Optimal
19	17	16	19	17	18	19	170	Optimal

15	13	6	11	15	10	4	117	Optimal
10	10	9	12	9	10	2	81	Marginal
15	10	7	16	16	10	8	127	Optimal
12	12	10	17	14	16	14	140	Optimal

12	12	15	14	16	12	3	120	Optimal
12	13	10	11	11	11	9	116	Optimal
16	13	15	12	14	16	12	147	Optimal
12	14	10	12	16	15	13	130	Optimal

16	15	14	13	15	18	14	142	Optimal
16	12	11	13	17	16	6	131	Optimal
15	10	10	11	12	16	10	127	Optimal
13	13	10	15	15	15	14	138	Optimal

16	16	16	12	16	13	4	129	Optimal
16	12	13	6	14	12	3	116	Optimal
16	11	12	7	16	10	3	123	Optimal
17	13	14	14	13	12	10	141	Optimal
16	6	8	12	12	11	9	117	Optimal
15	11	12	15	13	14	11	137	Optimal
16	10	10	16	17	13	11	132	Optimal

18	10	17	16	14	6	3	130	Optimal
11	6	8	14	17	17	11	128	Optimal
13	13	13	12	12	15	16	131	Optimal
18	15	15	16	11	15	11	142	Optimal
14	10	11	13	13	14	13	130	Optimal

15	14	16	20	18	20	20	159	Optimal

10	5	5	13	13	11	9	101	Marginal
15	12	7	13	13	12	9	119	Optimal
9	10	12	14	14	12	5	112	Optimal
12	11	12	13	16	16	18	138	Optimal
11	11	10	16	13	17	16	136	Optimal

11	11	8	10	14	10	4	110	Optimal
16	16	10	18	17	14	15	156	Optimal
16	11	9	18	15	14	11	139	Optimal
3	8	1	14	13	10	10	98	Marginal

14	9	12	16	15	13	13	135	Optimal

10	10	10	12	16	13	3	114	Optimal

12	17	17	13	13	14	2	129	Optimal
15	15	13	15	12	12	12	142	Optimal
8	13	13	11	11	10	10	116	Optimal
12	15	14	14	14	15	5	130	Optimal

16	19	16	17	12	15	6	144	Optimal
15	14	11	19	8	11	13	129	Optimal
15	12	10	19	17	18	20	163	Optimal
17	16	15	12	16	13	9	139	Optimal
10	11	10	18	4	14	14	119	Optimal

12	13	11	16	16	17	3	122	Optimal
18	15	15	16	14	10	5	132	Optimal
15	15	13	15	10	15	17	137	Optimal

17	10	7	16	11	13	14	129	Optimal
18	14	8	13	14	14	12	143	Optimal
15	17	9	13	19	15	10	149	Optimal
18	14	15	19	16	18	20	168	Optimal
17	16	15	16	14	16	14	143	Optimal

16	15	15	19	12	12	11	139	Optimal
12	11	11	17	14	16	13	130	Optimal
15	15	6	16	11	14	15	141	Optimal
14	12	16	18	12	14	15	139	Optimal
11	6	5	10	17	10	9	117	Optimal
16	14	14	7	18	17	5	129	Optimal

SCORE

Matthew Klasen/DC/USEPA/US
01/27/2011 12:52 PM

To Michael Slimak
cc Gregory Peck
bcc
Subject Re: Fw: Mining call Jan.25--heads up

Hi Mike,

Sorry for the delay, and nothing's been set up thus far. I'm copying Greg to get his sense of what the easiest way to set up such a meeting would be.

Next week would still be ideal but I know there's limited time between now and then for folks to prep and scheduling could be tough.

As I mentioned in my message, I think the important topics for the meeting are:

- Summary of SAB's recommendations (both reports, but most of the time on conductivity)
- Summary of public comments (both reports, but focus on conductivity and NMA)
- Getting OW/AO advice on how to target your report revisions (something you've noted would help ORD)
- Brief discussion of next steps (timeline for SAB, timeline for report finalization, handoff to OST on WQC, etc.)

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Michael Slimak | Matt: I was not able to call-in for the Jan 25 MT... | 01/26/2011 04:31:11 PM

From: Michael Slimak/DC/USEPA/US
To: Matthew Klasen/DC/USEPA/US@EPA
Date: 01/26/2011 04:31 PM
Subject: Fw: Mining call Jan.25--heads up

Matt: I was not able to call-in for the Jan 25 MTM call, but please note Susan's email below. Is there a meeting with Bob Sussman next week on ORD's response to the SAB?

Mike
----- Forwarded by Michael Slimak/DC/USEPA/US on 01/26/2011 04:28 PM -----

From: Susan Cormier/CI/USEPA/US
To: Michael Slimak/DC/USEPA/US@EPA, Michael Troyer/CI/USEPA/US@EPA, Jeff Frithsen/DC/USEPA/US@EPA
Cc: Susan Norton/DC/USEPA/US@EPA, Glenn Suter/CI/USEPA/US@EPA
Date: 01/26/2011 04:22 PM
Subject: Mining call Jan.25--heads up

On the Jan 25 Mining call ORD was asked about SAB. I indicated that there was one more round of review after edits made by the panel and we expected this next review in 3 weeks.
Questions were asked regarding using other measures besides conductivity. I indicated that TDS is more

expensive to measure but can be converted. Osmotic pressure as asked, I indicated that I would need to know how it was measured or if it was a calculated value.

Matt Klasen indicated that a call is being set up with Sussman and ORD regarding the response to SAB and public comments for next week. I have not more information on this.

Other items:
Tetratech should complete edits to the Excel spread sheet. ORD will still need to update the response to SAB comments and generally make decisions on each suggested change by the contractor.

I am going to attempt to resend the response to public comments on the April 1st Guidance by OW.

back to writing. Susan

Susan M. Cormier, Ph. D.
National Center for Environmental Assessment
USEPA
26 W. M. L. King Drive
Cincinnati, OH 45268
Telephone: 513-569-7995
Alternate work phone: (b) (6) [redacted]
Fax: 513-569-2540

Gregory Peck/DC/USEPA/US	To	Matthew Klasen
01/27/2011 04:29 PM	cc	
	bcc	
	Subject	Re: Fw: Eastern Coal Regional Roundtable meeting, March 21-23

Randy Pomponio

Gregory E. Peck
Chief of Staff
Office of Water
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

202-564-5778

Matthew Klasen	Hey Greg, See below. Any thoughts on a speak...	01/27/2011 04:15:38 PM

From: Matthew Klasen/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA
Date: 01/27/2011 04:15 PM
Subject: Fw: Eastern Coal Regional Roundtable meeting, March 21-23

Hey Greg,

See below. Any thoughts on a speaker for this meeting coming up in WV? The relevant draft session description is below:

http://www.easterncoal.org/StateoftheRegionRoundtable.html

EPA's conductivity ruling, OSM's Stream Protection Ruling, Nationwide Permit 21
What are the benefits of using conductivity as a basis for ecological viability? What in energy extraction/ production, leads
How might this affect the economic viability of business? How will water quality for human use be impacted with lower co
likely to benefit from lower conductivity?

What proposed rulings are particularly helpful/ challenging to each stakeholder group?

What will be the significance of fewer exceptions to the "approximate original contour" requirement of surface mining ope
definition of a stream impact business and how is water quality downstream impacted based on these definitions? Are there
be generally agreed upon by everyone? OSM is proposing new Stream Protection Rules under 11 different proposals.

What is Nationwide Permit 21? What are the ramifications to all parties in having a generalized permitting process? How a
impacted by its suspension? How are watersheds impacted? What are the causes of suspension, will it continue?

My initial instinct would be Joe in OST or someone in R3, but this could get dicey and very non-science-based very quickly -- and the timing is a bit sensitive being so soon before April 1.

Thanks,
Matt

Matt Klasen
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----- Forwarded by Matthew Klasen/DC/USEPA/US on 01/27/2011 04:14 PM -----

From: Matthew Klasen/DC/USEPA/US
To: Michael Slimak/DC/USEPA/US@EPA
Cc: Jeff Frithsen/DC/USEPA/US@EPA, Michael Troyer/CI/USEPA/US@EPA
Date: 01/27/2011 04:11 PM
Subject: Re: Fw: Eastern Coal Regional Roundtable meeting, March 21-23

Definitely sounds like a fair assessment to me. The meeting website does use strange phrases like "conductivity rule" that suggests much more of a policy focus, as Mike mentions.

Let me check with folks here; I imagine someone from R3 or OST might be better for this instead.

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
(b) (6) [redacted]

Michael Slimak | Matt: ORD's conductivity team is in need of ever... | 01/27/2011 03:48:55 PM

From: Michael Slimak/DC/USEPA/US
To: Matthew Klasen/DC/USEPA/US@EPA
Cc: Michael Troyer/CI/USEPA/US@EPA, Jeff Frithsen/DC/USEPA/US@EPA
Date: 01/27/2011 03:48 PM
Subject: Fw: Eastern Coal Regional Roundtable meeting, March 21-23

Matt: ORD's conductivity team is in need of every day to complete the report by the end of March. While we would like to attend, we do not feel we have the time.

Mike
----- Forwarded by Michael Slimak/DC/USEPA/US on 01/27/2011 03:47 PM -----

From: Michael Troyer/CI/USEPA/US
To: slimak.michael@epa.gov, Jeff Frithsen/DC/USEPA/US@EPA
Date: 01/27/2011 03:01 PM
Subject: Eastern Coal Regional Roundtable meeting, March 21-23

I have a voice mail from a Devon Duncan of ECRR to suggest someone to attend their upcoming "State of the Region" meeting. Looks like they're more interested in "rulemaking" than the science of our MTM or conductivity reports. Any suggestions?

Thanks,

Mike

Greg Pond/R3/USEPA/US
01/28/2011 02:04 PM

To Margaret Passmore
cc
bcc
Subject EPA benthics kmz

See if this works. Here are sites for all 298 samples we have in the MTM database. Multiple collections per site for your PEIS survey of conditions report.

Give me some feedback. I like seeing conductivity value but can re-import w/ diff. template.

EPA benthics Google Earth.kmz

Greg Pond
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pond.greg@epa.gov
Website: http://epa.gov/reg3esd1/3ea50.htm

Michael Troyer/CI/USEPA/US	To	Matthew Klasen, Michael Dunn
01/31/2011 10:04 AM	cc	slimak.michael
	bcc	
	Subject	Re: Fw: Eastern Coal Regional Roundtable meeting, March 21-23

Thanks Matt. It was a cold call to me so I don't have any further details... here's the contact info to get back with this organization...

Dvon Duncan
(b) (6) [redacted]

http://www.easterncoal.org/staff.html

Best,

Mike

Michael E. Troyer, PhD
Chief, Biological Risk Assessment Branch
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U.S. Environmental Protection Agency
Cincinnati, OH 45268

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troyer.michael@epa.gov | http://www.epa.gov/ncea

Matthew Klasen	Hi Mike, Hope you enjoyed your weekend.	01/31/2011 09:05:29 AM

From:	Matthew Klasen/DC/USEPA/US
To:	Michael Dunn/R3/USEPA/US@EPA
Cc:	Michael Slimak/DC/USEPA/US@EPA, Michael Troyer/CI/USEPA/US@EPA, Jeff Frithsen/DC/USEPA/US@EPA, Gregory Peck/DC/USEPA/US@EPA
Date:	01/31/2011 09:05 AM
Subject:	Fw: Eastern Coal Regional Roundtable meeting, March 21-23

Hi Mike,

Hope you enjoyed your weekend.

See the note below from Mike Slimak in ORD. I've talked with folks in OW and we think that Randy would be the best EPA rep for the following session of the coal conference in Pipestem, WV in late March. (This roundtable conference was mentioned by the Corps at our January CEQ MTM meeting, and it looks like R3 has played a role in facilitating this event.)

Details are at http://www.easterncoal.org/StateoftheRegionRoundtable.html -- and I think the session Mike Troyer was asked about is as follows (with presumed EPA contributions in **bold**):

> EPA's conductivity ruling, OSM's Stream Protection Ruling, Nationwide Permit 21
>
> What are the benefits of using conductivity as a basis for ecological viability ? What in energy extraction/ production, leads to increases in conductivity ? How might this affect the economic viability of business ? How will water quality for human use be impacted with lower conductivity ?

What species are likely to benefit from lower conductivity ?

What proposed rulings are particularly helpful/ challenging to each stakeholder group?

What will be the significance of fewer exceptions to the "approximate original contour" requirement of surface mining operations? How does the definition of a stream impact business and how is water quality downstream impacted based on these definitions? Are there any proposed actions that can be generally agreed upon by everyone? OSM is proposing new Stream Protection Rules under 11 different proposals.

What is Nationwide Permit 21? What are the ramifications to all parties in having a generalized permitting process? How are energy extraction businesses impacted by its suspension? How are watersheds impacted? What are the causes of suspension, will it continue?

Can you check with Randy to see if he's available to attend and be a panelist during this session? Mike Troyer probably has a better idea of which day the organizers are planning to hold this session (given that this is a three-day conference). I'd suspect the 22nd or 23rd, given that this is Track 5 of a five-track conference.

Let me know if this works -- thanks!

-Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
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-----Forwarded by Matthew Klasen/DC/USEPA/US on 01/30/2011 10:33PM -----

To: Matthew Klasen/DC/USEPA/US@EPA
From: Michael Slimak/DC/USEPA/US
Date: 01/27/2011 03:48PM
Cc: Michael Troyer/CI/USEPA/US@EPA, Jeff Frithsen/DC/USEPA/US@EPA
Subject: Fw: Eastern Coal Regional Roundtable meeting, March 21-23

Matt: ORD's conductivity team is in need of every day to complete the report by the end of March. While we would like to attend, we do not feel we have the time.

Mike

----- Forwarded by Michael Slimak/DC/USEPA/US on 01/27/2011 03:47 PM -----

From: Michael Troyer/CI/USEPA/US
To: slimak.michael@epa.gov, Jeff Frithsen/DC/USEPA/US@EPA
Date: 01/27/2011 03:01 PM
Subject: Eastern Coal Regional Roundtable meeting, March 21-23

I have a voice mail from a Devon Duncan of ECRR to suggest someone to attend their upcoming "State of the Region" meeting. Looks like they're more interested in "rulemaking" than the science of our MTM or conductivity reports. Any suggestions?

Thanks,

Mike

Tom Laverty/DC/USEPA/US
01/19/2011 06:31 PM

To Gary Hudiburgh, Sharmin Syed, David Hair, Js Wilson, Marcus Zobrist, Colleen Forestieri, Sarita Hoyt
cc
bcc
Subject Fw: Summary of SAB call today on ORD MTM reports

Folks,

I think we need to alert Deborah and Jim to the direction that the SAB review is likely to push the reports in, particularly with respect to the geographic and hydrologic range of applicability for the conducitivity results.

tom

----- Forwarded by Tom Laverty/DC/USEPA/US on 01/19/2011 06:29 PM -----

From: Matthew Klasen/DC/USEPA/US
To: Gregory Peck/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA, Bob Sussman/DC/USEPA/US@EPA, Nancy Stoner/DC/USEPA/US@EPA, Peter Silva/DC/USEPA/US@EPA, Karyn Wendelowski/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA, MichaelG Lee/DC/USEPA/US@EPA, Sharmin Syed/DC/USEPA/US@EPA, Tom Laverty/DC/USEPA/US@EPA, Marcus Zobrist/DC/USEPA/US@EPA, Brian Frazer/DC/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA, Brian Topping/DC/USEPA/US@EPA, Timothy Landers/DC/USEPA/US@EPA, David Evans/DC/USEPA/US@EPA, Tanya Code/DC/USEPA/US@EPA, Js Wilson/DC/USEPA/US@EPA, Colleen Forestieri/DC/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA, John Pomponio/R3/USEPA/US@EPA, Jon Capacasa/R3/USEPA/US@EPA, Jim Giattina/R4/USEPA/US@EPA, Tinka Hyde/R5/USEPA/US@EPA, Ephraim King/DC/USEPA/US@EPA, Betsy Behl/DC/USEPA/US@EPA
Cc: Michael Slimak/DC/USEPA/US@EPA, Susan Cormier/CI/USEPA/US@EPA, Glenn Suter/CI/USEPA/US@EPA, Susan Norton/DC/USEPA/US@EPA, Joe Beaman/DC/USEPA/US@EPA, Lisa Huff/DC/USEPA/US@EPA, Joe Beaman/DC/USEPA/US@EPA, Rachael Novak/DC/USEPA/US@EPA
Date: 01/19/2011 06:08 PM
Subject: Summary of SAB call today on ORD MTM reports

Hi everyone,

Given the broad interest in the SAB's review of ORD's draft MTM reports, I thought I'd send around a summary of the discussion. (This represents my unofficial summary only.)

Background: Today's teleconference was a "quality review" by the full SAB of the SAB Panel's draft reports. Today's call, run by the Chair of the SAB, consisted of public comments, a summary of each report from the Panel, a set of oral comments provided by a set of SAB reviewers, and a vote by the SAB on how to proceed with each report.

Summary of Discussion: In general, the SAB was supportive of the content of the Panel's draft reports, and offered suggested improvements (largely to encourage the Panel to take a second look at specific issues or to clarify its recommendations). The Panel spent more time discussing the MTM/VF impacts report than the conductivity report, and the call finished well ahead of schedule. A more detailed summary of the issues that were discussed is attached.

NMA Comments: NMA provided public comments at the outset of the meeting, criticizing the SAB process for its "disappointing" draft reports and its inadequate consideration of NMA's public comments and scientific analyses.

Next Steps: At the conclusion of the discussion, the Board approved each report pending revisions by the Panel and a re-review by a subset of SAB members. So the full SAB will not meet again to consider these reports and will defer to a subset of the group for final approval. The SAB staff office expects final SAB reports to be sent to the Administrator within 30 days.

Attached is a more detailed summary of what was discussed.

Finally, in terms of responding to any press inquiries that come in regarding NMA's strong process comments on today's call, it's worth pointing out that while the SAB does not pull together a formal response to public comments, ORD is pulling together a response to all public comments as it works to revise both reports.

Let me know if you have any questions.

Thanks,
Matt

[attachment "2011-01-19 MTM SAB Quality Review Telecon Summary.docx" deleted by Tom Laverty/DC/USEPA/US]

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Stefania Shamet/R3/USEPA/US
11/01/2010 10:38 AM

To Palmer Hough, Christopher Hunter
cc
bcc
Subject This might be useful for Spruce FD -- Fw: Golden Algae Growth Rate Study - Final Report

----- Forwarded by Stefania Shamet/R3/USEPA/US on 11/01/2010 10:37 AM -----

From: Louis Reynolds/R3/USEPA/US
To: Frank Borsuk/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US, Greg Pond/R3/USEPA/US@EPA, Amy Bergdale/R3/USEPA/US@EPA, Kelly Krock/R3/USEPA/US@EPA, Jennifer Fulton/R3/USEPA/US@EPA
Cc: Stefania Shamet/R3/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA
Date: 10/28/2010 04:46 PM
Subject: Fw: Golden Algae Growth Rate Study - Final Report

(b) (5) [redacted]

A nice piece of work funded by WVDEP.

Lou

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Freshwater Biology Team
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----- Forwarded by Louis Reynolds/R3/USEPA/US on 10/28/2010 04:34 PM -----

From: Chad Harsh/R3/USEPA/US
To: Louis Reynolds/R3/USEPA/US@EPA, Frank Borsuk/R3/USEPA/US@EPA
Date: 10/28/2010 07:43 AM
Subject: Fw: Golden Algae Growth Rate Study - Final Report

in case you did not get this from wv.
----- Forwarded by Chad Harsh/R3/USEPA/US on 10/28/2010 07:42 AM -----

From: "Zeto, Michael A" <Michael.A.Zeto@wv.gov>
To: Chad Harsh/R3/USEPA/US@EPA, Nina Rivera/R3/USEPA/US@EPA, Amanda Helwig/DC/USEPA/US@EPA, "Hinrichsen, Britta (ENRD)" (b) (6) [redacted], "Thoms, (b) (6) [redacted]
Date: 10/27/2010 02:49 PM
Subject: FW: Golden Algae Growth Rate Study - Final Report

fyi

From: Wirts, John C
Sent: Wednesday, October 27, 2010 10:13 AM
To: Spear, Richard; Schwartz, Ronald; Jernejcic, Frank; Mandirola, Scott G; Zeto, Michael A; Swiger,

Bradley C; Parsons, Mark J; Clarke, Thomas L; Preston, Bret A; Carico, Charles M; Wiles, Loren B
Subject: Golden Algae Growth Rate Study - Final Report

WVDEP contracted Dr. Dave Hambright (U of Oklahoma) to compare the growth rates of Dunkard strain P. parvum at varying salinities.
Attached is his final report summarizing his study.
Dave measured growth of P. parvum in various concentrations of Dunkard like chemistry (high sulfate and chlorides) as well as a more typical salt water mix (Instant Ocean).
As expected and in line with other studies, he found both that the growth of P. parvum slowed and was increasingly out-competed by other algae in lower conductivity waters.

John Wirts
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GrowthRate_FinalReport.pdf

Prymnesium parvum Growth Studies Using the Dunkard Creek Isolate (WANA Strain)

Report submitted to:
West Virginia Department of Environmental Protection
Division of Water and Waste Management
Charleston, WV

K. David Hambright
Plankton Ecology Laboratory
Biological Station
and
Program in Ecology and Evolutionary Biology
Department of Zoology
University of Oklahoma, Norman, OK

7 October 2010 (amended 25 Oct 2010)

Prymnesium parvum Growth Studies Using the Dunkard Creek Isolate (WANA Strain)

Introduction

The golden alga *Prymnesium parum* bloomed in Dunkard Creek (WV-PA) in September and October 2009 resulting in devastating fish, mussel, and salamander kills over a 30 mile stretch of the stream. Preliminary investigations led to the hypothesis that increased salinities resulting from high saline discharges by local mining activity were conducive to the bloom. Study with strains of *P. parvum* isolated from Texas and Oklahoma, in waters of relatively high salinities, suggest that *P. parvum* growth rates are depressed at lower salinities. It is further hypothesized growth rates of the Dunkard Creek strain of *P. parvum* might also be reduced at lower salinities. If so, a possible management action aimed at Dunkard Creek salinity reduction is warranted. The purpose of this study was to analyze growth rates of the Dunkard Creek *P. parvum* strain at different salinities.

Methods

The strain of *P. parvum* that was found in the Dunkard Creek Watershed and identified as the proximate cause of fish and other aquatic life kills in September and October 2009 was used to establish laboratory cultures at University of Oklahoma Biological Station (UOBS). Water from Dunkard Creek was shipped to UOBS for establishment of non-axenic cultures in modified COMBO medium (Kilham et al. 1998) with high salinity (6 or 15 g Instant Ocean L^{-1}; equivalent to ~10,000 and 23,000 µS cm^{-1}, respectively) and high nutrients (800 and 50 µ moles L^{-1} N and P). Cultures used in experiments reported here (WANA 576 and WANA 578; different cell lineages isolated from the original water sample) were >99% pure, with unidentified green unicells and diatoms present in extremely low abundances.

We performed two replicate 6-day experiments (experiments 1 and 2) and one 14-day experiment (experiment 3) to track golden algae growth rates (absolute and relative to other Dunkard Creek algae present in cultures) across gradients of salinity. In experiments 1 and 2, salinity treatments were created to mimic the 4:1 sulfate and chloride concentrations in Dunkard Creek water in the area of the coal mine discharge (2 g sulfate, as calcium sulfate, and 0.5 g chloride, as sodium chloride, L^{-1}; i.e., full-strength or 1× mine pool water) and multiple dilutions of full-strength mine discharge water (i.e., at 0.5×, 0.25×, 0.125×, 0.06×, and 0× mine pool water). All salinity treatments were replicated 5 times. Experiments were conducted in 250- (experiment 1) and 125-mL (experiment 2) Erlenmeyer flasks at room temperature and on a 12-hr light:12-hr dark schedule. Following inoculation of experimental flasks, golden algal densities were tracked using flow cytometry-based enumeration of cell densities initially and every second day. Both experiments were terminated after 6 days due to high incidence of contamination in experimental cultures. Experiment 3 was set up in a similar manner, but using Instant Ocean to establish the salinity gradient (0, 2, 4, 6, 10, and 15 g Instant Ocean L^{-1}, three replicates each) and was run for 14 days to measure both, initial growth rates of golden algae, but also to quantify golden algae's growth response to different salinities relative to other algae in the cultures.

Experiment 1 was initiated from a WANA 576 culture containing 7,600 cells mL^{-1}, by adding 30-mL aliquots to 1-L flasks containing COMBO, 80 µ mole N and 5 µ mole P L^{-1}, and variable salinities. Each liter was then divided evenly among five 250-mL Erlenmeyer flasks, 150 mL each, with starting densities of golden algae ~228 cells mL^{-1} in each flask. Experiment 2 was initiated from a WANA 576 culture containing 10,800 cells mL^{-1}, by adding 15-mL aliquots to 500-mL flasks containing COMBO and variable salinities as above. Each liter was then divided evenly among five 125-mL Erlenmeyer flasks, 75 mL each, with starting densities of golden algae ~324 cells mL^{-1} in each flask. Experiment 3 was initiated from WANA 578 culture containing 2,020,000 cells mL^{-1}, by adding 3.5-mL aliquots to 500-mL flasks

containing COMBO, 80 µ mole N and 5 µ mole P L^{-1}, and variable salinities. Starting densities of golden algae in each flask were ~15,000 cells mL^{-1}.

Salinity for each sample was measured as conductivity (Hach HQ40d meter) at 22.4 C and recorded in µS cm^{-1}. pH was measured using a Fisher Accumet pH Meter Model 915. Flasks were swirled daily. Initially, and every second day, a 500 µL sample was analyzed on a BD FACSCaliber flow cytometer to determine golden algal cell densities. For Experiment 3, densities of contaminant algae were also recorded. Additional samples from all experiments were preserved in Lugol's solution and used to verify flow cytometer counts.

In all sulfate-chloride salinity treatments of experiments 1 and 2, the sudden change in culture medium from COMBO with Instant Ocean to COMBO with sulfates and chlorides only as the source of salts resulted in high mortality of golden algae (mean = 37%). Similar initial mortality, or shock, has been observed previously when transferring golden algae to new culture medium conditions. After two days, all cultures had recovered and were growing well, except the highest sulfate-chloride treatments, which are not considered in the analyses below. Maximum growth rates in each treatment were calculated as the slope of the exponential regression of cell density and time (Fig. 1). Maximum growth rates of *P. parvum* in experiment 3 were calculated using data from day 0 to day 7.

Results

Both experiments 1 and 2 revealed similar responses of WANA 576 to changes in salinities using sulfates and chlorides and have been combined for analysis. Growth rates of *P. parvum* between day 2 and day 6 were positive, but declined with declining salinities, especially below 1000 µS cm^{-1} (Fig. 2). Experiments were terminated after day 6 because of relatively high contamination (data not shown). Experiment 3 revealed that the decline in *P. parvum* growth rates with declining salinity, as well as the high level of contamination over time was not an artifact of using sulfate and chloride as sources of salinity in the cultures. Growth rates in the lowest salinity treatment were more than 50% lower than in the highest salinity treatment (Fig. 3). Although all treatments were eventually highly contaminated over time, the level of contamination increased with decreasing salinity (Fig. 4). The contaminants, a small diatom and unidentified green unicell (~4 µm diameter), both presumably from the original Dunkard Creek water and present in all cultures at extremely low abundances, had highest growth rates in low salinity treatments and declining growth rates with increasing salinity (Fig. 5).

Discussion and Conclusions

All experiments revealed a relatively strong relationship between *P. parvum* and culture salinities. Patterns observed for isolates from Dunkard Creek were similar to patterns observed previously in other *P. parvum* isolates (Baker et al. 2007). In general, positive growth rates can be maintained by *P. parvum* across a broad range of salinities (note that Expt 3 salinities covered a much greater range of salinities – up to 15 g L^{-1} Instant Ocean, maximum conductivities >20,000 µS cm^{-1}), but growth rates are substantially lower at salinities equivalent to those observed in most fresh waters (i.e., < 1000 µS cm^{-1}). Moreover, our experiments revealed that not only are *P. parvum* growth rates reduced at lower salinities, but that growth rates of other, presumably native, algae are enhanced at lower salinities. Thus reduced salinities shift the competitive edge from *P. parvum* to other algae.

Reasons behind the lack of *P. parvum* growth in the highest sulfate-chloride treatment are not known. The maximum conductivity obtained with the addition of 2 g of sulfate and 0.5 g of chloride was 4,275 µS cm^{-1}, although the actual amount of sulfate in solution was less than 100%. Compared with Instant Ocean, our standard salinity source of *P. parvum* cultures, this amount of sulfate is high. At 6.6% sulfate by weight, our highest salinity cultures (i.e., 15 g Instant Ocean L^{-1}) contain 1.0 g sulfate L^{-1}, or half the

amount added in the high treatments of experiments 1 and 2. Studies have shown that high sulfates can interfere with nitrogenases in phytoplankton, particularly those associated with nitrogen fixation in cyanobacteria (Marino et al. 1990). But it is also possible that other nitrogenases, such as those used in nitrate assimilation, might also be negatively affected.

High calcium concentrations could be another factor involved with lack of *P. parvum* growth in the high sulfate-chloride treatments and overall low growth rates in all sulfate-chloride treatments (experiments 1 and 2) relative to Instant Ocean treatments (experiment 3) (c.f. Figs. 2 and 3). Sulfates were added as calcium sulfate, in which there is 466 mg of calcium for every 1 g of sulfate. Instant Ocean contains only 1.02% calcium by weight. Thus a 15 g Instant Ocean L^{-1} culture contains only 153 mg calcium L^{-1}. Studies have demonstrated that calcium ions can act as cofactors to *P. parvum* toxins, increasing their toxicity substantially (Shilo 1981). As such, it is conceivable that our use of calcium sulfate inadvertently created conditions of higher toxicity, which may have negatively affected growth or increased mortality via self-toxicity (Olli and Trunov 2007).

Nevertheless, further research could add substantially to our understanding of specific factors involved in the 2009 Dunkard Creek *P. parvum* bloom. In particular, it is recommended that further monitoring and analysis of the chemical composition of the mine water discharges be conducted in order to enhance understanding of the roles of high sulfates and other ions in *P. parvum* population growth and toxicity. Further experimentation also will be required to confidently assess the relative roles of sulfates, calcium, or other ions, in *P. parvum* growth and toxicity in general, but also with respect to the potential for future Dunkard Creek *P. parvum* blooms. While our experiments were conducted in the laboratory with artificially nutrient replete culture media, and there remains uncertainty with respect to sulfates and calcium as described above, our results corroborate the general understanding of *P. parvum* populations, blooms, and fish kills globally – high nutrients and high salinities are major requisites for *P. parvum* domination of algal communities, and especially for *P. parvum* blooms.

Acknowledgments
Algal cultures are maintained by James Easton and Anne Easton. All experiments were performed by Karen Glenn, James Easton, Ann Morris, and Anne Easton. Karen Glenn and Rich Zamor read and commented on earlier drafts of this report. Funding was provided by the West Virginia Department of Environmental Protection.

Literature cited

Baker, J. W., J. P. Grover, B. W. Brooks, F. Urena-Boeck, D. L. Roelke, R. Errera, and R. L. Kiesling. 2007. Growth and toxicity of *Prymnesium parvum* (Haptophyta) as a function of salinity, light, and temperature. J. Phycol. **43:** 219-227.

Marino, R., R. W. Howarth, J. Shamess, and E. Prepas. 1990. Molybdenum and sulfate as controls on the abundance of nitrogen-fixing cyanobacteria in saline lakes in Alberta. Limnol. Oceanogr. **35**: 245-259.

Olli, K., and K. Trunov. 2007. Self-toxicity of *Prymnesium parvum* (Prymnesiophyceae). Phycologia 46: 109-112.

Shilo, M. 1981. The toxic principles of *Prymnesium parvum*, p. 37-47. In W. W. Carmichael [ed.], The water environment: algal toxins and health. Plenum Press.

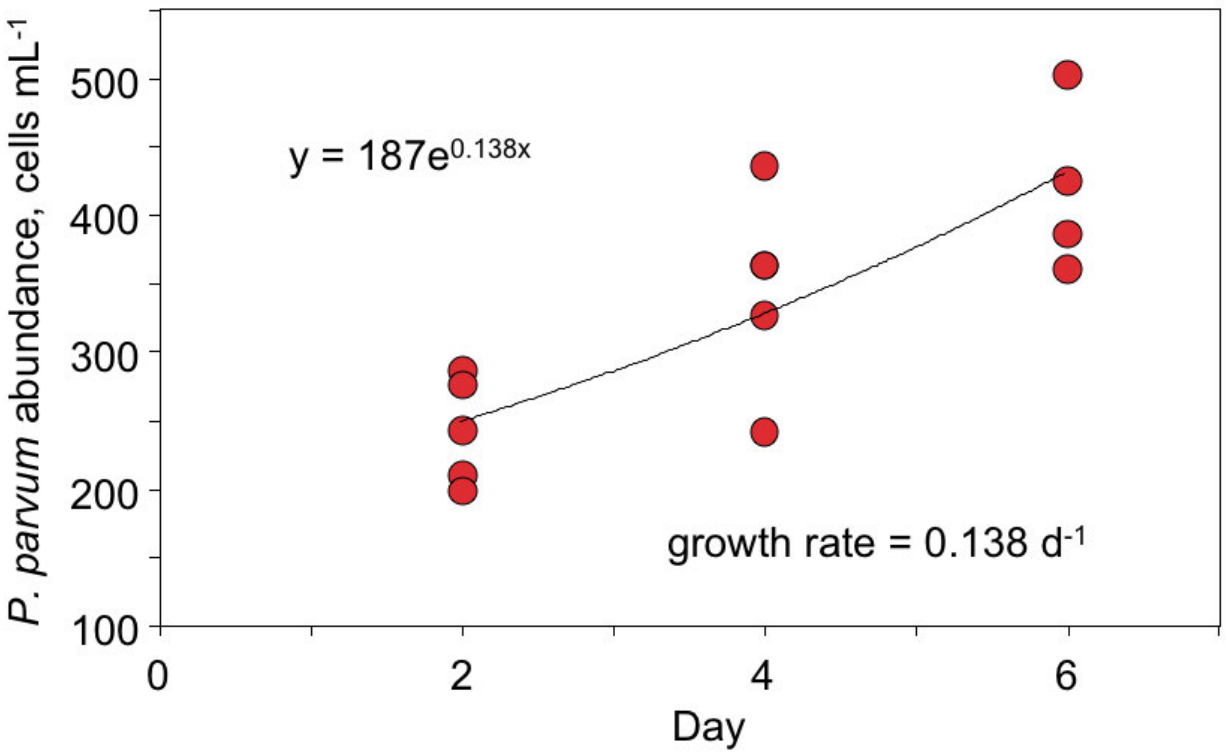

Figure 1. Representative example of growth rate calculation. Points represent *P. parvum* cell densities in experimental flasks (in this case, the 0× treatment of experiment 1) on days 2, 4, and 6. The slope (i.e., the exponent) of an exponential regression through these points is a measure of the instantaneous growth rate in units of per day.

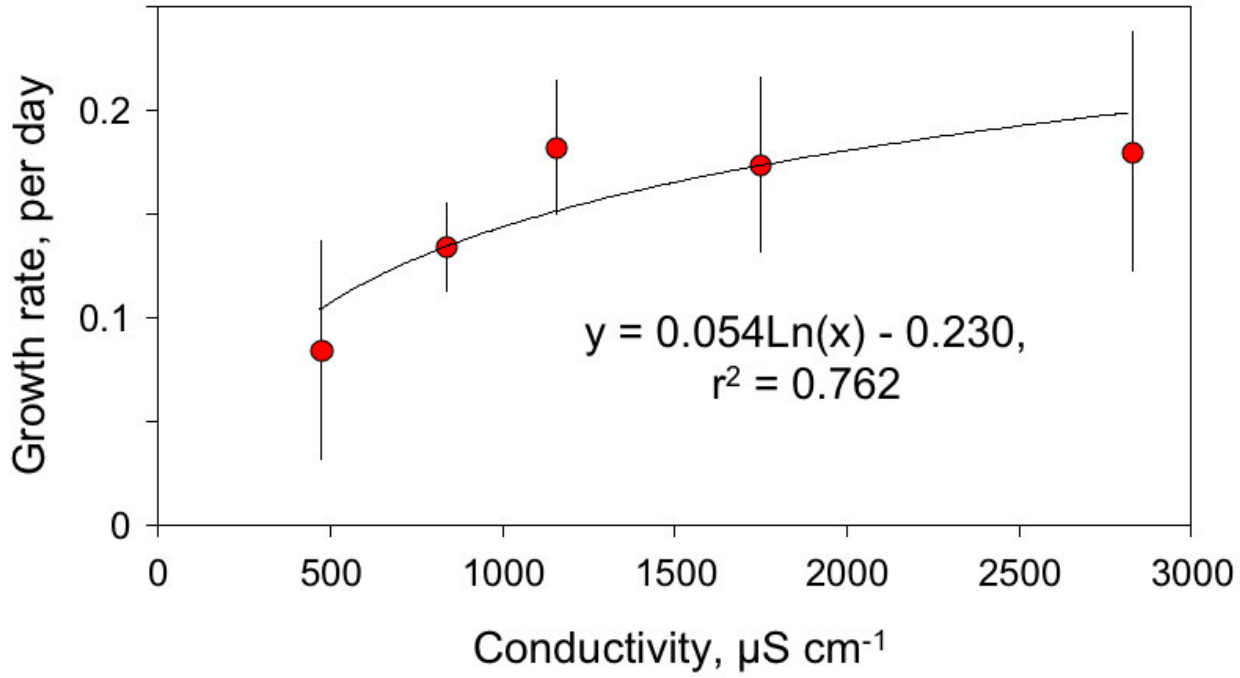

Figure 2. Growth rate of *P. parvum* as a function of sulfate and chloride concentrations (here indicated by conductivity (µS cm^{-1}). Treatments, each replicated 5-fold per experiment and from highest to lowest conductivity, are 1000 mg sulfate and 250 mg chloride, 500 mg sulfate and 125 mg chloride, 250 mg sulfate and 62.5 mg chloride, 125 mg sulfate and 31.3 mg chloride, and 0 mg sulfate and 0 mg chloride. Points represent mean (±SE) values generated separately from experiments 1 and 2 using *P. parvum* cell densities from day 2 to day 6. The highest salinity treatment (2000 mg sulfate and 1000 mg chloride, ~4,082 µS cm^{-1}) was not conducive to *P. parvum* growth and has been omitted here.

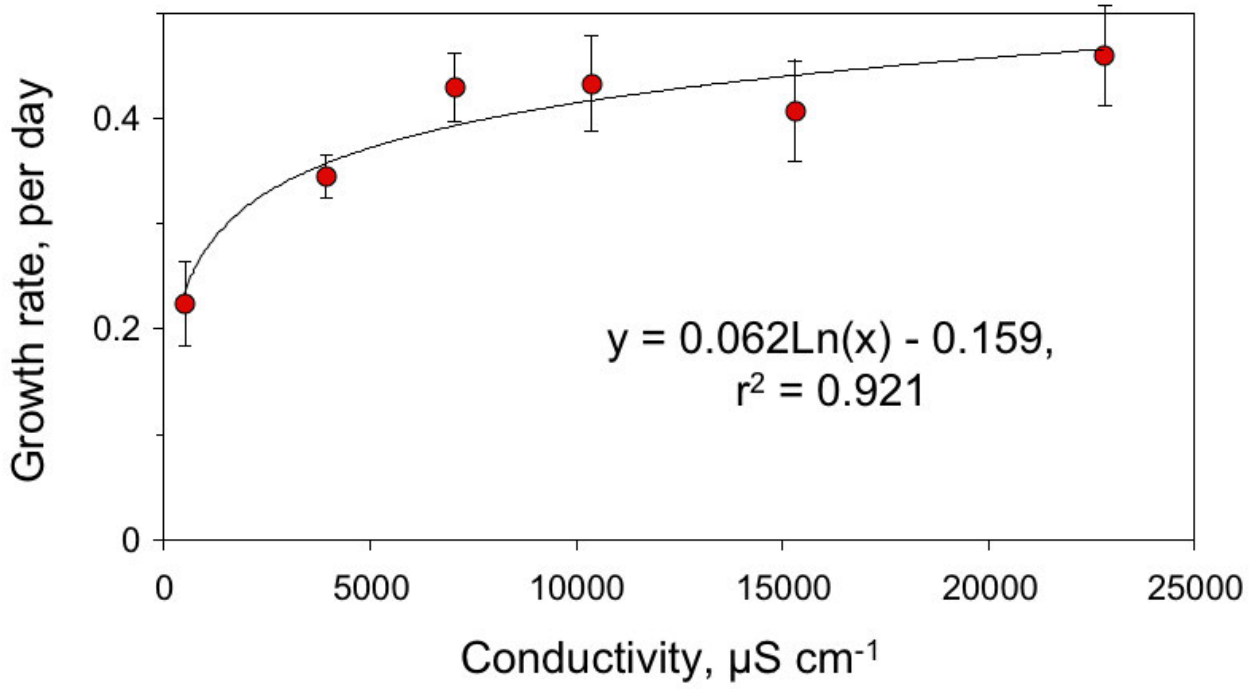

Figure 3. Growth rate of *P. parvum* as a function of Instant Ocean concentrations (here indicated by conductivity (µS cm^{-1}). Treatments, from highest to lowest conductivity, are 15, 10, 6, 4, 2, and 0 g Instant Ocean L^{-1}. Points represent mean (±SE) values generated from day 0 to day 7 growth of *P. parvum* in each treatment from Experiment 3.

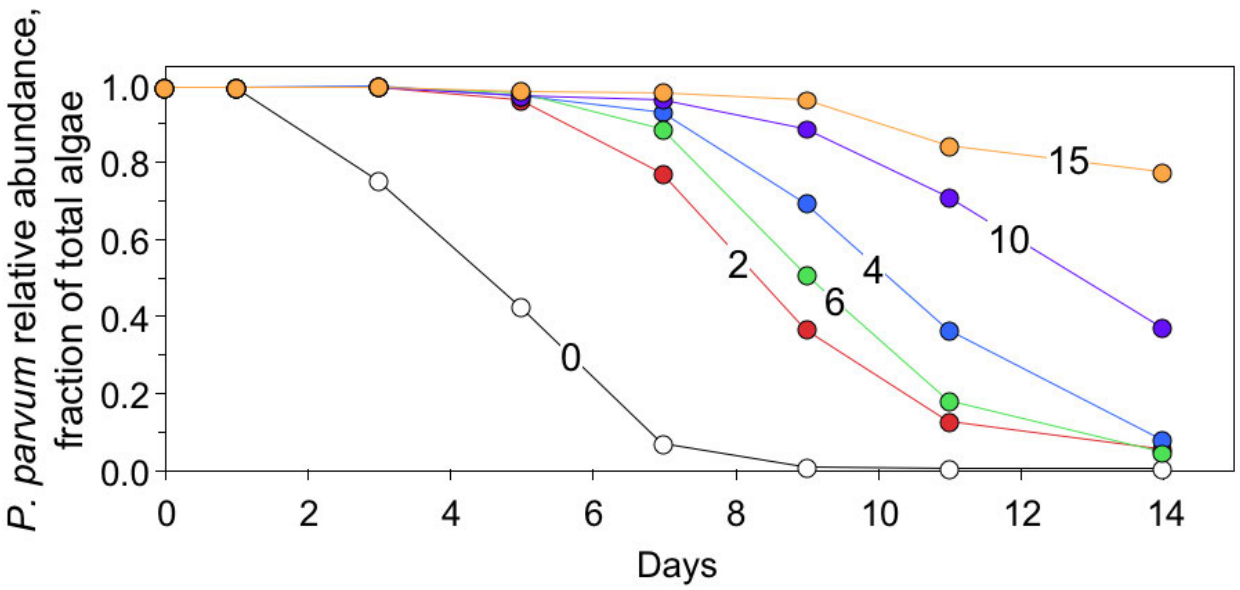

Figure 4. Relative abundance of *P. parvum* (fraction of total algae) in salinity treatments over time in experiment 3. Treatments (i.e., g Instant Ocean L^{-1}) are indicated.

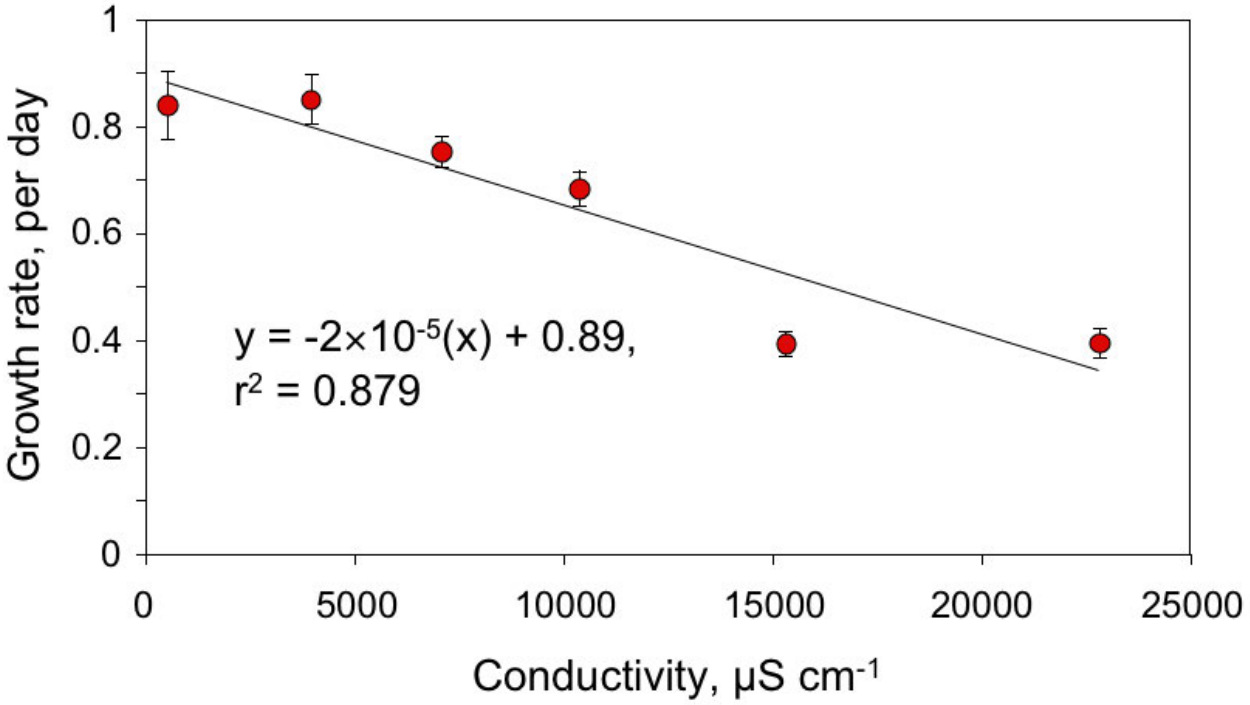

Figure 5. Growth rate of contaminant algae (small unidentified diatom and green unicell) in experiment 3 as a function of Instant Ocean concentrations (here indicated by conductivity (µS cm^{-1}). Rates were calculated from cell densities in days 3 through 14.

Louis Reynolds/R3/USEPA/US
11/01/2010 01:07 PM

To Carrie Traver
cc Regina Poeske
bcc
Subject Fw: Golden Algae Growth Rate Study - Final Report

Carrie,

Please add the attached pdf to the Spruce Refs. This was referred to in the Golden Algae section but a final report was not available at the time. It is now.

Thanks,

Lou

Also - have you figured out a way to get the darter refs to me? Can't we upload them to the connector?

Lou Reynolds
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----- Forwarded by Louis Reynolds/R3/USEPA/US on 11/01/2010 01:03 PM -----

From: Louis Reynolds/R3/USEPA/US
To: Frank Borsuk/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US, Greg Pond/R3/USEPA/US@EPA, Amy Bergdale/R3/USEPA/US@EPA, Kelly Krock/R3/USEPA/US@EPA, Jennifer Fulton/R3/USEPA/US@EPA
Cc: Stefania Shamet/R3/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA
Date: 10/28/2010 04:46 PM
Subject: Fw: Golden Algae Growth Rate Study - Final Report

This work confirms the correlation of golden algae growth with increasing salinity. Also indicates the role of competition (i.e., salinity inhibits competitors of golden algae).

A nice piece of work funded by WVDEP.

Lou

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----- Forwarded by Louis Reynolds/R3/USEPA/US on 10/28/2010 04:34 PM -----

From: Chad Harsh/R3/USEPA/US
To: Louis Reynolds/R3/USEPA/US@EPA, Frank Borsuk/R3/USEPA/US@EPA

Date: 10/28/2010 07:43 AM
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in case you did not get this from wv.
----- Forwarded by Chad Harsh/R3/USEPA/US on 10/28/2010 07:42 AM -----

From: "Zeto, Michael A" <Michael.A.Zeto@wv.gov>
To: Chad Harsh/R3/USEPA/US@EPA, Nina Rivera/R3/USEPA/US@EPA, Amanda Helwig/DC/USEPA/US@EPA, "Hinrichsen, Britta (ENRD)" <Britta.Hinrichsen@usdoj.gov>, "Thoms, Laura (ENRD)" <Laura.Thoms@usdoj.gov>
Date: 10/27/2010 02:49 PM
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fyi

From: Wirts, John C
Sent: Wednesday, October 27, 2010 10:13 AM
To: Spear, Richard; Schwartz, Ronald; Jernejcic, Frank; Mandirola, Scott G; Zeto, Michael A; Swiger, Bradley C; Parsons, Mark J; Clarke, Thomas L; Preston, Bret A; Carico, Charles M; Wiles, Loren B
Subject: Golden Algae Growth Rate Study - Final Report

WVDEP contracted Dr. Dave Hambright (U of Oklahoma) to compare the growth rates of Dunkard strain P. parvum at varying salinities.
Attached is his final report summarizing his study.
Dave measured growth of P. parvum in various concentrations of Dunkard like chemistry (high sulfate and chlorides) as well as a more typical salt water mix (Instant Ocean).
As expected and in line with other studies, he found both that the growth of P. parvum slowed and was increasingly out-competed by other algae in lower conductivity waters.

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Prymnesium parvum Growth Studies Using the Dunkard Creek Isolate (WANA Strain)

Report submitted to:
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7 October 2010 (amended 25 Oct 2010)

Prymnesium parvum Growth Studies Using the Dunkard Creek Isolate (WANA Strain)

Introduction

The golden alga *Prymnesium parum* bloomed in Dunkard Creek (WV-PA) in September and October 2009 resulting in devastating fish, mussel, and salamander kills over a 30 mile stretch of the stream. Preliminary investigations led to the hypothesis that increased salinities resulting from high saline discharges by local mining activity were conducive to the bloom. Study with strains of *P. parvum* isolated from Texas and Oklahoma, in waters of relatively high salinities, suggest that *P. parvum* growth rates are depressed at lower salinities. It is further hypothesized growth rates of the Dunkard Creek strain of *P. parvum* might also be reduced at lower salinities. If so, a possible management action aimed at Dunkard Creek salinity reduction is warranted. The purpose of this study was to analyze growth rates of the Dunkard Creek *P. parvum* strain at different salinities.

Methods

The strain of *P. parvum* that was found in the Dunkard Creek Watershed and identified as the proximate cause of fish and other aquatic life kills in September and October 2009 was used to establish laboratory cultures at University of Oklahoma Biological Station (UOBS). Water from Dunkard Creek was shipped to UOBS for establishment of non-axenic cultures in modified COMBO medium (Kilham et al. 1998) with high salinity (6 or 15 g Instant Ocean L^{-1}; equivalent to ~10,000 and 23,000 µS cm^{-1}, respectively) and high nutrients (800 and 50 µ moles L^{-1} N and P). Cultures used in experiments reported here (WANA 576 and WANA 578; different cell lineages isolated from the original water sample) were >99% pure, with unidentified green unicells and diatoms present in extremely low abundances.

We performed two replicate 6-day experiments (experiments 1 and 2) and one 14-day experiment (experiment 3) to track golden algae growth rates (absolute and relative to other Dunkard Creek algae present in cultures) across gradients of salinity. In experiments 1 and 2, salinity treatments were created to mimic the 4:1 sulfate and chloride concentrations in Dunkard Creek water in the area of the coal mine discharge (2 g sulfate, as calcium sulfate, and 0.5 g chloride, as sodium chloride, L^{-1}; i.e., full-strength or 1× mine pool water) and multiple dilutions of full-strength mine discharge water (i.e., at 0.5×, 0.25×, 0.125×, 0.06×, and 0× mine pool water). All salinity treatments were replicated 5 times. Experiments were conducted in 250- (experiment 1) and 125-mL (experiment 2) Erlenmeyer flasks at room temperature and on a 12-hr light:12-hr dark schedule. Following inoculation of experimental flasks, golden algal densities were tracked using flow cytometry-based enumeration of cell densities initially and every second day. Both experiments were terminated after 6 days due to high incidence of contamination in experimental cultures. Experiment 3 was set up in a similar manner, but using Instant Ocean to establish the salinity gradient (0, 2, 4, 6, 10, and 15 g Instant Ocean L^{-1}, three replicates each) and was run for 14 days to measure both, initial growth rates of golden algae, but also to quantify golden algae's growth response to different salinities relative to other algae in the cultures.

Experiment 1 was initiated from a WANA 576 culture containing 7,600 cells mL^{-1}, by adding 30-mL aliquots to 1-L flasks containing COMBO, 80 µ mole N and 5 µ mole P L^{-1}, and variable salinities. Each liter was then divided evenly among five 250-mL Erlenmeyer flasks, 150 mL each, with starting densities of golden algae ~228 cells mL^{-1} in each flask. Experiment 2 was initiated from a WANA 576 culture containing 10,800 cells mL^{-1}, by adding 15-mL aliquots to 500-mL flasks containing COMBO and variable salinities as above. Each liter was then divided evenly among five 125-mL Erlenmeyer flasks, 75 mL each, with starting densities of golden algae ~324 cells mL^{-1} in each flask. Experiment 3 was initiated from WANA 578 culture containing 2,020,000 cells mL^{-1}, by adding 3.5-mL aliquots to 500-mL flasks

containing COMBO, 80 µ mole N and 5 µ mole P L^{-1}, and variable salinities. Starting densities of golden algae in each flask were ~15,000 cells mL^{-1}.

Salinity for each sample was measured as conductivity (Hach HQ40d meter) at 22.4 C and recorded in µS cm^{-1}. pH was measured using a Fisher Accumet pH Meter Model 915. Flasks were swirled daily. Initially, and every second day, a 500 µL sample was analyzed on a BD FACSCaliber flow cytometer to determine golden algal cell densities. For Experiment 3, densities of contaminant algae were also recorded. Additional samples from all experiments were preserved in Lugol's solution and used to verify flow cytometer counts.

In all sulfate-chloride salinity treatments of experiments 1 and 2, the sudden change in culture medium from COMBO with Instant Ocean to COMBO with sulfates and chlorides only as the source of salts resulted in high mortality of golden algae (mean = 37%). Similar initial mortality, or shock, has been observed previously when transferring golden algae to new culture medium conditions. After two days, all cultures had recovered and were growing well, except the highest sulfate-chloride treatments, which are not considered in the analyses below. Maximum growth rates in each treatment were calculated as the slope of the exponential regression of cell density and time (Fig. 1). Maximum growth rates of *P. parvum* in experiment 3 were calculated using data from day 0 to day 7.

Results

Both experiments 1 and 2 revealed similar responses of WANA 576 to changes in salinities using sulfates and chlorides and have been combined for analysis. Growth rates of *P. parvum* between day 2 and day 6 were positive, but declined with declining salinities, especially below 1000 µS cm^{-1} (Fig. 2). Experiments were terminated after day 6 because of relatively high contamination (data not shown). Experiment 3 revealed that the decline in *P. parvum* growth rates with declining salinity, as well as the high level of contamination over time was not an artifact of using sulfate and chloride as sources of salinity in the cultures. Growth rates in the lowest salinity treatment were more than 50% lower than in the highest salinity treatment (Fig. 3). Although all treatments were eventually highly contaminated over time, the level of contamination increased with decreasing salinity (Fig. 4). The contaminants, a small diatom and unidentified green unicell (~4 µm diameter), both presumably from the original Dunkard Creek water and present in all cultures at extremely low abundances, had highest growth rates in low salinity treatments and declining growth rates with increasing salinity (Fig. 5).

Discussion and Conclusions

All experiments revealed a relatively strong relationship between *P. parvum* and culture salinities. Patterns observed for isolates from Dunkard Creek were similar to patterns observed previously in other *P. parvum* isolates (Baker et al. 2007). In general, positive growth rates can be maintained by *P. parvum* across a broad range of salinities (note that Expt 3 salinities covered a much greater range of salinities – up to 15 g L^{-1} Instant Ocean, maximum conductivities >20,000 µS cm^{-1}), but growth rates are substantially lower at salinities equivalent to those observed in most fresh waters (i.e., < 1000 µS cm^{-1}). Moreover, our experiments revealed that not only are *P. parvum* growth rates reduced at lower salinities, but that growth rates of other, presumably native, algae are enhanced at lower salinities. Thus reduced salinities shift the competitive edge from *P. parvum* to other algae.

Reasons behind the lack of *P. parvum* growth in the highest sulfate-chloride treatment are not known. The maximum conductivity obtained with the addition of 2 g of sulfate and 0.5 g of chloride was 4,275 µS cm^{-1}, although the actual amount of sulfate in solution was less than 100%. Compared with Instant Ocean, our standard salinity source of *P. parvum* cultures, this amount of sulfate is high. At 6.6% sulfate by weight, our highest salinity cultures (i.e., 15 g Instant Ocean L^{-1}) contain 1.0 g sulfate L^{-1}, or half the

amount added in the high treatments of experiments 1 and 2. Studies have shown that high sulfates can interfere with nitrogenases in phytoplankton, particularly those associated with nitrogen fixation in cyanobacteria (Marino et al. 1990). But it is also possible that other nitrogenases, such as those used in nitrate assimilation, might also be negatively affected.

High calcium concentrations could be another factor involved with lack of *P. parvum* growth in the high sulfate-chloride treatments and overall low growth rates in all sulfate-chloride treatments (experiments 1 and 2) relative to Instant Ocean treatments (experiment 3) (c.f. Figs. 2 and 3). Sulfates were added as calcium sulfate, in which there is 466 mg of calcium for every 1 g of sulfate. Instant Ocean contains only 1.02% calcium by weight. Thus a 15 g Instant Ocean L^{-1} culture contains only 153 mg calcium L^{-1}. Studies have demonstrated that calcium ions can act as cofactors to *P. parvum* toxins, increasing their toxicity substantially (Shilo 1981). As such, it is conceivable that our use of calcium sulfate inadvertently created conditions of higher toxicity, which may have negatively affected growth or increased mortality via self-toxicity (Olli and Trunov 2007).

Nevertheless, further research could add substantially to our understanding of specific factors involved in the 2009 Dunkard Creek *P. parvum* bloom. In particular, it is recommended that further monitoring and analysis of the chemical composition of the mine water discharges be conducted in order to enhance understanding of the roles of high sulfates and other ions in *P. parvum* population growth and toxicity. Further experimentation also will be required to confidently assess the relative roles of sulfates, calcium, or other ions, in *P. parvum* growth and toxicity in general, but also with respect to the potential for future Dunkard Creek *P. parvum* blooms. While our experiments were conducted in the laboratory with artificially nutrient replete culture media, and there remains uncertainty with respect to sulfates and calcium as described above, our results corroborate the general understanding of *P. parvum* populations, blooms, and fish kills globally – high nutrients and high salinities are major requisites for *P. parvum* domination of algal communities, and especially for *P. parvum* blooms.

Acknowledgments
Algal cultures are maintained by James Easton and Anne Easton. All experiments were performed by Karen Glenn, James Easton, Ann Morris, and Anne Easton. Karen Glenn and Rich Zamor read and commented on earlier drafts of this report. Funding was provided by the West Virginia Department of Environmental Protection.

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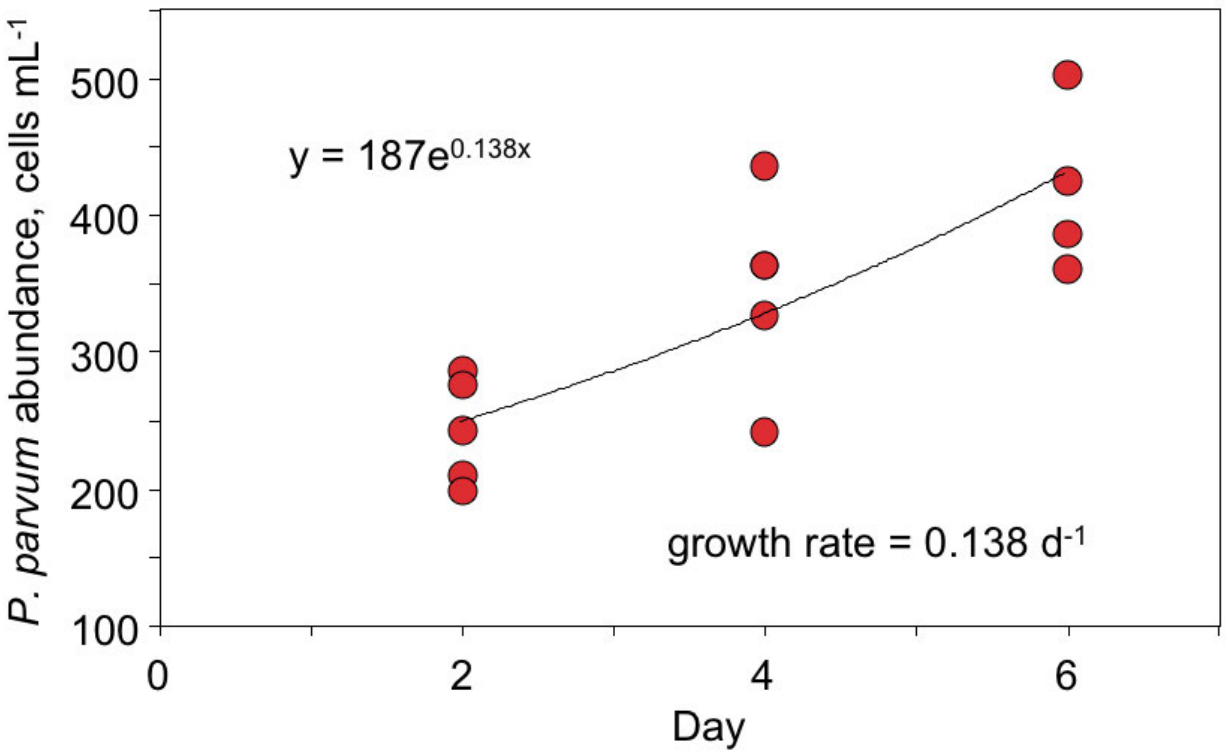

Figure 1. Representative example of growth rate calculation. Points represent *P. parvum* cell densities in experimental flasks (in this case, the 0× treatment of experiment 1) on days 2, 4, and 6. The slope (i.e., the exponent) of an exponential regression through these points is a measure of the instantaneous growth rate in units of per day.

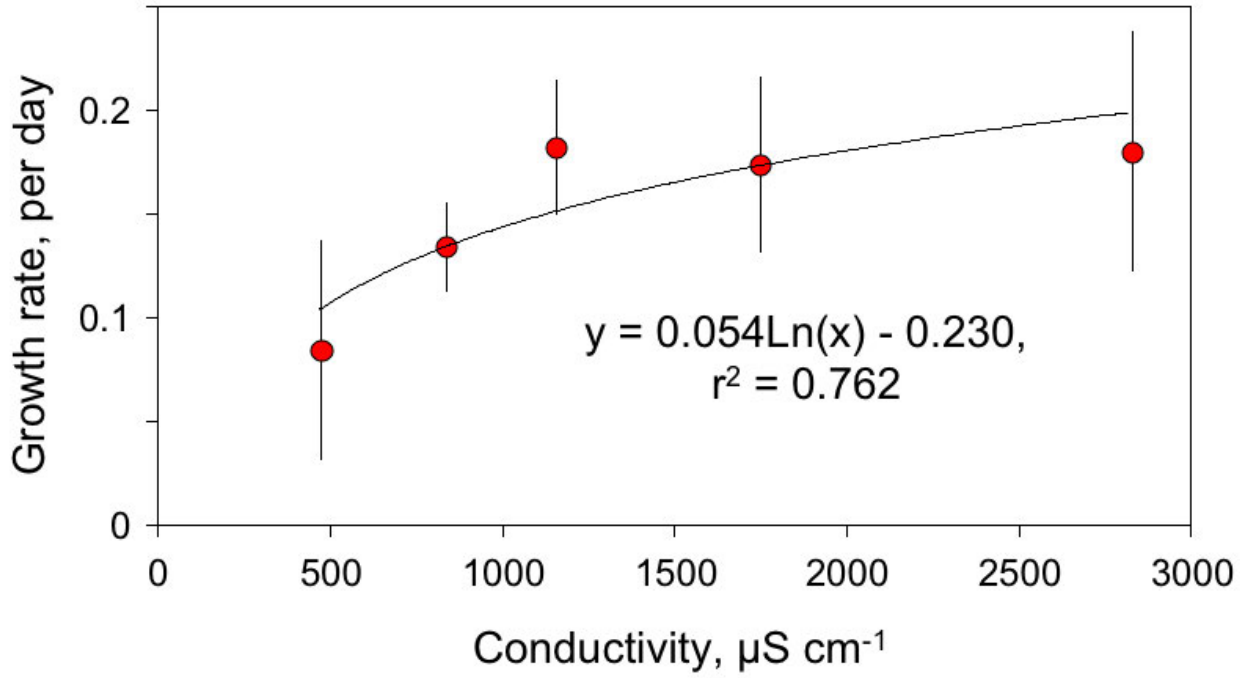

Figure 2. Growth rate of *P. parvum* as a function of sulfate and chloride concentrations (here indicated by conductivity (µS cm^{-1}). Treatments, each replicated 5-fold per experiment and from highest to lowest conductivity, are 1000 mg sulfate and 250 mg chloride, 500 mg sulfate and 125 mg chloride, 250 mg sulfate and 62.5 mg chloride, 125 mg sulfate and 31.3 mg chloride, and 0 mg sulfate and 0 mg chloride. Points represent mean (±SE) values generated separately from experiments 1 and 2 using *P. parvum* cell densities from day 2 to day 6. The highest salinity treatment (2000 mg sulfate and 1000 mg chloride, ~4,082 µS cm^{-1}) was not conducive to *P. parvum* growth and has been omitted here.

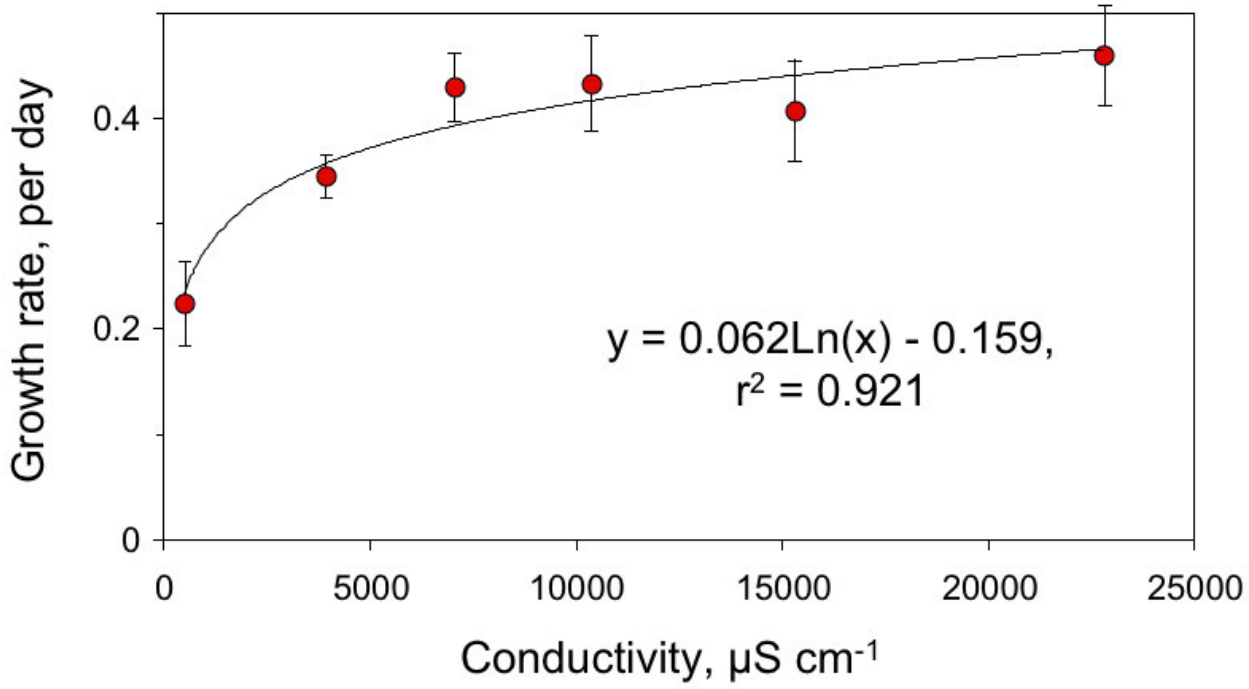

Figure 3. Growth rate of *P. parvum* as a function of Instant Ocean concentrations (here indicated by conductivity (µS cm^{-1}). Treatments, from highest to lowest conductivity, are 15, 10, 6, 4, 2, and 0 g Instant Ocean L^{-1}. Points represent mean (±SE) values generated from day 0 to day 7 growth of *P. parvum* in each treatment from Experiment 3.

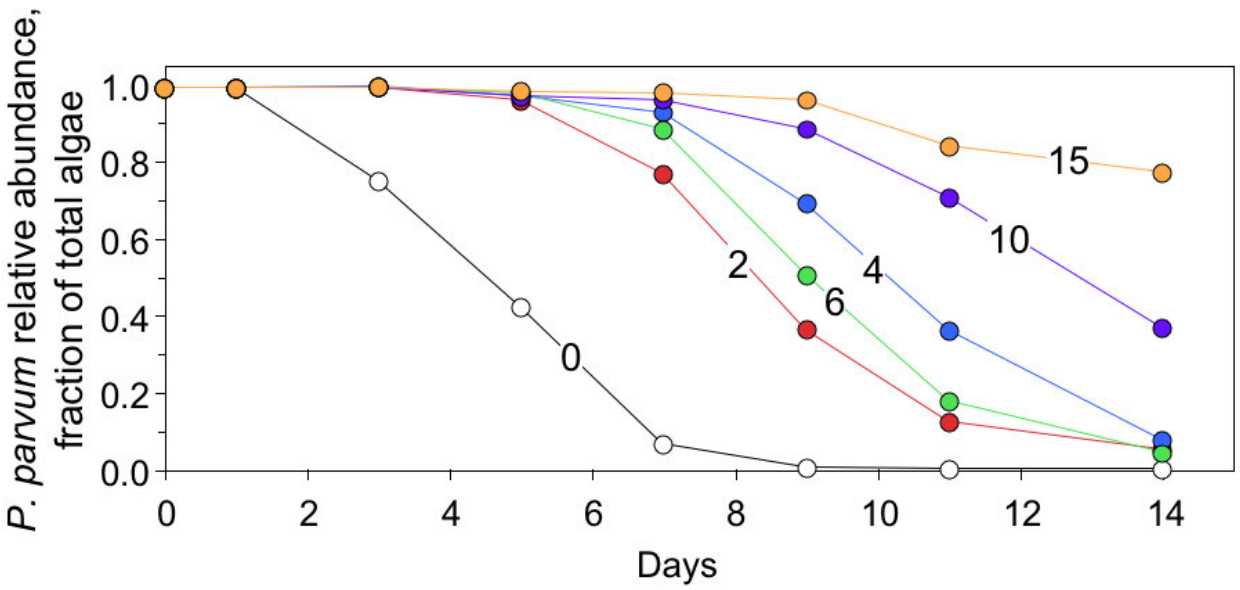

Figure 4. Relative abundance of *P. parvum* (fraction of total algae) in salinity treatments over time in experiment 3. Treatments (i.e., g Instant Ocean L^{-1}) are indicated.

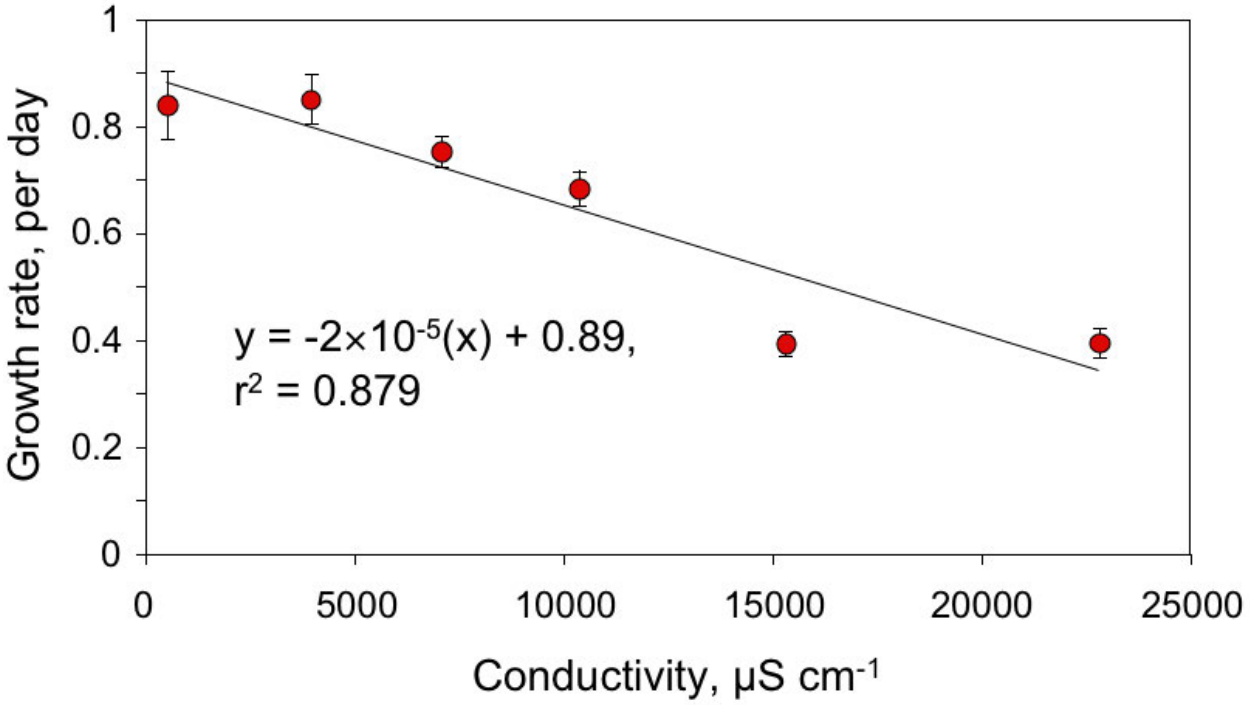

Figure 5. Growth rate of contaminant algae (small unidentified diatom and green unicell) in experiment 3 as a function of Instant Ocean concentrations (here indicated by conductivity (µS cm^{-1}). Rates were calculated from cell densities in days 3 through 14.

Christopher Hunter/DC/USEPA/US
11/02/2010 12:09 PM

To Rose Kwok
cc
bcc
Subject Our current coal mining guidance docs

2010_04_01_wetlands_guidance_appalachian_mtntop_mining_detailed.pdf

2009_06_10_wetlands_pdf_Final_MTM_MOU_6-11-09.pdf

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 01 2010

MEMORANDUM

SUBJECT: Detailed Guidance: Improving EPA Review of Appalachian Surface Coal Mining Operations under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order

FROM: Peter S. Silva
Assistant Administrator for Water

Cynthia Giles
Assistant Administrator for Enforcement and Compliance Assurance

TO: Shawn Garvin
Regional Administrator, EPA Region 3

A. Stanley Meiburg
Acting Regional Administrator, EPA Region 4

Bharat Mathur
Acting Regional Administrator, EPA Region 5

I. Purpose

The purpose of this detailed memorandum is to provide further clarification of EPA's roles and expectations, in coordinating with our federal and state partners, to assure more consistent, effective, and timely compliance of Appalachian surface coal mining operations with the provisions of the Clean Water Act (CWA), National Environmental Policy Act (NEPA), and the Environmental Justice Executive Order (E.O. 12898).[1,2] This memorandum reflects reviews of past practices and emerging science to improve and strengthen permit decision-making in order

[1] This memorandum is effective immediately. Concurrent with its release, however, EPA is seeking public comment on this interim final document. We fully understand the importance of this memorandum to our federal and state partners, the coal industry, and the public, and we recognize the value in receiving their input based on experience with its implementation. The public comment period will conclude on December 1, 2010. No later than April 1, 2011, EPA will issue final guidance after consideration of public comments and the results of the Science Advisory Board (SAB) review, and consistent with our experience in implementation of this memorandum. EPA may revise the guidance sooner, as appropriate, consistent with the SAB review. EPA is publishing a notice in the *Federal Register* that provides additional details on the public comment process.

[2] In addition to this memorandum, EPA is working with other federal agency partners to develop and implement an interagency environmental justice strategy to more fully evaluate environmental justice considerations in review of Appalachian surface coal mining activities. This strategy will provide more detailed information and specific actions to avoid and mitigate adverse impacts to low-income and minority populations.

to better ensure compliance with federal environmental statutes, implementing regulations, and policies.[3] We hope this memorandum will also be helpful to our federal and state partners, the regulated public, and others in clarifying EPA's expectations regarding the need to reduce harmful impacts on public health and the environment associated with Appalachian surface coal mining and to more effectively include the voices of adversely affected communities in the Appalachian coalfields, including low-income or minority populations.[4] We expect you to begin using this interim final guidance immediately in your review of Appalachian surface coal mining activities.

II. Introduction

A. Background

The CWA entrusts EPA with overall responsibility to administer its provisions, including protection of human health, water quality, and the environment in coalfield communities throughout Appalachia. CWA protections, including water quality requirements, extend to all waters of the United States, from headwater streams to the larger downstream systems that they feed. In particular, EPA's CWA responsibility includes preserving the long-term integrity of Appalachian watersheds, which is important in protecting their ecological condition and maintaining safe, clean, and abundant water for local communities. We make every effort to fulfill these responsibilities without compromising the economic and energy benefits that coal mining provides to both the Appalachian region and the entire nation.

In recent months, the Obama Administration has worked to ensure timely review of permit applications that have faced delays in the courts for many years. It is our hope that our efforts to make responsible and expeditious decisions on these applications will reduce the likelihood of judicial challenges to the permits and thus will be seen as a demonstration of our commitment to an Appalachian coal industry that provides economic security and protects the health of Appalachian communities, without violating environmental standards established under the law.

The environmental legacy of mining operations in the Appalachian region is far-reaching. Recent studies, as well as the experiences of Appalachian coalfield communities, point to new environmental and health challenges that were largely unknown even ten years ago. Since 1992, nearly 2,000 miles of Appalachian streams have been filled at a rate of 120 miles per year by

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[3] The CWA and NEPA provisions and regulations described in this document contain legally binding requirements. This guidance does not substitute for those provisions or regulations, nor is it a regulation itself. It does not impose legally binding requirements on EPA, the U.S. Army Corps of Engineers (Corps), the States, or the regulated community, and may not apply to a particular situation depending on the circumstances. Any decisions regarding a particular permit will be based on the applicable statutes, regulations, case-specific facts and circumstances, and case law. Therefore, interested persons are free to raise questions about the appropriateness of the application of this guidance to a particular situation, and EPA and/or the Corps will consider whether or not the recommendations or interpretations of this guidance are appropriate in that situation based on the statutes, regulations, and case law.

[4] The discussion of the provisions of the CWA, NEPA, and E.O. 12898 in this memorandum focuses on their applicability to Appalachian surface coal mining operations in Kentucky, West Virginia, Virginia, Ohio, Tennessee, and Pennsylvania.

surface mining practices. A recent EPA study found that nine out of every 10 streams downstream from surface mining operations were impaired based on a genus-level assessment of aquatic life.[5] Another federal study found elevated levels of highly toxic and bioaccumulative selenium in streams downstream from valley fills.[6] These impairments are linked to contamination of surface water supplies and resulting health concerns, as well as widespread impacts to stream life in downstream rivers and streams. Further, the estimated scale of deforestation from existing Appalachian surface mining operations is equivalent in size to the state of Delaware. Appalachian deforestation has been linked to significant changes in aquatic communities as well as to modified storm runoff regimes, accelerated sediment and nutrient transport, reduced organic matter inputs, shifts in the stream's energy base, and altered thermal regimes.[7] Such impacts have placed further stresses on water quality and the ecological viability of watersheds.

It has been a high priority of this Administration – and EPA Administrator Lisa P. Jackson – to reduce the substantial environmental and human health consequences of surface coal mining in Appalachia, and minimize further impairment of already compromised watersheds. Administrator Jackson has also made working toward environmental justice a priority. EPA seeks to enhance water quality and environmental protection in close partnership with the states and other federal agencies, which have key implementation roles under the CWA, and under NEPA and E.O. 12898, respectively. As scientific evidence grows, EPA has a legal responsibility to address the environmental consequences of Appalachian surface coal mining.

In June 2009, the Department of the Army, EPA, and the Department of the Interior (DOI) signed a Memorandum of Understanding (MOU) to minimize the harmful consequences of Appalachian surface coal mining practices. The MOU reflects an agreement among the agencies to strengthen the environmental reviews of Appalachian surface coal mining projects under the CWA, NEPA, and the Surface Mining Control and Reclamation Act (SMCRA). EPA committed to improve its review of permits issued under Section 404 and to bolster coordination with states on both Section 402 permits for pollutant discharges from valley fills and state water quality certifications (Section 401) for mining operations. The Corps committed to reassess Nationwide Permit 21, a general permit used to authorize some surface coal mining activities, and to work with EPA to clarify Section 404 policies for environmental review and mitigation. DOI committed to evaluate how the Office of Surface Mining Reclamation and Enforcement (OSM) can more effectively oversee state permitting and enforcement activities under SMCRA.

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B. CWA, NEPA, and E.O. 12898

The CWA, 33 U.S.C. 1251 *et seq.*, establishes a comprehensive program designed "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. Section 1251(a). To achieve that objective, CWA Section 301(a) prohibits the "discharge of any pollutant" – defined as the addition of any pollutant to the waters of the U.S. from any point source – except "as in compliance with" specified provisions of the CWA. 33 U.S.C. Sections 1311(a), 1362(7), 1362(12). In most cases, regulated entities achieve compliance with the relevant CWA provisions by obeying the terms of a permit issued under one of the CWA's two complementary permitting programs: (1) a permit program for discharges of dredged or fill material, which is administered primarily by the Corps pursuant to Section 404 of the CWA, 33 U.S.C. 1344; or (2) the National Pollutant Discharge Elimination System (NPDES), which is administered by the EPA and authorized states pursuant to Section 402 of the CWA, 33 U.S.C. 1342. Section 401 of the CWA also applies where federal permits are issued, enabling states to certify (or waive) that discharges from permitted operations are in compliance with state environmental regulations. Typically, surface coal mining operations in the steep slopes of Central Appalachia require Section 404 permits for the discharge of mining overburden into waters of the United States (e.g., valley fills, mine-through operations), mine faceups, stream diversions, road crossings, coal process waste impoundments, and for discharges to create sediment ponds. Discharges from the sediment ponds and any other stormwater discharges require Section 402 permits. Because the Corps issues Section 404 permits in Appalachia, states have authority to condition those permits under Section 401.

In addition, NEPA requires an assessment of the environmental impacts of federal actions, including the preparation of an Environmental Impact Statement (EIS) for federal actions that have a significant effect on the quality of the human environment. For example, the Section 404 review by the Corps of a proposed mining operation with discharges into waters of the U.S. triggers review under NEPA. An EIS presents a comprehensive and transparent evaluation of the wide range of potential environmental and human health impacts associated with a federal action, as well as project alternatives that may avoid and minimize significant adverse impacts.

E.O. 12898 and the Presidential Memorandum that accompanies it also need to be addressed appropriately in the context of any federal action – such as federal permitting under the CWA and SMCRA – including federal actions that are subject to NEPA. E.O. 12898 provides that: "To the greatest extent practicable and permitted by law…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

Consideration of environmental justice concerns is vital to understanding the potential human health and environmental impacts of surface coal mining during the CWA and SMCRA permitting and NEPA review processes. The Presidential Memorandum articulates the role of federal environmental statutes in securing human health and environmental protection of vulnerable populations and assuring their participation in the process.

E.O. 12898 calls for actions that can address several key environmental justice issues associated with surface coal mining. These include: conducting research, data collection, and analysis on direct, indirect and cumulative impacts; identifying patterns of subsistence consumption of fish and wildlife; and providing effective public participation and access to information. EPA will implement the E.O. by identifying and addressing, as appropriate, any adverse effects of proposed federal activities on low-income and minority populations, including ways or measures to mitigate any adverse effects.

C. Recent Program Reviews and Emerging Science

Three key considerations have motivated the Agency's development of this memorandum. First has been the collection and publication of technical information documenting the scope and significance of adverse environmental and water quality effects associated with surface coal mining practices. Second, EPA has recently completed reviews of permitting actions under CWA Sections 402 and 404 for Appalachian surface coal mining. These reviews demonstrate that current permitting practices can be more effective in addressing adverse environmental and water quality effects associated with coal mining by more robustly conducting analyses required by the CWA. Third, EPA scientific offices are conducting extensive work evaluating the relationship between pollutants in streams associated with surface coal mining and impacts from these pollutants on aquatic ecosystems. As a result of this work, EPA is poised to initiate additional independent technical review and public evaluation of potential new water quality values for conductivity based on effective science and the need to improve protection of water quality, public health, and the environment.

Numerous studies, data submitted to permitting authorities for proposed mining activities, and some state impaired waters lists published pursuant to CWA Section 303(d), have shown that high levels of conductivity, dissolved solids, and sulfates are a primary cause of water quality impairments downstream from mine discharges. These studies build upon existing research from other regions that demonstrated the toxicity of specific ions, such as sulfate, as well as the complex interplay of ionic constituents associated with coal mining operations.[8] Dissolved solids contained in waters draining from valley fills are a primary cause of biological impairment resulting from changes in benthic species richness and diversity (particularly species of mayflies, a key component of headwater stream communities). An example of these studies is Pond et al. (2008), which found evidence that mining activities have subtle to severe impacts on downstream aquatic life and the biological conditions of a stream.[9] A 2003 published study by Kennedy et al. linked elevated conductivity levels in coal effluent to impaired, sensitive aquatic fauna.[10] A 2004 Kentucky Department for Environmental Protection study found that the loss of mayflies in streams below mined sites indicates that these organisms are especially sensitive to

[8] Soucek, D.J. and A.J. Kennedy. 2005. Effects of hardness, chloride, and acclimation on the acute toxicity of sulfate to freshwater invertebrates. Environmental Toxicology and Chemistry 24:1204-1210.
[9] Pond et al. 2008.
[10] Kennedy, A.J., DS. Cherry, and R.J. Currie. Field and laboratory assessment of a coal processing effluent in the Leading Creek Watershed, Meigs County, Ohio. Archives of Environmental Contamination and Toxicology 44:324–331.

coal mine drainage.[11] A 2005 published study by Kennedy et al. linked impairment of aquatic life to elevated levels of Total Dissolved Solids (TDS).[12] Finally, a 2010 published study by Pond links specific conductance as the most strongly correlated factor to a reduction of *Ephemeroptera* in streams impacted by mining and residential development.[13]

In addition, an analysis of peer-reviewed studies recently published in the journal *Science* shows that ecological losses downstream of coal mining valley fills are associated with increased levels of TDS and conductivity, sulfates, and selenium.[14] EPA's Office of Research and Development (ORD) recently completed a review of the scientific literature on surface coal mining and found effects that included resource loss, water quality impairment, and adverse effects on aquatic ecosystems. This report is being submitted to the EPA Science Advisory Board (SAB) for review and is also publicly available.

EPA recently conducted assessments of permitting practices under CWA Sections 402 and 404 for surface coal mining projects in Appalachia. The Permit Quality Review of Section 402 permits in West Virginia, Kentucky, Tennessee and Ohio, conducted in September and October 2009, identified concerns related to effective protection of downstream water quality consistent with requirements of the CWA. The concerns focus on the interpretation of narrative and numeric criteria in CWA Section 402 permits for surface coal mining projects. In addition, the evaluation of pending coal mining projects under the EPA-Corps Section 404 Enhanced Coordination Procedures (ECP) found that many of these projects may not be consistent with EPA and Corps regulations, including the Section 404(b)(1) Guidelines. As many as 80% of these permits raised concerns with respect to compliance with state narrative water quality standards, while more than half raised concern for the potential for significant degradation of aquatic ecosystems.

The emerging science related to adverse environmental and water quality effects is based on data and analyses subjected to the rigors of peer-reviewed science and quality assurance reviews. EPA places a high priority on quality assurance and agency policy specifies necessary quality assurance activities be performed to ensure data are of sufficient quantity and adequate quality for their intended use. EPA's reviews of ambient chemical and biological data and analyses that support some permitting decisions have revealed consistent and serious issues with underlying data quality, such as erroneous field meter readings, biological samples collected outside of state index periods or during extreme low flows, and inclusion of non-endemic taxa in taxonomic lists. Analyses of these data also have demonstrated concerns, such as inappropriate aggregation of biological data from several stream types (headwater to larger river) or several

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[11] Kentucky Department for Environmental Protection, Division of Water, Water Quality Branch. Effects of Surface Mining and Residential Land Use on Headwater Stream Biotic Integrity in the Eastern Kentucky Coalfield Region.
[12] Kennedy A. J., D.S. Cherry and C.E. Zipper. Evaluation of Ionic Contribution to the Toxicity of a Coal-Mine Effluent Using *Ceriodaphnia dubia*. Archives of environmental contamination and toxicology vol. 49.2:155-162.
[13] Pond, G.J. "Patterns of *Ephemeroptera* taxa loss in Appalachian headwater streams (Kentucky, USA)." Hydrobiologia 641(1):185-201.
[14] Palmer, M.A., E.S. Bernhardt, W.H. Schlesinger, K.N. Eshleman, E. Foufoula-Georgiou, M.S. Hendryx, A.D. Lemly, G.E. Likens, O.L. Loucks, M.E. Power, P.S. White, P.R. Wilcock. 2010. Mountaintop Mining Consequences. Science 327(5962):148-149.

seasons, failing to reflect natural data variability, and inappropriately including several samples from one site as independent samples in a statistical analysis (pseudoreplication).

Regions should ensure that the environmental data supporting CWA decision-making are carefully scrutinized to ensure they are of sufficient quality to support their intended use. Regions should encourage the incorporation of Quality Assurance Project Plans (QAPPs) for sampling data and Quality Assurance/Quality Control (QA/QC) data within data submitted to EPA through the permitting process. For guidance in ensuring environmental data are of sufficient quality, Regions should consult the agency's quality assurance policy at http://www.epa.gov/quality/index.html.

EPA has made substantial progress in recent months in the development of high-quality scientific information to support new numeric water quality values for conductivity, which is regularly observed at high levels in streams downstream from Appalachian surface coal mining operations. EPA expects, consistent with the requirements of the CWA, that the use of these values and the extensive scientific information that supports these numbers will be extremely helpful to states in the development of water quality-based effluent limits for Section 402 permits. Establishing enforceable numeric limits for conductivity, selenium, and other parameters in state Section 402 permits will help to improve water quality and better protect public health and aquatic life in streams downstream from Appalachian surface coal mining operations.

III. EPA Oversight of NPDES Permitting for Surface Coal Mining Operations in Appalachia

EPA has reason to believe that discharges from surface mining activities have a significant potential to cause nonattainment of applicable water quality standards downstream from valley fills, impoundments, and sediment ponds. Discharges from Appalachian surface coal mining activities have been found to have a high potential to impact aquatic life uses.[15] Numerous studies, data submitted to permitting authorities for proposed mining activities, and some state Section 303(d) lists have shown high levels of conductivity and dissolved solids and sulfates to be a primary cause of water quality impairments downstream from such mine discharges.

The Office of Water has been working closely with Regions 3, 4, and 5 to assess the quality of state-issued CWA Section 402 (NPDES) permits for surface coal mining operations with respect to the requirements of each state's permitting program in the Appalachian states of Tennessee, Ohio, Kentucky, and West Virginia. EPA has also been assessing permits for their compliance with applicable federal requirements. The goal of this assessment is to strengthen these state-issued NPDES permits to better address the impacts discussed above.

The CWA and EPA's implementing regulations require NPDES permits to contain technology-based effluent limits and, where necessary to protect water quality, water quality-based effluent limits. All permits reviewed by EPA included appropriate technology-based

[15] Pond et al. 2008.

limits for pollutant parameters listed in the effluent limitation guidelines for coal mining (40 CFR Part 434). However, based on observations from both ongoing program oversight and a focused Permit Quality Review of permits for surface coal mining activities, including detailed discussions with state permit writers, EPA has identified certain concerns common to many of the reviewed permits that warrant immediate attention to ensure that water quality is protected. Therefore, when Regional offices exercise their authority to review draft or proposed state NPDES permits for discharges to waters of the U.S. associated with Appalachian surface coal mining operations, Regions should evaluate several aspects of those permits as detailed below.

The sections below detail requirements of the Act and issues identified during EPA's recent Permit Quality Review. Should Regions identify similar concerns when reviewing draft or proposed permits in the future, we encourage you to work with your authorized states to resolve these concerns. As noted below, however, where discussions with the state do not produce a proposed permit that, in the Region's judgment, satisfies the requirements of the Act, an objection to the issuance of the proposed permit would be an appropriate response. We encourage the Water Division Directors of the three Regions to work together to ensure a comparable level of review and response across Appalachia.

A. Completion of Required Reasonable Potential Analyses

As noted above, the CWA requires NPDES permits to contain water quality-based effluent limits when necessary to meet water quality standards (CWA Section 301(b)(1)(C); 40 CFR Section 122.44(d)(1)). In order to determine whether water quality-based effluent limits are necessary, the permitting authority is required to conduct a "reasonable potential analysis." A reasonable potential analysis determines whether a discharge will cause, or has the reasonable potential to cause or contribute to, an excursion above a numeric or narrative water quality standard. EPA's regulations, EPA's 1991 Technical Support Document (TSD) for Water Quality-based Toxics Control (EPA/505/2-90-001 PB91-127415)[16], and established state procedures explain how to conduct this analysis.

EPA's review of NPDES permit administrative records found that parameters known to be present in the effluent, based on data submitted with the permit applications, were often not assessed for the reasonable potential to cause or contribute to an excursion above water quality standards. Although each permit requires a case-specific analysis, in general, an NPDES permit that fails to show evidence of a parameter-specific reasonable potential analysis will be inconsistent with the requirements of the CWA. Furthermore, EPA expects that in many, if not most, cases the available science will demonstrate that there is a reasonable potential for these discharges to cause or contribute to an excursion above numeric or narrative water quality standards, thus making water quality-based effluent limits necessary.

To characterize the effluent, existing dischargers applying or reapplying for NPDES permit coverage should provide the permitting authority with screening data for a suite of pollutants and pollutant parameters listed in the applicable NPDES permit application form. However, for new (proposed) discharges, the application form for an individual permit requires

[16] This publication is available at http://www.epa.gov/npdes/pubs/owm0264.pdf.

only an estimate of the effluent characteristics. In addition to data specifically required by permit applications, 40 CFR Section 122.21 allows permitting authorities to request any additional data as necessary to support an assessment of potential water quality impacts (e.g., conductivity and total dissolved solids). Facilities applying for coverage under an NPDES general permit are required to submit information specifically identified in the Notice of Intent provisions of the general permit. EPA's review of permits and associated records found that states generally did not adequately document or explain how information submitted by applicants was used to characterize the nature of their actual or proposed discharges. In particular, where facilities had proposed to discharge, but had not yet begun construction or operation, the files contained little discussion of how the permitting authority projected or anticipated the types and concentrations of pollutants expected in the effluent.

Where effluent data are available (i.e., for existing discharges), EPA's expectation is that permitting authorities will use all valid and representative data to determine whether the discharge causes, has the reasonable potential to cause, or contributes to an excursion of numeric and/or narrative water quality criteria and standards. For new (proposed) discharges, the permitting authority should require the applicant to characterize the anticipated pollutant concentrations and loads using data from similar discharges and/or based on characteristics of local soils and geology. For example, these data may be from mining facilities located adjacent to or having similar geologic characteristics as the mine under review, or from ambient data collected as part of the Section 404 or SMCRA permit applications. Permitting authorities should independently seek to obtain such data if not submitted by the applicant or can reject the application as not sufficient. Ambient water quality data collected as part of the SMCRA and Section 404 permitting processes should be included in the NPDES permit development process and, where appropriate, should be incorporated as "background" conditions in reasonable potential analyses.

B. Incorporation of Numeric Water Quality Standards in Terms of NPDES Permits

Where a surface coal mining discharge is found to have reasonable potential to exceed a numeric water quality standard, the regulations require that NPDES permits include water quality-based effluent limits (WQBELs) based on the existing numeric water quality criteria in state water quality standards. While EPA's Permit Quality Review found that many permits did incorporate all relevant numeric water quality standards, some permits omitted them. As one example, all Appalachian states have adopted a chronic numeric criterion for selenium of 5 µg/l for the protection of aquatic life. Should a reasonable potential analysis indicate that the discharge of selenium (or another parameter) has the potential to cause or contribute to an excursion above any state standard and a state fails to include a WQBEL based on the existing state water quality standard, EPA expects that such a permit would not be consistent with the CWA.

It is the responsibility of the applicant to characterize the wastewater to be discharged from the permitted facility. In order to have a complete NPDES permit application, data must be presented by the applicant to properly characterize its discharge to enable a reasonable potential analysis to be completed by the permit writer at the time of permit issuance. Data may be

secured through evaluation of similarly situated facilities in adjacent watersheds or similar practices in the same ecological or geological setting.

Where there is an approved Total Maximum Daily Load (TMDL) for the receiving waterbody, the receiving waterbody is listed as impaired on the state's approved Section 303(d) list, or a downstream waterbody may be affected by the discharge, it will be important that the reasonable potential analysis include an analysis of the pollutants for which the TMDL was established or for which the waterbody is listed as impaired, or for pollutants that may affect downstream waters.

1. Specific Guidance Regarding Compliance Schedules

Compliance with all NPDES permit terms is required at the time of permit issuance. However, federal regulations at 40 CFR Section 122.47 allow for NPDES permits to include compliance schedules for the achievement of WQBELs, when determined to be appropriate under discharger-specific circumstances. When determined to be appropriate, a compliance schedule must require compliance with the WQBEL within a time determined to be "as soon as possible" based on a discharger-specific evaluation. Compliance schedules are only available for WQBELs based on water quality standards that have been newly adopted after July 1, 1977, and where the applicable water quality standards authorize the use of such schedules. For further guidance regarding considerations for Regions when evaluating compliance schedules, please see the May 10, 2007, Memorandum from James Hanlon, Director, Office of Wastewater Management to Alexis Strauss, Director, Water Division, EPA Region IX, and the November 16, 2007, Letter from Jon M. Capacasa, Director, Water Protection Division, US EPA Region III, to Lisa A. McClung, Director, Division of Water and Water Management, West Virginia DEP, and Randy Huffman, Director, Division of Mining And Reclamation, West Virginia DEP.[17]

C. Incorporation of Narrative Water Quality Standards in the Terms of NPDES Permits

In addition to those parameters for which there are numeric water quality standards, all Appalachian states have adopted narrative water quality standards. Of particular relevance here, nearly all Appalachian states do not currently have applicable numeric water quality criteria that account for the effects associated with high levels of conductivity, total dissolved solids, and sulfates. In lieu of such numeric criteria, all Appalachian states have applicable narrative water quality criteria. EPA regulations are clear that NPDES permits must contain provisions that implement both numeric water quality standards <u>and</u> narrative water quality standards and that the same reasonable potential analysis completed for numeric standards must be completed for narrative standards as well. 40 CFR Sections 122.44(d)(1) and (d)(1)(vi).

EPA's review of permits found that states did not incorporate provisions that would implement the relevant narrative water quality standards relating to discharges that increase the levels of conductivity, total dissolved solids, and sulfates. The permits do not contain limits based on whole effluent toxicity (WET) and/or a chemical-specific numeric interpretation of the

[17] These documents are available at http://www.epa.gov/owow/wetlands/guidance/mining.html

narrative criteria as required by 40 CFR Sections 122.44(d)(1)(v) and (vi). In addition, the permits' statements of basis or fact sheets do not provide information indicating that the narrative criteria were considered as part of the determination of which effluent limitations are necessary. Although EPA's review of each permit is case-specific, EPA expects that a permit that fails to include provisions implementing the narrative water quality standards and fails to explain why such omission is appropriate under the regulations will not be consistent with the requirements of the CWA.[18]

1. Documentation on How States Will Derive Effluent Limits Based on Narrative Water Quality Standards

EPA Regions should request that states provide documentation describing how the states will perform a reasonable potential analysis and, where necessary, develop effluent limits (or other permit conditions), to ensure compliance with the state's narrative water quality standards. The state should provide a detailed description of the decision-making process, including the types and sources of data used to characterize both expected effluent quality and receiving water quality with respect to narrative water quality standards. Baseline water quality analyses required for SMCRA permit applications and projected or estimated effluent concentrations characterizing expected effluent quality are expected to be used to inform each state's decisions.

In documenting how they will interpret and implement their narrative standards, the states should take into account that the NPDES regulations at 40 CFR Section 122.44(d)(1)(vi) require the consideration of relevant information pertaining to a pollutant that may cause or contribute to an excursion above an applicable state narrative water quality standard. The scientific literature is increasingly recognizing the relationship between conductivity levels in Appalachian streams and impacts to aquatic biota in streams below surface coal mining operations. Based on field measurements comparing unmined and mined watersheds in Central Appalachia, the peer-reviewed 2008 "Pond-Passmore" study concluded that aquatic life at sites with specific conductance greater than 500 µS/cm were observed to have been adversely impacted based on a genus-level multi-metric biological index.[19] In addition, EPA's draft report, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*,[20] also recognizes stream-life impacts associated with conductivity. This study, which is publicly available and will undergo external peer review by the SAB, applies EPA's standard method for

[18] In the limited cases in which a state determines that it is infeasible to calculate a numeric effluent limit to implement a narrative water quality standard, the state should include in the permit appropriate WET limits and best management practices (BMPs) to control or abate the discharge of pollutants, consistent with 40 C.F.R. Section 122.44(k)(3). In these limited circumstances, the state would need to document the basis for its determination that a numeric effluent limit for the narrative standard was infeasible to calculate, and would need to include associated provisions for monitoring the effectiveness of BMPs. Monitoring should include in-stream conditions of aquatic biota consistent with state biocriteria. Should downstream impacts exceed biocriteria, provisions for adaptive remedial action should be included.

[19] Pond et al. 2008.

[20] This methodology and benchmark were developed in a parallel but unrelated track to a literature review summary of the effects of mountaintop mining and valley fills produced by EPA that has also been issued for Science Advisory Board review and consultation.

deriving water quality criteria to field measurements and concludes that genus-level impacts to the biological community occur at conductivity levels of 300 µS/cm.[21]

During the SAB review process, EPA believes that this report should be considered by Appalachian states as relevant information per 40 CFR Section 122.44(d)(1)(vi) in implementing applicable state narrative water quality standards in NPDES permits, and by Regions in your review of these permits. Documentation of how each state will interpret and implement its narrative water quality standards (in light of the data and conclusions of this conductivity report and other relevant information) will help ensure that the public and the regulated community have a better understanding of the state's decision-making process and increased certainty that narrative water quality standards are adequately met. As a general matter, EPA expects that the conductivity impacts of projects with predicted conductivity levels below 300 µS/cm generally will not cause a water quality standard violation and that in-stream conductivity levels above 500 µS/cm are likely to be associated with adverse impacts that may rise to the level of exceedances of narrative state water quality standards.[22] If water quality modeling suggests that in-stream levels will exceed 500 µS/cm, EPA believes that reasonable potential likely exists to cause or contribute to an excursion above applicable water quality standards; unless, based on site-specific data, the state has an alternative interpretation of their water quality standards that is supported by relevant science. Similarly, if water quality monitoring suggests that in-stream levels will exceed 300 µS/cm but will be below 500 µS/cm, EPA should work with the permitting authority to ensure that the permit includes conditions that protect against conductivity levels exceeding 500 µS/cm. In circumstances where conductivity levels in waters proposed for new mining related discharges already exceed 500 µS/cm, EPA will coordinate with the permitting authority on a site-specific basis to ensure these new discharges will not cause or contribute to a violation of water quality standards. Once EPA's draft conductivity report is finalized following SAB review, we will evaluate whether changes to the conductivity benchmarks identified here are appropriate.

At a minimum, should the record indicate that a reasonable potential exists, the permitting authority must demonstrate in the administrative record, based on site- or receiving-water-specific information, how the permit implements the narrative water quality standards in a manner that is consistent with the CWA, and Regions are encouraged to review such a record carefully. For new (proposed) discharges, the permitting authority should require the applicant to characterize the anticipated pollutant concentrations and loads using data from similar discharges and/or based on the characteristics of local soils and geology. As noted above, as a general matter, EPA expects that in-stream conductivity levels above 500 µS/cm are likely to be associated with adverse impacts to water quality. The scientific literature has identified conductivity levels above this level in impaired streams below surface coal mining operations in Appalachian ecoregions 68, 69, and 70 and, therefore, it is generally likely that such surface coal mining operations will have a reasonable potential to cause or contribute to an exceedance of

[21] As described in the report, this study may be applied to all waters in the Appalachian region that are dominated by salts of SO_4^{2-} and HCO_3^- at circum-neutral pH and low levels of chloride.
[22] In certain fact-specific circumstances, conductivity levels above 500 µS/cm may not be associated with adverse aquatic impacts. EPA will work with permitting authorities on a site-specific basis to assess reasonable potential.

water quality standards.[23] Permits for discharges associated with activities other than surface coal mining should also be evaluated to determine whether they are likely to result in in-stream conductivity levels above 500 µS/cm. We believe that circumstances unique to surface coal mining, however, are principally responsible for the increase in conductivity levels observed in surface waters downstream of mining practices. Surface coal mining involves disturbing large volumes of rock and dirt, land clearing, and spoil disposal activities at a scale not typically associated with activities such as development practices or forestry. We do not have studies of other non-mining activities demonstrating a likelihood that they will have a reasonable potential to cause or contribute to an exceedance of water quality standards. EPA should coordinate with the permitting authority to consider relevant information when conducting a reasonable potential analysis for other activities on a case by case basis.

The state must provide adequate documentation in the permit fact sheet or statement of basis to demonstrate that it has assessed reasonable potential and, where necessary, developed effluent limits (or other permit conditions) adequate to protect all applicable water quality standards, including narrative water quality standards. EPA will review the adequacy of the state's explanation in its fact sheet or statement of basis, considering the available scientific and other information. Where EPA concludes that the state's explanation is not adequate, or the state fails to provide an explanation of how it has interpreted or applied its narrative water quality standards, EPA may object to the permit in accordance with the provisions of 40 CFR Section 123.44(c).

D. Completing an Appropriate Antidegradation Analysis

As EPA increases its oversight of permits associated with surface coal mining activities, EPA will also focus on ensuring that permits are issued consistent with water quality standards-related antidegradation regulations, policies and procedures. State antidegradation policies provide protection of waters from degradation. EPA will, in its oversight of NPDES permits, ensure that adequate antidegradation reviews have been conducted for the receiving water consistent with applicable state water quality standards.

Antidegradation regulations require that all permits include limits sufficient to maintain and protect existing uses (Tier 1). For outstanding national resource waters (Tier 3), antidegradation requires the maintenance and protection of ambient water quality (e.g., no lowering of water quality). For high quality waters (Tier 2), where the quality of waters exceeds the level necessary to protect the use, EPA will particularly focus on ensuring that the state has made the finding that allowing lower water quality is "necessary to accommodate important social or economic development in the area in which the waters are located." 40 CFR Section 131.12(a)(2). This amounts to a two-part test: demonstration of the extent to which the discharge is "necessary" in the manner and magnitude proposed, and of its importance for social or economic development.

[23] Ecoregions 68, 69, and 70 include portions of the six Appalachian states referenced earlier in this memorandum. A map of these ecoregions is available at http://www.epa.gov/wed/pages/ecoregions/level_iii htm.

The finding of necessity is among the most important and useful aspects of an antidegradation program. EPA expects an alternatives analysis to evaluate whether the proposed discharge is "necessary." This analysis should include consideration of a range of less-degrading or non-degrading alternatives to the direct discharge or to the manner of discharge (e.g., non-discharging options, relocation of discharge, alternative processes, and innovative treatments). In the finding of social or economic importance of the proposed activity, EPA expects the state to analyze the social and/or economic impact associated with the lowering of water quality. The state should provide documentation to support its antidegradation analysis.

There are similar analyses of alternatives performed under CWA Sections 401, 402, and 404; NEPA; and SMCRA. To the extent that a Section 402 antidegradation analysis has been completed concurrently or in advance of analyses performed under these related authorities, Regions should encourage permitting authorities to use the Section 402 antidegradation analysis to inform similar analyses under these related authorities.

E. Conclusions Regarding Improved NPDES Permitting

Initially, we want to encourage the Regions to continue to work proactively with authorized states to improve the quality of state-issued NPDES permits for surface coal mining. In that regard, we offer eight specific suggestions:

1. Regions should request information from each state as to how that state is interpreting and incorporating applicable numeric and narrative water quality standards within its permitting decisions.

2. The permitting authority must demonstrate in the administrative record, based on site- or receiving-water-specific information, the reasonable potential determination and the basis for any limits or other permit requirements including how the permit implements the narrative water quality standards in a manner that is consistent with the CWA.

3. In recognition of the fact that during discussions with state permitting staff, some state permit writers indicated they did not have sufficient tools to interpret the narrative water quality standards for these discharges, Regions should foster additional dialogue on information and tools EPA could provide to assist the states in translating their narrative criteria into numeric effluent limits.

4. Permitting authorities should consider data from similarly situated mines in their reasonable potential analyses for new facilities. In addition, as noted in Chapter 3.2 of EPA's "Technical Support Document for Water Quality-based Toxics Control,"[24] permitting authorities may determine reasonable potential based on information other than effluent data, such as the nature of the operation and its potential impact on the receiving water. Regions should evaluate whether required and appropriate data are

[24] "Technical Support Document for Water Quality-based Toxics Control." EPA Office of Water, March 1991.

submitted with permit applications and encourage permitting authorities to consider permit applications incomplete if the data characterization is not sufficient.

5. Regions should consider objecting to permits that do not assess reasonable potential effectively or fail to implement numeric and narrative standards.

6. Regions should review, as appropriate, general permits, notices of intent, individual permits, and public participation efforts, and provide comments on eligibility, WQBELs, and antidegradation in particular.

7. In situations where an NPDES permit has already been issued, but other permits or authorizations are required before a project may proceed, we encourage Regions to work with the other permitting or authorizing authorities to address any concerns left unaddressed by the NPDES permit, as appropriate.

8. Regions should evaluate the consistency of a permit's monitoring provisions with the statutory and regulatory requirements.

When reviewing state-issued permits, we strongly encourage you to ensure that the items discussed above are addressed in a manner consistent with the CWA and EPA's implementing regulations. In instances in which the Region concludes that a proposed permit is not consistent with the CWA and EPA's implementing regulations, Regions should work closely with the state to make improvements. Historically, Regions have used several tools to try and resolve concerns regarding the sufficiency of state NPDES permits, ranging from comment letters to face-to-face meetings. We encourage Regions to continue to utilize those tools. If, however, in the Region's judgment discussions with the state do not produce a proposed permit that satisfies the requirements of the Act, an objection to the issuance of the proposed permit would be an appropriate response.[25]

1. Specific Guidance Regarding Oversight of General Permits

Some discharges at surface coal mining sites are authorized through state-issued general NPDES permits. In light of the case-specific analysis necessary to ensure that surface coal mining activities will achieve water quality standards, general permits will often be inadequate. Regions are strongly encouraged to advise the permitting authorities whether the Region agrees that general permits are appropriate for these discharges or whether the Region believes that, in light of the environmental impacts caused by these discharges and the need for tailoring permit conditions by receiving water, permitting authorities should require individual permits in all instances.

[25] Following such an objection, the state or other interested parties may request a hearing and provide additional information supporting their position. After such a hearing is held (if requested), EPA can reassert its objection, modify its objection, or withdraw its objection. If EPA continues to object (or if no hearing is requested) and if EPA's objections are not satisfactorily resolved by the state permitting authority, authority to issue the permit will pass to EPA (40 CFR Section 123.44(h)).

When reviewing a general permit, Regions should review it closely to ensure that it includes all relevant CWA requirements. Some general permits and state NPDES Memoranda of Agreement (MOAs) provide EPA with the opportunity to review notices of intent to be covered under a general permit. When you have that opportunity, we encourage you to review the notices of intent. For example, EPA and Kentucky have entered into a MOA that sets out EPA's role in reviewing both individual NPDES permits and individual NOIs to be covered under a general permit. As provided for in the MOA, EPA notified Kentucky in a June 16, 2009, letter that EPA was exercising its option to review and comment, prior to issuance or modification, on all draft NPDES individual permits, and NOIs for all proposed coverages under an NPDES general permit for proposed projects being evaluated under the ECP process. As a result, under the MOA, EPA will review the general permit NOIs and has 10 days to notify the Kentucky Division of Water of any objection to the applicant's suitability for coverage under the General Permit.

2. Specific Guidance on Environmental Justice Considerations under CWA Section 402

There are important provisions under CWA Section 402 that may be relevant to environmental justice issues stemming from surface coal mining and its impact on human health and the environment. EPA will address the adequacy of the technical and scientific aspects of the permit, as well as public participation, in reviewing NPDES draft permits. In particular, EPA will consider whether the public has been given meaningful opportunity for participation in development of the permit pursuant to 40 CFR Section 124.11.

As explained above, when EPA determines that a draft or proposed permit fails to comply with the CWA, EPA has the authority to object to the issuance of that permit. When Regions review draft or proposed permits for compliance with the Act, we encourage you to also review those permits to determine the extent to which issuing the permit may result in adverse human health or environmental effects on low-income and minority populations. For example, a Region may determine that the issuance of a permit will have adverse effects on drinking water supplies or fisheries that are relied on by subsistence fishers, or wildlife used as a subsistence food source by the local population. If EPA determines that issuing the NPDES permit may result in adverse human health or environmental effects, EPA will consider such effects when determining whether to exercise its discretion to object to a draft state permit under CWA Section 402(d) and EPA's implementing regulations.

IV. Strengthening EPA's Environmental Review Under CWA Section 404 in Coordination with the Corps of Engineers

EPA has long played a role in assessing environmental and water quality implications of proposed Section 404 permits, and is authorized to prohibit or deny projects that do not meet the criteria in the CWA and implementing regulations. While states are responsible, in coordination with EPA, for establishing state water quality standards, EPA has the critical authority under CWA Section 404(b)(1) to make independent judgments about threats to water quality. In

addition to the documented impacts from increased sediment loading, a growing body of data demonstrates that high conductivity and/or selenium levels in streams downstream from mining operations contribute to the impairment of biological diversity and ecological integrity of these streams and can lead to significant adverse impacts on the aquatic ecosystem and contamination of drinking water supplies. EPA and Corps regulations require consideration of these environmental and water quality concerns in the evaluations of applications for permits under CWA Section 404.

Under Section 404(a) of the CWA, the Corps is authorized to issue permits, after notice and opportunity for public hearings, for the discharge of dredged or fill material into waters of the U.S., including wetlands. Under Section 404(b)(1), EPA is authorized to develop guidelines, in conjunction with the Corps, to ensure that the goals of the CWA are met. These regulations are located at 40 C.F.R. Section 230. These Section 404(b)(1) Guidelines (Guidelines) are applicable to all discharges of dredged or fill material to waters of the U.S, and the Corps issues Section 404 permits after evaluating proposed discharges for consistency with the Guidelines and its own implementing regulations. 40 C.F.R. Section 230.2. EPA also reviews public notices and general permit pre-construction notifications for Section 404 permits for consistency with the Guidelines. Under Section 404(q) of the CWA, the Agencies have entered into a Memorandum of Agreement (404(q) MOA) governing the sharing of information and elevating of decisions when there is a dispute between regional and district offices over implementation of the Guidelines.[26] Finally, under Section 404(c) of the CWA, the Administrator is authorized to "veto" a permit if the Administrator determines that a discharge will have an unacceptable adverse effect.[27]

When reviewing Corps public notices and general permit pre-construction notifications for CWA Section 404 authorizations for surface coal mining-related discharges to waters of the United States in Appalachian states, Regions should be guided by the following sections.

A. Principles for Regional Review of Appalachian Surface Coal Mining Section 404 Permit Applications

The fundamental premise of the Guidelines is that no discharge of dredged or fill material may be permitted if: (1) it causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable state water quality standard; (2) a practicable alternative exists that is less damaging to the aquatic environment; or (3) the nation's waters

[26] Clean Water Act Section 404(q): Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army (1992). Available at http://www.usace.army.mil/CECW/Documents/cecwo/reg/mou/moa_epa404q.pdf.

[27] "The Administrator is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site, and he is authorized to deny or restrict the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever he determines, after notice and opportunity for public hearings, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. Before making such determination, the Administrator shall consult with the Secretary. The Administrator shall set forth in writing and make public his findings and his reasons for making any determination under this subsection." CWA Section 404(c).

would be significantly degraded. 40 C.F.R. Section 230.10. In addition, if the proposed discharge is associated with a non-water-dependent activity, upland alternatives are presumed to exist. 40 C.F.R. Section 230.10(a)(3). Avoidance and minimization of the direct, indirect, and cumulative adverse environmental and water quality impacts to streams, wetlands, and other aquatic resources should be required. A demonstration must first be made that there is no practicable alternative to the proposed discharge to the waters of the United States that would have less adverse impact on the aquatic ecosystem. If there is no less damaging practicable alternative, then all appropriate and practicable steps to minimize potential adverse impacts of the discharge must be taken. Finally, mitigation is required to compensate for any remaining aquatic impacts.

To better ensure that surface mining proposals meet these requirements, Regions should affirm in their review that mining projects are consistent with the following principles:

1. Mining activities will not cause or contribute to violations of water quality standards, contaminate drinking water supplies, or add toxic pollutants that kill or impair stream life. 40 C.F.R. Section 230.10(b). Mining discharges must also not result in significant degradation of the aquatic environment, including contamination of water supplies. 40 C.F.R. Section 230.10(c).

2. Applicants have evaluated a full range of potential alternatives to discharging into waters of the U.S., including off-site and/or other disposal alternatives, with clear documentation regarding practicability for each alternative. 40 C.F.R. Section 230.10(a). Alternative mining methods that reduce generation of excess spoil should also be analyzed. Practicable, modern engineering and materials handling practices should be used to reduce the size and number of valley fills or the extent of streams impacted as a result of mine-through operations that bury, eliminate, and pollute local streams.

3. Mining companies have avoided and minimized their direct, indirect, and cumulative adverse environmental impacts to streams, wetlands, watersheds, and other aquatic resources. 40 C.F.R. Sections 230.10(a) and 230.10(d).

4. Remaining mining-related aquatic impacts have been effectively mitigated by establishing, restoring, enhancing, or preserving streams and wetlands; protecting water quality, including drinking water; and reclaiming watersheds when mining is completed. 40 C.F.R. Section 230.10(d).

Water quality standards are fundamental to achieving the purposes of the CWA. EPA has a role and responsibility for ensuring that water quality standards are not exceeded because of discharges regulated under Section 404 from Appalachian surface coal mining operations. In their review to determine whether a proposed discharge will cause or contribute to an exceedance of water quality standards, Regions should be guided by the principles articulated in Sections III.B. and III.C. of this memorandum addressing implementation of both numeric and narrative water quality standards. EPA retains its responsibility for ensuring that neither numeric nor narrative water quality standards are exceeded due to discharges of fill material even if a state has issued a water quality certification under Section 401 of the CWA. State certifications of

compliance with applicable water quality standards will be considered conclusive by the Corps with respect to water quality considerations unless the Regional Administrator advises the Corps of other water quality aspects to be taken into consideration. 33 C.F.R. Section 320.4(d). Thus, Regions should convey their conclusions with respect to possible exceedances of water quality standards to the Corps and, if appropriate changes to the permit are not made in response to these water quality concerns, may proceed under the 404(q) MOA and/or Section 404(c).

Similarly, with respect to the four review principles identified in this section and the guidance for applying the Guidelines in the next section, Regions should convey the results of their reviews to the Corps, the permit applicant, and the state and, if appropriate changes to the permit are not made in response to these water quality concerns, may proceed under the 404(q) MOA and/ or Section 404(c).

B. Key Information for Evaluating Permit Applications for Appalachian Surface Coal Mining

Because of the complexity, size, and scale of surface coal mining projects, in reviewing proposed Section 404 permit applications for these activities, it is essential that federal and state agencies have appropriate data to fully review the aquatic ecosystem impacts anticipated to occur. EPA Regions should evaluate project-specific data including, but not limited to, the following information. Where such data are also required by other federal and state regulatory partners, the agencies are encouraged to collaborate in sharing this information among one another to increase efficiency and better ensure regulatory decisions are being made using the same base of technical information.

- Geospatial information – Digital geospatial boundaries for the proposed project and individual valley fills. Location of nearby, reference, or unmined tributaries in the same catchment.
- Surface area disturbed – Total acreage of surface disturbance area (mineral extraction area).
- Spoil material – Volume of overburden excavated and volume of excess spoil (in cubic yards).
- Disposal location – Detailed as on site, off site, or a combination or percentage.
- Spoil for each valley fill – In cubic yards, where applicable.
- Drainage area – Above each toe of fill and each sediment pond, whichever is further downstream (in acres).
- Impacts – Aquatic resource impacts resulting from, but not limited to, valley fills, sediment ponds, slurry ponds, in-stream mining, or other mining operation features, in linear feet by type of stream (perennial, intermittent, ephemeral) or acres for other resource types, and by type of impact (permanent or temporary).
- Baseline monitoring – Pre-mine (land disturbance) sampling data and sampling location for total suspended solids, total dissolved solids, conductivity, sulfates, bicarbonate, chloride, magnesium, potassium, calcium, sodium, pH, selenium, and list of the presence and abundance of aquatic organisms identified to the loweset

practicable taxonomic level, usually genus-level for invertebrates and species-level for vertebrates.

- Hydrology – Cumulative Hydrologic Impact Assessments (CHIAs) and Probable Hydrologic Consequences (PHC).
- Watershed condition – Any sampling data for total suspended solids, total dissolved solids, conductivity, sulfates, bicarbonate, chloride, magnesium, potassium, calcium, and macroinvertebrate presence and abundance for adjacent mines included with the CHIA or other sources.
- Geology – Geologic strata information from core samples, including analysis of selenium, pyrite, calcium carbonate, acid-producing strata, and any strata that may cause or contribute to conductivity.
- Drinking water supplies – Location of drinking water supplies that could be affected, including private wells.
- Subsistence consumption – Patterns of local consumption of fish and wildlife that may be affected by loss of waters and impacts to surface water quality.

C. Applying the 404(b)(1) Guidelines for Surface Coal Mining Activities

The Section 404(b)(1) Guidelines prohibit issuance of a permit that will cause or contribute to excursions from applicable state water quality standards or to significant degradation of the aquatic ecosystem. 40 C.F.R. Sections 230.10(b) and (c). While issuance of the Section 402 permit is required to control discharges of pollutants into waters of the United States from surface mining operations, the discharge of fill material resulting in physical modification and elimination of portions of headwater streams may have water quality impacts that are not addressed in the NPDES permit. For example, elimination of all or even part of a headwater stream may remove from the overall watershed system an important source of freshwater dilution that contributes to water quality. Accordingly, even where a NPDES permit has been issued, the Section 404 permit must independently ensure that water quality is protected. The applicant should be required to demonstrate up front, based on proposed mining techniques, best management practices, or other actions, that the project will not cause or contribute to an excursion from applicable water quality standards or to significant degradation. The permit should include a condition, pursuant to 40 C.F.R. Sections 230.10(b) and (c), prohibiting the project from causing or contributing to an excursion from applicable water quality standards or to significant degradation.

The following discussion represents EPA's expectations for the analyses necessary to ensure compliance with water quality standards, prevention of significant degradation, and full analysis of avoidance, minimization, and (where necessary) mitigation, to achieve full compliance with the 404(b)(1) Guidelines.

1. Preventing Violations of Water Quality Standards

The Section 404(b)(1) Guidelines require that Section 404 permits must not cause or contribute, after consideration of site dilution and dispersion, to violations of applicable state

water quality standards. 40 CFR Section 230.10(b)(1). As explained more fully above in Section III, Appalachian states have narrative water quality standards that protect the native aquatic community, including protection from adverse effects associated with elevated levels of in-stream conductivity. Nearly all Appalachian states, however, have not established numeric water quality criteria for conductivity or TDS and historically have not included numeric effluent limitations to address conductivity or TDS in state-issued NPDES permits. The absence of necessary WQBELs in 402 permits has meant that EPA has needed to consider whether issuance of a 404 permit would be inconsistent with the Guidelines because authorization of a particular mining project would result in exceedances of a state's narrative standards. Section III.C. of this memorandum provides specific guidance to the Regions on how to evaluate whether provisions of NPDES permits are adequate to protect against violations of water quality standards, and that guidance also applies to how Regions should conduct that evaluation for Section 404 permits. As discussed below, even where a Section 402 permit has addressed protection of water quality standards, the Guidelines establish an independent obligation to address potential violations of water quality standards associated with discharges of dredged or fill material and to protect against significant degradation.

2. Preventing Significant Degradation

In addition to the provision in the Section 404(b)(1) Guidelines requiring that Section 404 permits must not cause or contribute, after consideration of site dilution and dispersion, to violations of applicable state water quality standards (Section 230.10(b)(1)), a separate, additional provision prohibits the permitting of a discharge that will cause or contribute to significant degradation of the waters of the U.S. (Section 230.10(c)). The Corps and EPA therefore have a responsibility to ensure sufficiently protective requirements are included when reviewing mining projects in draft Section 404 permits. To date, this has involved coordination with the Corps to develop adequate numeric action triggers in 404 permits. Our general approach has been to rely on peer-reviewed studies (including those by EPA) examining the relationship between conductivity values and water quality impairment in Appalachia. These studies point to a strong relationship between conductivity values in the range of 400-500 µS/cm in headwater streams and significant degradation of benthic communities in Appalachian streams as a result of mining activity. In response to these studies, the Corps and EPA included conditions in the recent Section 404 permit for the Hobet 45 mine that trigger remedial action requirements when conductivity levels in streams associated with this mine reach the 400-500 µS/cm level.

A recently prepared EPA ORD study, which is being noticed in the Federal Register for public comment and which will be submitted for SAB review, augments existing studies and provides an additional analysis of the relationship between impairment of stream quality in Appalachia and conductivity levels. This study identifies conductivity levels of 300 µS/cm or below in Appalachian headwater streams as a benchmark for retaining 95% of native benthic species. The study also identifies substantial impacts to native invertebrate species at conductivity levels exceeding 500 µS/cm. Because the study will be reviewed by the SAB, it does not represent a final Agency position at this time. However, EPA will need to continue reviewing 404 permits while this external peer review process is underway.

For purposes of Section 230.10(c) of the Guidelines, the Regions should consider the ORD report when examining whether a draft 404 permit is likely to result in significant degradation of waters of the U.S. During this interim period, the Regions should make a case-by-case determination based upon all available relevant scientific information including the ORD report. EPA anticipates that the conductivity impacts of projects with predicted conductivity levels below 300 µS/cm generally will not cause a water quality standard violation or significant degradation of the aquatic ecosystem. On the other hand, EPA expects that in-stream conductivity levels above 500 µS/cm are likely to be associated with adverse impacts that could rise to the level of significant degradation of the aquatic ecosystem. At a minimum, should a proposed Section 404 permit allow for increases in levels of conductivity above 500 µS/cm, the administrative record for the permit should demonstrate, based on site or receiving water specific information, how the permit is consistent with the CWA and the 404(b)(1) Guidelines, and Regions are encouraged to review such a record carefully. EPA, the Corps, and individual mining operators should be coordinating, in the context of a "sequenced" permitting approach (see IV.C.4 below), or other similarly protective measures, to ensure conductivity levels remain at levels not likely to contribute to degraded water quality, as discussed above in III.C.1. Projects projected to increase conductivity levels above 300 µS/cm should include permit conditions requiring adaptive remedial action to prevent conductivity levels from rising to levels that may contribute to water quality degradation, as discussed in III.C.1. After EPA's draft conductivity report is finalized after peer review, we will reexamine this approach.

In conjunction with the conductivity threshold, ORD's review of the scientific literature on surface coal mining (as mentioned above, scheduled to be reviewed by the SAB) and *Science* magazine found effects, including resource loss, water quality impairment, and adverse effects on aquatic ecosystems, that could support a conclusion of significant degradation of waters of the U.S. under applicable regulations.

3. Ensuring Effective Monitoring

To ensure compliance with these provisions of the Guidelines, the permit should effectively require water quality and biological monitoring in streams below surface coal mining operations to ensure permit conditions are being met and to collect data to inform continued operations as described below. Monitoring should be conducted during construction and post-construction. The permittee should be required to submit baseline monitoring data for biological condition, conductivity, total dissolved solids, sulfates, bicarbonate, chloride, magnesium, potassium, calcium, sodium, pH, and selenium to help provide information necessary to assure compliance with water quality standards and prevent significant degradation. The permittee should use the methodology employed by the state for assessing its waters pursuant to Section 303(d) or other methodology utilized by the state. In addition, with respect to biological data, the permittee should identify taxa to the genus level where the state methodology does not do so. The permittee should implement a monitoring plan for the foregoing parameters at appropriate locations upstream and downstream of the project, where applicable. As set forth in more detail below, the permit should include clear requirements for remedial actions to protect water quality

in the event monitoring reveals a trend toward excursion from water quality standards or a trend toward significant degradation.

4. Ensuring Independent Water Quality Protection from Section 404 Permits

Regions should ensure that, if a Section 402 permit has already been issued and does not address current science-based values for contaminants, the Section 404 permit includes needed conditions to protect water quality and to prevent significant degradation of the aquatic ecosystem. In addition to the monitoring requirements discussed in #1 above, additional conditions should explicitly address the levels of specific contaminants that must be achieved. These conditions should also address the adaptive remedial actions that will be implemented if water quality protection values are exceeded.

5. Ensuring Adequate Cumulative Impact Assessment Consistent with the 404(b)(1) Guidelines

Regions should ensure that watershed-scale (e.g., Hydrologic Unit Code 12 (HUC-12)) cumulative impact analyses are conducted as an element of the factual determinations required by the 404(b)(1) Guidelines. 40 CFR Section 230.11(g). These analyses should assess the consequences of past, present, and reasonably foreseeable future discharges of dredged or fill material (federal and non-federal) in the affected watersheds, on water quality and the aquatic environment. To the extent the cumulative impacts to water quality and the aquatic environment also affect human use characteristics, such as water supplies or fisheries, those impacts also should be addressed. Regions are encouraged to ensure that cumulative impact assessments conducted pursuant to the Guidelines are coordinated with required NEPA evaluations described in Section VI. below.

6. Assessing and Mitigating for Affected Stream Functions

Regions should ensure that applicants or the Corps conduct functional stream impact assessments and ensure they are effectively used to quantify the environmental effects of individual mining projects on streams. Regions are encouraged to work with and provide technical assistance to the Corps and states on the development and implementation of effective assessment methods. These assessments should be used to ensure that compensatory mitigation adequately replaces lost stream functions. For example, EPA should recommend alternatives to drainageways (e.g., groin ditches) as methods of stream mitigation, as they do not replace lost stream functions and are therefore not an acceptable form of compensatory mitigation. Some additional specific expectations for compensatory mitigation consistent with the agencies mitigation regulations include:

a. Timeframe – An expected timeframe for success should be identified and the mitigation should be monitored for that length of time in order to ensure success.

b. Mitigation monitoring – A detailed monitoring plan outlining the observable and measureable physical, chemical and biological criteria, and expected standards to be achieved, should be incorporated into permit conditions.

c. Adaptive remedial action – Include an adaptive remedial action plan that identifies specific triggers in the performance standards and alternate plans and strategies should the desired targets not be achieved. The plan should require additional actions and/or supplemental mitigation in the event success criteria are not achieved within an appropriate timeframe.

d. Stream establishment – Created stream channels should be designed to develop good water quality, healthy and diverse biological communities, and similar hydrologic regimes as streams to be impacted by mining activities. The goal of these compensation projects is to replace the lost stream functions impacted through mining activities; therefore, they should be designed to achieve designated uses for aquatic life support.

e. Ditches – No Section 404 compensation credit should be given for sediment, groin, or other water control ditches required for mining projects under SMCRA and CWA Section 402.

7. Ensuring Environmental Justice in Section 404 Permitting

Regions should identify whether issuing a permit would result in adverse human health or environmental effects on low-income and minority populations, including impacts to water supplies and fisheries. Where such effects are likely, EPA Regions should suggest ways and measures to avoid and/or mitigate such impacts through comments to the Corps.

In addition to the principles outlined above, EPA expects that the following best management practices will help to reduce or eliminate potential increases in conductivity levels in surface waters downstream of mining-related discharges to levels consistent with meeting narrative water quality standards and preventing significant degradation, as discussed in this memo, and to minimize associated impacts to the aquatic environment.

1. Sequencing Multiple Valley Fills for Projects Proposing More Than One Fill

Many of the proposed best management practices associated with the design of mining operations are currently unproven in their effectiveness to protect water quality and to prevent significant degradation. As a general matter, an effective approach for managing this uncertainty is to sequence multiple fills on a project. The sequenced approach, or another comparably effective measure, should be employed to account for uncertainty regarding the ability of current project best management practices to address the potential adverse impacts of multiple fills. In this context, the term "sequenced" means:

a. Valley fills that are part of the same project or complex should generally be constructed one at a time, unless site-specific data suggest no potential downstream water quality concerns; and

b. The permittee should demonstrate compliance with applicable water quality standards, and that significant degradation has not occurred, at each valley fill before the permittee may begin construction of subsequent valley fills.

EPA encourages applicants to fully sequence fills (e.g., one at a time) where monitoring and watershed-specific factors suggest water quality impacts may occur. On a case-by-case basis, if available data suggest that concurrently constructing more than one initial fill would not be likely to lead to water quality concerns, such an approach may be evaluated. A trends analysis as referenced above should be performed from the conductivity monitoring data. The trends analysis should then be evaluated against two threshold conductivity values established within the permit. The first value would establish a threshold at which a trend toward causing or contributing to water quality exceedances and significant degradation is identified, and the operator would be required to implement an adaptive remedial action plan to prevent further degradation. The second value would establish a threshold at which an excursion from applicable water quality standards and/or significant degradation is likely, and the permittee would be prohibited from constructing additional valley fills until such time as the excursion from water quality standards and/or significant degradation has been remediated and the permittee has demonstrated that no further excursion from water quality standards and/or significant degradation will occur. As discussed above, for many Appalachian streams, available scientific evidence supports using thresholds of 300 and 500 uS/cm in this context, though site-specific evidence may support alternate thresholds.

2. Protecting Water Quality for Projects Proposing One Valley Fill

For operations proposing a single valley fill, the sequencing as described above is not an option. As stated above, the applicant should be required to demonstrate prior to authorization and construction, based on proposed mining techniques, best management practices, or other actions, that the project will not cause or contribute to an excursion from applicable water quality standards or to significant degradation. The permit should include a condition, pursuant to 40 CFR Sections 230.10(b) and (c), prohibiting the project from causing or contributing to an excursion from applicable water quality standards or to significant degradation. In order to carry out this requirement and to assure that the permit will not cause or contribute to an excursion from applicable state water quality standards or to significant degradation of downstream waters, a monitoring plan as described above should generally still be required. Such permit conditions are also applicable and should be required for projects proposing multiple valley fills.

3. Minimizing Spoil Generation and Water Quality Impacts Through Avoidance and Minimization

Because larger and more numerous valley fills in waters of the U.S. are associated with increasing both direct adverse impacts to streams and watersheds and indirect downstream water quality impacts, projects should incorporate cost effective and technologically feasible limits on the quantity of excess spoil being generated per ton of coal produced by conducting a robust alternatives analysis. By relying on more efficient mining practices, impacts to streams and watersheds can be reduced. High-ratio mining operations generally do not represent the least environmentally damaging alternative. Consistent with the June 2009 interagency surface coal mining MOU, applicable federal and state regulatory agencies should coordinate environmental reviews of pending permit applications under the CWA and SMCRA to require practicable mining techniques that maximize the amount of spoil returned to the mine bench and minimize the amount of excess spoil that must be disposed of in streams and other aquatic systems. For mine-through operations, stream impacts should be avoided to the maximum practicable extent and spoil placement should be controlled to reduce drainage through overburden into streams. Options for disposing of mine waste in uplands, including relying on remaining excess spoil capacity at adjacent mine sites, must be fully evaluated. "Piecemealing" of multiple small mines to replace fewer large mines should be carefully evaluated to ensure that substitution of smaller mines is not resulting in greater direct, secondary, and cumulative adverse environmental impacts, which is not consistent with the Guidelines.

Projects should also incorporate environmentally effective limits on the linear extent of stream impacts per ton of excess spoil produced through a robust alternatives analysis. Such limits provide for improved efficiencies in spoil handling to minimize impacts to streams and is applicable to most mining operations, including mine-through projects. Where valley fills are necessary to accommodate disposal of excess spoil, overburden should be configured to maximize disposal as far up the valley as is feasible from an engineering perspective. To reduce direct stream impacts, valley fill construction should generally be from the head of the valley downwards instead of beginning at a point downstream and moving back upstream.

4. Certifying Mine Plan and Ensuring Full Utilization of Fill Disposal Sites

It is EPA's experience that permitted mine plans do not always reflect the "on-the-ground" construction and operation of a mine project. For many reasons, as construction and operation of the mine is underway, it is possible that the mine plan may change and that an operation may not fully utilize authorized capacity in valley fills. To prevent under-utilization of fills and to encourage additional avoidance and minimization of impacts to waters of the United States during construction, EPA should recommend that an issued permit be conditioned to require the operator to certify the mine plan and provide such certification to the Corps and EPA prior to construction of each valley fill. The operator should also be required to provide post-mining "as-built" plans.

5. Minimizing Conductivity Impacts and In-Stream Impoundments

Projects should fully evaluate and, where feasible, incorporate the following specific aspects of effective impacts avoidance and minimization:

a. Materials handling plans – Ensure that soils and rock on the mine site have been tested for concentrations of acid-, selenium- or heavy-metals-bearing or soluble strata that are likely to lead to high conductivity concerns. Overburden with high concentrations of these pollutants should be handled to minimize exposure to rainwater and groundwater and subsequent drainage into surface waters.

b. Fill construction – To prevent infiltration of surface runoff into the fill mass whenever possible, overburden should be compacted, leaving the top six feet unconsolidated. The use of end dumps should be discouraged whenever possible.

c. Sedimentation ponds – While achieving adequate sediment control, minimize the number of sediment ponds placed in waters of the U.S. and ensure that post-mining reclamation plans remove such ponds and restore affected streams.

6. Reducing Drainage Area Flowing Through Fills

Projects should reduce the drainage area flowing through valley fills to the maximum practicable extent consistent with sound engineering and safety considerations. Recent studies have suggested that water (e.g., precipitation and groundwater) flowing through valley fills contributes significantly to downstream water quality concerns as infiltrating water accumulates metals, dissolved solids, and sulfates. Designing mines (including mine-through operations) and valley fills to minimize drainage through mining spoil can contribute significantly to protecting downstream water quality. Regions should ensure that projects evaluate and, where feasible, incorporate current best mining practices that reduce infiltration and protect water quality, such as constructing valley fills as "side-hill" fills to reduce infiltration by precipitation, incorporating drains in valley fills to intercept and divert groundwater, and designing mines to take more consistent advantage of natural drainage through coal and rock formations that divert flow away from surface waters.

D. Addressing a Broad Range of Environmental Impacts

While the Guidelines evaluation process addresses impacts to the aquatic environment and the consequences of those impacts, we recognize that issuance of Section 404 permits can have other important environmental and human health impacts that are considered by the Corps as part of the "public interest review" process (33 CFR Section 320.4(a)). The public interest review process explicitly requires a "careful weighing" of up to 21 relevant public interest factors, including economics, aesthetics, energy needs, safety, and the general "needs and welfare of the people." In that light, we recommend that Regions provide comments to the Corps that address relevant public interest factors associated with the discharge of fill material

into waters of the United States, with a particular emphasis on ways or measures to mitigate potential adverse impacts to low-income and minority populations.

E. Conclusion

We encourage the Regions to discuss these general strategies with Corps Districts and states. Consistent with long-standing practice, we encourage Regional staff to offer specific recommendations to permit applicants who want to work with EPA to resolve individual permit issues. We have, in fact, engaged in productive dialogues with several permit applicants. Experience has shown that these discussions can provide an efficient and effective path to agreement on permit conditions that meet the requirements of the law while allowing mining companies to proceed on a cost-effective and environmentally responsible basis. We encourage more interaction between industry and EPA to resolve permit issues through dialogue and technical cooperation.

V. CWA Section 401 Certifications by States

Section 401 conveys to states directly and eligible Tribes the authority to approve (certify), condition, or deny all federal permits or licenses authorizing a discharge to waters of the U.S., including wetlands, including CWA Section 404 permits and federally issued SMCRA permits. States and Tribes may choose to waive their Section 401 certification authority and, if they fail to respond to a request for certification within the proscribed time (generally one year), their Section 401 authority is waived by default.

States and Tribes most commonly make their decisions to deny, certify, or condition permits or licenses primarily in consideration of whether the activity will comply with state water quality standards. However, they also look at whether the activity will violate effluent limitations, new source performance standards, toxic pollutant controls, or other appropriate requirements of state or Tribal law or regulation. EPA is in the process of developing an updated handbook on the basics of state Section 401 certification actions, which is intended to help clarify how states and tribes can most effectively employ this statutory water quality management tool for applicable projects, including surface coal mining projects permitted under Section 404.

Although Section 401 certification authority rests with the jurisdiction where the discharge originates, neighboring states and tribes downstream or otherwise potentially affected by the discharge have an opportunity to raise objections to, and comment on, the federal permit or license. EPA should determine if a discharge subject to Section 401 certification may affect the water quality of other states or tribes and, if there may be such an effect, EPA Regions should notify other jurisdictions whose water quality may be affected. The other jurisdictions should then be provided an opportunity to submit their views and objections, including opportunities for public hearings, consistent with CWA Section 401(a)(2). Although, the nature of recommendations from neighboring jurisdictions do not have the same force as conditions from a

Section 401 certifying state, the federal agency must develop measures to address the downstream jurisdictions' concerns.

Section 401(a)(1) requires that a state "establish procedures for public notice in the case of all applications for certification by it and, to the extent it deems appropriate, procedures for public hearings in connection with specific applications." 33 U.S.C. Section 401(a)(1). To enable meaningful participation by affected communities, we recommend that Regions work with the states to ensure that these public participation procedures are in place, and encourage the states to provide appropriate opportunities for public hearings on specific certifications.

VI. **National Environmental Policy Act Considerations**

The Regions should work with the Corps and OSM to ensure that the NEPA analyses associated with federal permit decisions provide, through an open and accountable process, a comprehensive evaluation of the potential impacts associated with proposed actions, as well as an analysis of reasonable alternatives that may avoid or minimize adverse impacts. The Corps has announced its intention to issue a notice of proposed rulemaking expanding the Corps NEPA scope of review to consider all of the effects of proposed surface coal mining "valley fills" on the aquatic environment. EPA will work with the Corps toward that objective, and furthering the purpose of NEPA to provide information to the decision maker, other federal and state agencies, and the public. In the interim, EPA will work with the Corps on a case by case basis to review permit applications and ensure that all relevant environmental information, as well as potential alternatives that may avoid or minimize the extent of the valley fills, is fully considered.

We also recommend that Regions work with the Corps and OSM to help establish opportunities for early and meaningful community input. These opportunities for increased community input may include Regions requesting that Corps Districts and OSM make draft Environmental Assessments (EAs) readily available to the public using a variety of methods, including online and print media, as early in the permitting process as possible. In addition, it is important that all agencies work with local communities, including low-income and minority populations, to identify potential adverse human health and environmental impacts and mitigation measures and improve the accessibility of meetings, crucial documents, and notices.

As discussed earlier, the NEPA process is also an effective vehicle for considering the potential cumulative effects of mining proposals. Using a watershed-scale analysis (e.g., HUC-12 analyses) would be an effective way to examine the cumulative environmental and human health impacts from past, present and reasonably foreseeable actions, including federal and non-federal actions. When working with the Corps and OSM to help define the proper scope of a NEPA cumulative impact assessment, Regions should be clear that while cumulative hydrological impact assessments (CHIAs) prepared as part of the SMCRA process can provide useful information regarding impacts to the hydrologic balance of an area, a NEPA cumulative impact assessment should consider the full suite of relevant environmental impacts.

When an agency develops and makes a commitment to require mitigation measures to avoid, minimize, rectify, reduce, or compensate for significant environmental impacts, NEPA

compliance can be accomplished with an EA, coupled with a Finding of No Significant Impact (FONSI) ("Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026 (March 23, 1981)). The Regions should, in evaluating permit applications and NEPA analyses, carefully evaluate any proposed mitigation measures to ensure that they will not only be effective at eliminating or reducing impacts, but also that they are clearly stated, include binding commitments and monitoring plans, and include provisions for public access to monitoring results and related documents. Recent scientific evidence referenced earlier in this memorandum, as well as field experience with surface coal mining mitigation projects, has raised technical concerns about the capacity of some forms of mitigation to reduce on-site and downstream impacts associated with Appalachian surface coal mining to below levels of significance. For example, as noted earlier, EPA believes that no mitigation credit should be given for sediment, groin, or other water control ditches. Consequently, construction of these ditches should not be used as a basis for supporting a FONSI. Moreover, mitigation measures that rely on establishing or re-establishing streams, rather than rehabilitating or enhancing existing streams, have less certainty of successfully offsetting impacts and should generally not be used to support a FONSI.

While no specific regulatory thresholds exist for determining whether a potential impact is significant under NEPA, it is EPA's general experience with surface coal mining projects in Appalachia that there are a number of factors that should be considered. First, the scale of the proposed impacts to stream habitats is of primary importance. While smaller projects should be reviewed to determine whether potential impacts warrant preparation of an EIS, it is EPA's experience that projects that involve more than one mile of stream loss or more than one valley fill are likely to result in significant adverse impacts.

Finally, consistent with EPA's *Policy and Procedures for the Review of Federal Actions Impacting the Environment*, the Regions should consult with the Office of Federal Activities (OFA) when recommending to the Corps or OSM that an EIS be prepared. OFA can also provide assistance when Regions are unable to reach agreement with Corps Districts or OSM on whether an EIS should be prepared in a particular case. Further, although the decision to prepare an EIS rests with the Corps and OSM, under EPA's Clean Air Act Section 309 authority, EPA must "refer" to CEQ matters that the Administrator finds are "unsatisfactory from the standpoint of public health or welfare or environmental quality." OFA will work with Regions to determine an appropriate course for resolving such disputes, including the potential for a referral to CEQ, if appropriate.

VII. Conclusions

EPA will continue to work with our federal regulatory partners, state agencies, the mining industry and the public to fulfill our common goals of reducing adverse impacts to water quality, aquatic ecosystems, and human health. We will also communicate effectively with local communities and mining companies to provide the transparency, consistency, and efficiency expected of government agencies in dealing with issues of such importance to health, the environment, and the economy. EPA's Regional offices will continue to be the Agency's primary field representatives to co-implementing agencies, mining companies, affected

communities, and interested members of the public as we work to respond to CWA, NEPA, and environmental justice issues associated with Appalachian surface coal mining permits. We look forward to your leadership as we coordinate to develop environmentally effective, scientifically sound, and economically responsible approaches for meeting the requirements of the law.

cc: Regional Water and Enforcement Division Directors, Regions 3, 4, and 5
Robert Sussman, Senior Policy Counsel to the Administrator
C. Scott Fulton, General Counsel

MEMORANDUM OF UNDERSTANDING AMONG THE
U.S. DEPARTMENT OF THE ARMY,
U.S. DEPARTMENT OF THE INTERIOR,
AND U.S. ENVIRONMENTAL PROTECTION AGENCY

IMPLEMENTING THE INTERAGENCY ACTION PLAN ON APPALACHIAN SURFACE COAL MINING[1]

JUNE 11, 2009

PREAMBLE

The mountains of Appalachia possess unique biological diversity, forests, and freshwater streams that historically have sustained rich and vibrant American communities. These mountains also contain some of the nation's richest deposits of coal, which have been mined by generations of Americans to provide heat and electricity to millions in the U.S. and around the world. After generations of mining, however, the region's most readily available coal resources have diminished, and the remaining coal seams are less accessible to non-surface mining methods.

In response, a surface mining technique commonly referred to as "mountaintop mining"[2] has become increasingly prevalent in the Appalachian region. Although its scale and efficiency has enabled the mining of once-inaccessible coal seams, this mining practice often stresses the natural environment and impacts the health and welfare of surrounding human communities. Streams once used for swimming, fishing, and drinking water have been adversely impacted, and groundwater resources used for drinking water have been contaminated. Some forest lands that sustain water quality and habitat and contribute to the Appalachian way of life have been fragmented or lost. These negative impacts are likely to further increase as mines transition to less accessible coal resources within already affected watersheds and communities.

With this Memorandum of Understanding (MOU), the Department of the Interior (DOI), U.S. Environmental Protection Agency (EPA), and the U.S. Army Corps of Engineers (Corps)

[1] For purposes of this MOU, "Appalachian surface coal mining" refers to mining techniques requiring permits under both the Surface Mining Control and Reclamation Act (SMCRA) and Section 404 of the Clean Water Act (CWA), in the states of Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.
[2] The term "mountaintop mining" may also be referred to as "mountaintop removal" or "valley fill mining."

are announcing this Interagency Action Plan (IAP) designed to significantly reduce the harmful environmental consequences of Appalachian surface coal mining operations, while ensuring that future mining remains consistent with federal law. This IAP includes a set of short-term actions to be implemented in 2009 to existing policy and guidance, and a longer term process for gathering public input, assessing the effectiveness of current policy, and developing regulatory actions.

The Federal government has made a commitment to move America toward a 21st-century clean energy economy based on the recognition that a sustainable economy and environment must work hand in hand. Federal Agencies will work in coordination with appropriate regional, state, and local entities to help diversify and strengthen the Appalachian regional economy and promote the health and welfare of Appalachian communities. This interagency effort will have a special focus on stimulating clean enterprise and green jobs development, encouraging better coordination among existing federal efforts, and supporting innovative new ideas and initiatives.

Interagency Action Plan

I. COORDINATION ON REGULATORY PROGRAMS

This MOU formalizes the agencies' IAP for coordinating the regulation of Appalachian surface coal mining. The elements of the plan are:

- A series of interim actions under existing authorities to minimize the adverse environmental consequences of Appalachian surface coal mining;
- A commitment by the agencies to investigate and, if appropriate, undertake longer term regulatory actions related to Appalachian surface coal mining;
- Coordinated environmental reviews of pending permit applications under the Clean Water Act (CWA) and Surface Mining Control and Reclamation Act (SMCRA); and
- A commitment to engage in robust public participation, through public comment mechanisms and Appalachian public outreach events, helping to inform Federal, State, and local decisions.

In addition to the steps taken above, the Federal government will help diversify and strengthen the Appalachian regional economy. This effort will include the agencies to this MOU, and other Federal agencies, as appropriate, and will work to focus clean energy investments and create green jobs in Appalachia.

Coordination of interagency policy discussions and assessment of policy effectiveness will be achieved in consultation with the Council on Environmental Quality.

II. SHORT-TERM ACTIONS TO MINIMIZE ENVIRONMENTAL HARM

The signatory agencies will take the following short-term actions under existing laws, regulations, and other authorities to reduce the harmful environmental consequences of Appalachian surface coal mining.

Before the end of 2009, the Corps and EPA will take the following steps:

- Within 30 days of the date of this MOU, the Corps will issue a public notice pursuant to 33 C.F.R. § 330.5 proposing to modify Nationwide Permit (NWP) 21 to preclude its use to authorize the discharge of fill material into streams for surface coal mining activities in the Appalachian region, and will seek public comment on the proposed action.
- EPA and the Corps, in coordination with DOI's Fish and Wildlife Service (FWS), will jointly develop guidance to strengthen the environmental review of proposed surface coal mining projects in Appalachia under the CWA Section 404(b)(1) Guidelines.
- Recognizing that the regulation of surface coal mining extends beyond CWA Section 404, EPA will improve and strengthen oversight and review of water pollution permits for discharges from valley fills under CWA Section 402, and of state water quality certifications under CWA Section 401, by taking appropriate steps to assist the States to strengthen state regulation, enforcement, and permitting of surface mining operations under these programs.
- The Corps and EPA, in coordination with FWS and consistent with the agencies' regulations governing compensatory mitigation, will jointly issue guidance clarifying how impacts to streams should be evaluated and how to evaluate proposed mitigation projects to improve the ecological performance of such mitigation implemented to compensate for losses of waters of the United States authorized by Section 404 permits.
- EPA, in coordination with the Corps, will clarify the applicability of the CWA waste treatment exemption for treatment facilities constructed in waters of the United States in order to minimize the temporary impacts of mining operations on streams.

Before the end of 2009, DOI will take the following steps:

- If the 2008 Stream Buffer Zone Rule is vacated by the U.S. District Court for the District of Columbia in Coal River Mountain Watch et al v. Kempthorne, 1:08-cv-02212-HHK C, as requested by the Secretary of the Interior on April 27, 2009, the Office of Surface Mining Reclamation and Enforcement (OSM) will issue guidance clarifying the application of the 1983 stream buffer zone provisions to further reduce adverse stream impacts.
- OSM will reevaluate and determine how it will more effectively conduct oversight of State permitting, State enforcement, and regulatory activities under SMCRA.
- OSM will remove impediments to its ability to require correction of permit defects in SMCRA primacy states.

III. DEVELOPMENT OF LONGER TERM REGULATORY ACTIONS TO BETTER MANAGE APPALACHIAN SURFACE COAL MINING

A. OBJECTIVES

The signatory agencies will review their existing regulatory authorities and procedures to determine whether regulatory modifications should be proposed to better protect the environment and public health from the impacts of Appalachian surface coal mining. At a minimum, the agencies will consider:

- Revisions to key provisions of current SMCRA regulations, including the Stream Buffer Zone Rule and Approximate Original Contour (AOC) requirements;
- Eliminating use of Nationwide Permit 21 in connection with surface coal mining in the Appalachian region when the Nationwide Permit Program is reauthorized in 2012; and
- Revisions to how surface coal mining activities are evaluated, authorized, and regulated under the CWA.

B. PROCESS

The signatory agencies will create an interagency working group to coordinate the development of short-term actions, longer term regulatory actions, and coordination procedures for Appalachian surface coal mining. The group will ensure robust public involvement in the development of any proposed actions or regulatory reforms.

For any proposed regulatory revision or other action under this MOU that is a major federal action significantly affecting the quality of the human environment (and is an action subject to NEPA), an Environmental Impact Statement (EIS) will be prepared to inform the decision-making process. At an early stage in the interagency coordination process, the working group will determine whether coordinating these NEPA processes programmatically would more effectively guide regulatory development and decision-making. The interagency group will coordinate with CEQ regarding the implementation of the National Environmental Policy Act (NEPA) in the development of regulatory reforms.

IV. INTERIM INTERAGENCY COORDINATION PROCEDURES

A. Clean Water Act

EPA and the Corps will begin immediately to implement enhanced coordination procedures applicable to the Clean Water Act review of Section 404 permit applications for Appalachian surface coal mining activities that have been submitted prior to execution of this MOU. The goal of these procedures is to ensure more timely, consistent, transparent, and environmentally effective review of permit applications under existing law and regulations. The agencies are issuing these

enhanced joint procedures concurrently with this MOU. Also concurrently, EPA is clarifying the factual considerations it is using to evaluate pending CWA permit applications under the 404(b)(1) Guidelines.

Pending Clean Water Act Section 404 permit applications for Appalachian surface coal mining activities will continue to be evaluated by the Corps and EPA on a case-by-case basis. The agencies will focus their reviews of Appalachian surface coal mining permit applications based on likely environmental impacts with the goal of avoiding, minimizing, and mitigating such impacts to the extent practicable under the CWA Section 404(b)(1) Guidelines and consistent with NEPA. This approach will enable the continued permitting of environmentally responsible projects.

B. Surface Mining Control and Reclamation Act

During 2009, OSM will issue guidance concerning appropriate application of the Stream Buffer Zone rule and other related rules and will ensure that states are implementing their counterpart provisions and SMCRA regulatory programs consistent with the guidance.

V. PUBLIC INVOLVEMENT

This IAP will be accompanied by robust public comment on its short- and longer term actions. The agencies will hold public meetings in Appalachia during 2009 to gather on-the-ground input and encourage ongoing local engagement in the environmental assessment and decision-making process. Additional public participation will occur as agency actions move forward.

VI. GENERAL

A. The policy and procedures contained within this MOU are intended solely as guidance and do not create any rights, substantive or procedural, enforceable by any party. This MOU does not constitute final agency action on any issue, and any actions contemplated by this MOU will be carried out in an appropriate administrative process by the action agency in accordance with all applicable laws and regulations.

B. This document does not, and is not intended to, impose any legally binding requirements on Federal agencies, States, or the regulated public, and does not restrict the authority of the employees of the signatory agencies to exercise their discretion in each case to make regulatory decisions based on their judgment about the specific facts and application of relevant statutes and regulations.

C. Nothing in this MOU is intended to diminish, modify, or otherwise affect statutory or regulatory authorities of any of the signatory agencies. All formal guidance interpreting this

MOU and background materials upon which this MOU is based will be issued jointly by the appropriate agencies.

D. Nothing in this MOU will be construed as indicating a financial commitment by DOI, the Corps, EPA, or any cooperating State agency for the expenditure of funds except as authorized in specific appropriations.

E. This MOU will take effect on the date shown above and will continue in effect until permanent procedures are established, or unless earlier modified or revoked by agreement of all signatory agencies. Modifications to this MOU may be made by mutual agreement of all the signatory agencies. Modifications to the MOU must be made in writing.

Signed,

Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency

Ken Salazar
Secretary
U.S. Department of the Interior

Terrence "Rock" Salt
Acting Assistant Secretary
of the Army (Civil Works)
U.S. Department of the Army

Christopher Hunter/DC/USEPA/US
11/02/2010 01:54 PM

To Tanya Code
cc
bcc
Subject Fw: Draft letter to OEJ on SPruce

Hi Tanya,
we had asked Denise to send a note to OEJ to review the proposed EJ section, but I don't think it went out. Can you check to confirm if it did or didn't, and if it didn't, ask Denise to send it out with a revised response date of Nov 12?

Thanks

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----- Forwarded by Christopher Hunter/DC/USEPA/US on 11/02/2010 01:53 PM -----

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Cc: Brian Frazer/DC/USEPA/US@EPA, David Evans/DC/USEPA/US@EPA
Date: 10/07/2010 01:03 PM
Subject: Draft letter to OEJ on SPruce

Thanks Denise, please send to Charles Lee, and cc Cliff Rader and Suzi Ruhl.

(b) (5) [redacted]

[redacted]

Thank you

Yazoo EJ.pdf Spruce RD 092410.doc

Recommended Determination of the U.S. Environmental Protection Agency Region III Pursuant to Section 404(c) of the Clean Water Act Concerning the Spruce No. 1 Mine, Logan County, West Virginia

U.S. Environmental Protection Agency
Region III

September 24, 2010

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I. Executive Summary

The Spruce No. 1 Mine as currently authorized Department of the Army (DA) Permit No. 199800436-3 (Section 10: Coal River), is one of the largest mountaintop mining projects ever authorized in West Virginia. If it is fully constructed, it will disturb approximately 2,278 acres and bury approximately 7.48 miles of streams.

As the phrase suggests, "mountaintop mining" involves removing the top of a mountain in order to recover coal seams contained within the mountain. Explosives are used to break apart the mountain's bedrock, and earth-moving equipment is used to remove the excess rock, soil, and debris (called "spoil") that formerly had composed the portions of the mountain above and immediately below the coal seams. The fractured material is larger in volume than when it was intact, fused bedrock within the mountain. The amount of spoil that may be placed on the mined area is also limited due to stability concerns. Hence mountaintop mining generates large quantities of "excess spoil" (i.e., volumes of rock, soil, and debris that cannot be placed back in the mined area) that are deposited in valleys, thereby burying streams that flow through those valleys. In this case, if the Spruce No. 1 Mine is constructed as currently authorized, it will bury headwater stream ecosystems under 110 million cubic yards of excess spoil.

The Spruce No. 1 Mine has a lengthy and complex history. The DA Permit No. 199800436-3 (Section 10: Coal River) (DA Permit) was issued by the US Army Corps of Engineers, Huntington District (Corps) in January 2007 authorizing the Mingo Logan Coal Company to construct six valley fills, associated sedimentation structures, and other discharges of fill material to the Right Fork of Seng Camp Creek, Pigeonroost Branch, Oldhouse Branch, and their tributaries. Due to litigation and an agreement with environmental groups, operations have been limited to the Seng Camp Creek watershed and as part of that agreement one valley fill is partially constructed.

Throughout review of the project, the U.S. Environmental Protection Agency has raised concerns regarding adverse impacts to the environment. Additionally, data and information have become available since permit issuance, which have confirmed EPA's earlier concerns regarding the potential for adverse water quality impacts, the potential for cumulative impacts, the availability of further avoidance and minimization measures and problems with the proposed mitigation measures.

On April 2, 2010, the U.S. Environmental Protection Agency Region III (EPA Region III or Region III) published in the Federal Register a Proposed Determination to prohibit, restrict or deny the specification or the use for specification (including withdrawal of specification) of certain waters at the project site as disposal sites for the discharge of dredged and/or fill material for the construction of the Spruce No. 1 Mine. Region III took this step because it believed, despite the regulatory review intended to protect the environment, that discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) could destroy wildlife habitat and cause significant degradation of downstream aquatic ecosystems and therefore could have unacceptable adverse effects on wildlife.

A public hearing was conducted on May 18, 2010. Region III received over 100 oral comments and over 50,000 written comments both supporting and opposing its Proposed Determination. Region III has carefully considered the comments received and conducted additional analysis, which will be described herein, before rendering this Recommended Determination.

Based on the foregoing analysis and upon consideration of the public comments received in response to Region III's proposed determination, Region III believes that discharges of dredged and/or fill material to Pigeonroost Branch and Oldhouse Branch for the purpose of constructing the Spruce No. 1 Surface Mine as currently authorized by DA Permit would likely have unacceptable adverse effects on wildlife. For this reason, it is the recommendation of the Regional Administrator that the specification embodied in DA Permit No. 199800436-3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material for construction of the Spruce No. 1 Surface Mine be withdrawn.

The goal of protecting water quality, plant and animal habitat, navigable waters, and other downstream resources requires as its first step the protection of headwater streams. Headwater streams perform services similar to those performed by capillaries in the human circulatory system. They are the largest network of waterbodies within our ecosystem and provide the most basic and fundamental building blocks to the remainder of the aquatic and human environment. As set forth herein, Pigeonroost Branch and Oldhouse Branch represent some of the very few remaining streams within the Spruce Fork sub-watershed and the Coal River sub-basin that represent “least degraded” conditions. They support diverse and healthy biological communities. As such, they are valuable in and of themselves and within the context of the Spruce Fork sub-watershed and Coal River sub-basin.

As currently authorized by DA Permit discharges of excess spoil to Pigeonroost Branch and Oldhouse Branch would bury those streams and their tributaries and the wildlife that live within them. Other wildlife would lose important headwater stream habitat on which they depend for all or part of their lifecycles.

In addition, the construction of valley fills, sedimentation ponds and other discharges into Pigeonroost Branch and Oldhouse Branch authorized by the DA Permit would likely have adverse impacts on downstream waters and wildlife living outside the footprint of the fill. These adverse impacts would be caused by the removal of functions performed by the buried resources and by transformation of the buried areas into sources that contribute contaminants to downstream waters. In addition, discharges to Pigeonroost Branch and Oldhouse Branch as currently authorized would likely contribute to conditions that would support blooms of golden algae that release toxins that kill fish and other aquatic life.

Based on these impacts, Region III has determined that discharges to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal

River) would likely have unacceptable adverse effects on wildlife. Particularly in light of the high quality of the impacted resources, it is unlikely that the compensatory mitigation plan (CMP) for the project would offset these impacts. The proposed on-site created streams would be unlikely to replace the physical, chemical, and especially biological functions of Pigeonroost Branch and Oldhouse Branch.

There are other impacts that, while not forming the basis of the Recommended Determination, are of concern to the Region. To the extent that discharge of excess spoil outside jurisdictional waters, deforestation, and other activities associated with the project depend upon specification of Pigeonroost Branch and Oldhouse Branch as disposal sites, there are likely to be other adverse impacts from those dependent activities. In addition, impacts from the project will contribute to cumulative impacts from multiple surface mining activities in the Coal River sub-basin. There are also concerns regarding environmental justice.

II. Introduction

This document explains the basis for the EPA Region III recommendation to withdraw the specification of Pigeonroost Branch, Oldhouse Branch and their tributaries (all of which are waters of the United States) within Logan County, West Virginia as a disposal site for dredged or fill material in connection with construction of the Spruce No. 1 Surface Mine (Spruce No. 1 Mine or the project) as currently authorized by DA Permit No. 199800436-3 (Section 10: Coal River)(DA Permit or permit) (See Figure 3). While the DA Permit also authorizes construction of valley fills and other discharges to the Right Fork of Seng Camp Creek and its tributaries, Region III is not recommending withdrawal of specification of those waters in part because some of those discharges have already occurred.

EPA Region III is recommending that action be taken under section 404(c) of the Clean Water Act (CWA) because the Region believes that the discharges to Pigeonroost Branch and Oldhouse Branch and their tributaries for the purpose of constructing Spruce No. 1 Mine as currently authorized by the DA Permit would likely have unacceptable adverse effects on wildlife. Pigeonroost Branch and Oldhouse Branch and their tributaries are some of the last remaining streams within the Spruce Fork sub-watershed and the larger Coal River sub-basin that represent "least degraded" conditions. As such, they perform important hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role within the context of the overall Spruce Fork sub-watershed and Coal River sub-basin. The Spruce No. 1 Mine as currently authorized would bury virtually all of Oldhouse Branch and its tributaries and much of Pigeonroost Branch and its tributaries under excess spoil generated by mountaintop removal surface coal mining operations. Region III does not believe that the anticipated effects of the burial of all of Oldhouse Branch and much of Pigeonroost Branch will be offset by the proposed mitigation because it will not replace the chemical, physical and biological functions of the lost aquatic resources.

In addition, this recommendation considers the adverse impacts from mining-related activities, such as deforestation, that are associated with the discharge of excess spoil to areas outside the jurisdictional waters to the extent that these activities necessarily depend upon specification of Pigeonroost Branch and Oldhouse Branch for the construction of valley fills and sedimentation ponds. Moreover, the discharges associated with the Spruce No. 1 Mine will contribute to a cumulative adverse impact to the Spruce Fork sub-watershed, the Little Coal River watershed and the Coal River sub-basin. Finally, the Region continues to be concerned that potential issues related to disproportionate and high impact on the local population from construction of the Spruce No. 1 Mine have not been fully considered.

The next Section provides an overview of the Section 404(c) procedures, describes the Spruce No. 1 Mine as authorized, and summarizes the history of the project. Section IV describes the environmental characteristics of the project area, specifically Pigeonroost Branch and Oldhouse Branch, and the overall Coal River sub-basin. Section V examines the anticipated impacts from the Spruce No. 1 Mine as currently authorized. Consistent with Section 404(c), this discussion will focus on impacts to wildlife. Section VI will discuss other considerations, including impacts from activities associated with the Spruce No. 1 Mine that do not include direct discharges of dredged and/or fill material to jurisdictional waters but which may depend upon authorization of such discharges, and that are likely to cause direct and cumulative impacts to the environment and to local communities. Section VII describes EPA Region III's conclusions and recommendations.

III. Background

A. Section 404(c) Procedures

The CWA, 33 U.S.C. §§ 1251 et seq., prohibits the discharge of pollutants, including dredged or fill material, into waters of the United States (including wetlands) except in compliance with, among other provisions, Section 404 of the CWA, 33 U.S.C. § 1344. Section 404 authorizes the Secretary of the Army (Secretary), acting through the Chief of Engineers, to authorize the discharge of dredged or fill material at specified disposal sites. This authorization is conducted, in part, through the application of environmental guidelines developed by EPA, in conjunction with the Secretary, under section 404(b) of the CWA, 33 U.S.C. § 1344(b) (Section 404(b)(1) Guidelines). Section 404(c) of the CWA, 33 U.S.C. § 1344(c), authorizes the EPA to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site. EPA is authorized to restrict or deny the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever it determines, after notice and opportunity for public hearing, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas.

The procedures for implementation of Section 404(c) are set forth in 40 CFR Part 231. Under those procedures, if the Regional Administrator has reason to believe that use of a site for the discharge of dredged or fill material may have an unacceptable adverse effect

on one or more of the aforementioned resources, he may initiate the section 404(c) process by notifying the U.S. Army Corps of Engineers (Corps) and the applicant (and/or project proponent) that he intends to issue a Proposed Determination. Each of those parties then has fifteen days to demonstrate to the satisfaction of the Regional Administrator that no unacceptable adverse effects will occur, or that corrective action to prevent an unacceptable adverse effect will be taken. If no such information is provided to the Regional Administrator, or if the Regional Administrator is not satisfied that no unacceptable adverse effect will occur, the Regional Administrator will publish a notice in the Federal Register of his Proposed Determination, soliciting public comment and offering an opportunity for a public hearing.

Following the public hearing and the close of the comment period, the Regional Administrator will decide whether to withdraw the Proposed Determination or prepare a Recommended Determination. A decision to withdraw may be reviewed at the discretion of the Assistant Administrator for Water at EPA Headquarters. If the Regional Administrator prepares a Recommended Determination, he then forwards it and the administrative record compiled in the Regional Office to the Assistant Administrator for Water at EPA Headquarters. The Assistant Administrator makes the Final Determination affirming, modifying, or rescinding the Recommended Determination.

This document represents the third step in the process and explains the basis for EPA Region III's Recommended Determination.

B. Project Description

The Spruce No. 1 Mine as currently authorized by DA Permit No. 199800436-3 (Section 10: Coal River), is one of the largest mountaintop mining projects ever authorized in West Virginia. As currently authorized, it will disturb approximately 2,278 acres (about 3.5 square miles) and bury approximately 7.48 miles of streams. By way of comparison, the project area would take up a sizeable portion of the downtown area of Pittsburgh, PA (Figure 1).

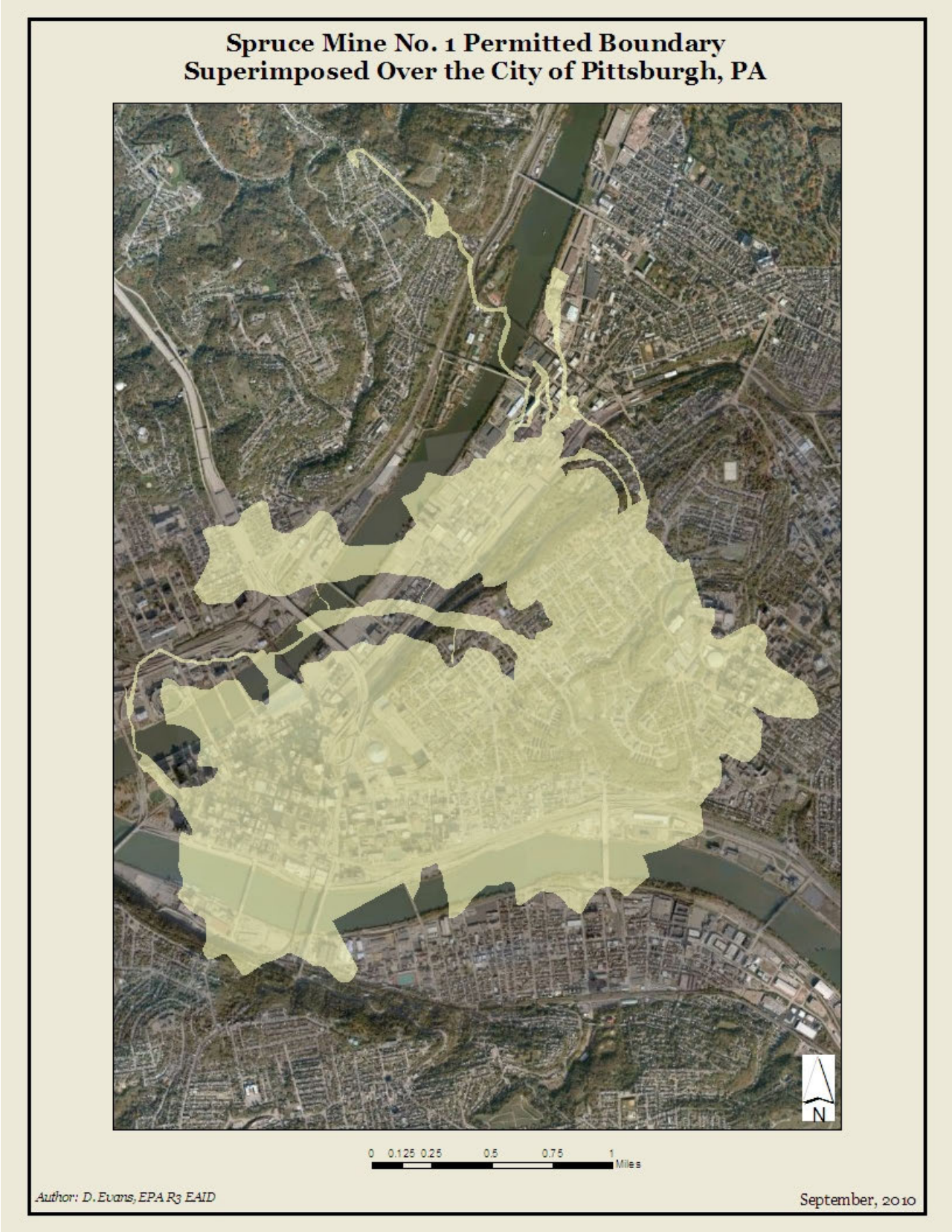

Figure 1 Spruce No. 1 Mine compared to downtown Pittsburgh, PA.

The project as authorized is located in the East District of Logan County, West Virginia at Latitude 38°52'39" and Longitude 81°47'52" depicted on the United States Geological Survey 7.5-minute Clothier and Amherstdale Quadrangles (Figure 2). The mine site is located approximately two miles northeast of Blair, in Logan County, West Virginia in the Central Appalachian ecoregion (Bryce, S.A., J.M. Omernik, and D.P. Larsen. 1999). http://www.epa.gov/wed/pages/ecoregions.htm

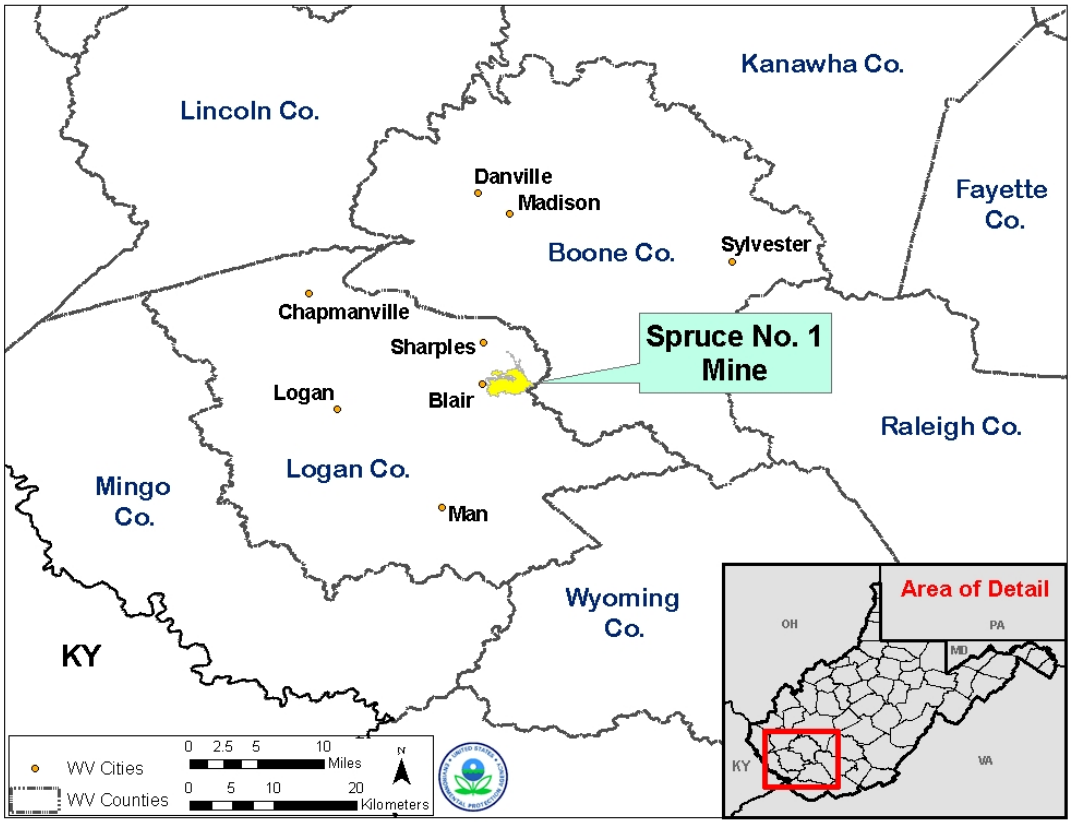

Figure 2: Spruce No. 1 mine location

According to the Environmental Impact Statement (EIS) prepared by the Corps in 2006 (Spruce No. 1 EIS) for the project, the Spruce No. 1 project is a mountaintop mining project targeting bituminous coal seams overlying and including the Middle Coalburg coal seam in the western portion of the project area. In the eastern portion of the project area, mountaintop mining would be limited to those seams including and overlying the Upper Stockton seam, with contour mining in conjunction with auger and/or highwall/thin-seam mining utilized to recover the Middle Coalburg seam.

As the phrase suggests, "mountaintop mining" involves removing the top of a mountain to recover coal seams contained within the mountain. Explosives are used to break apart the mountain's bedrock and earth-moving equipment is used to remove the excess rock, soil and debris (called “spoil”) that formerly had composed the portions of the mountain above and immediately below the coal seam. The fractured material is larger in volume

than when it was intact, fused bedrock within the mountain. The amount of spoil that may be placed back on the mined area is also limited due to stability concerns. Hence mountaintop mining generates large quantities of "excess spoil" that cannot be placed back in the mined area. The “spoil” is then deposited in valleys, thereby burying streams that flow through those valleys.

The Spruce No. 1 EIS describes the project impacts as a disturbance of a total of 2,278 acres to recover seventy-five percent (75%) of the coal reserve targeted for extraction within the project area during fifteen (15) phases. The mining process would remove 400 to 450 vertical feet from the height of the mountain, about 501 million cubic yards of overburden material. Nearly 391 million cubic yards of spoil would be placed within the mined area (i.e., back on the mountain) and the remaining 110 million cubic yards of excess spoil would be placed in six valley fills, burying all or portions of the Right Fork of Seng Camp Creek, Pigeonroost Branch, and Oldhouse Branch and their tributaries (hereafter, references to Seng Camp Creek, Pigeonroost Branch, and Oldhouse Branch also include all tributaries to those waters that would be impacted by the project as authorized). Specifically, the DA Permit authorizes construction of Valley Fills 1A and 1B in Seng Camp Creek; Valley Fills 2A, 2B, and 3 in Pigeonroost Branch; and Valley Fill 4 in Oldhouse Branch, and numerous sedimentation ponds, mined-through areas and other fills in waters of the U.S (Figure 3). A detailed discussion of Spruce No. 1 project can be found in the Spruce No. 1 EIS on pages 2-35 through 2-61.

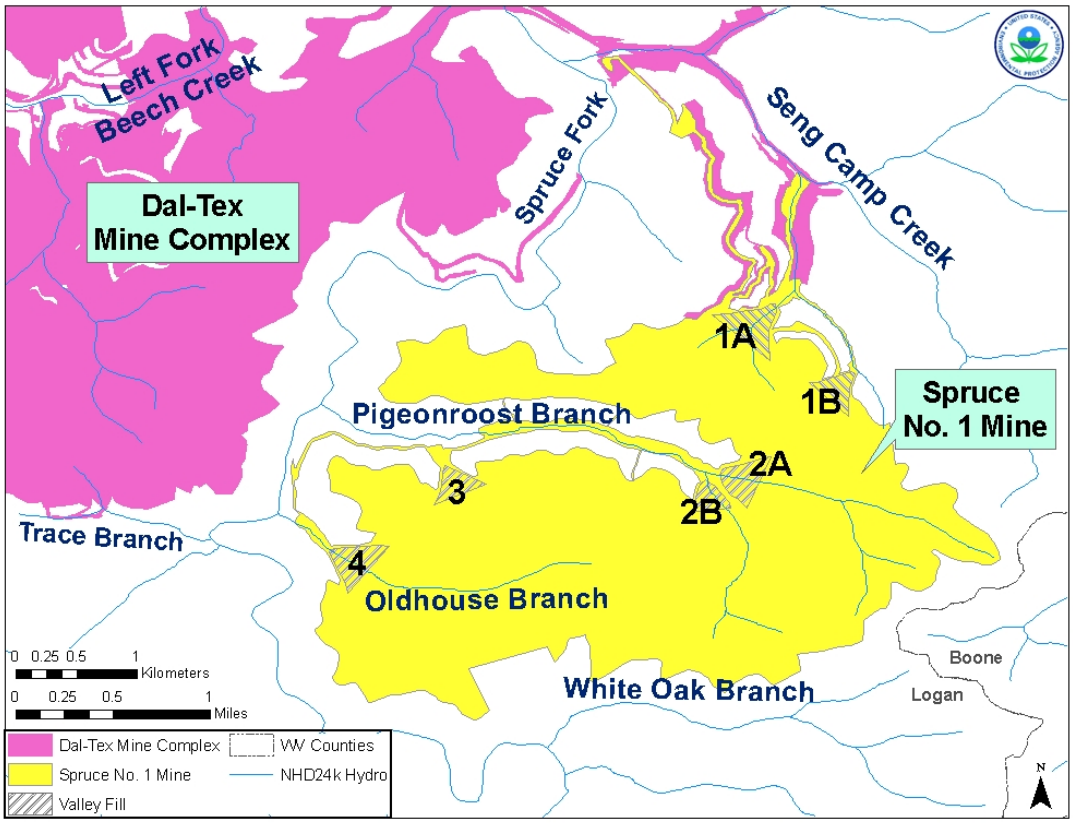

Figure 3. Spruce No. 1 Mine and associated valleyfills.

The Spruce No.1 Mine Surface Mining Control and Reclamation Act (SMCRA) Permit S-5013-97, Incidental Boundary Revision (IBR4, Modification 11) describes impacts from the project as including placement of dredged and fill material into approximately:

- 0.12 acre of emergent wetlands
- 10,630 linear feet (1.83 acres) of ephemeral stream channels (all permanent),
- 28,698 linear feet (6.12 acres) of intermittent stream channels
    - (26,184 linear feet [5.77 acres] permanent
    - 2,514 linear feet [0.35 acre] temporary)
- 165 linear feet (0.034 acre) of perennial stream channel (all temporary),

While Region III is providing the foregoing summary from the SMCRA Permit S-5013-97 IBR for descriptive purposes, as set forth in more detail in Section V.C.2. below, Region III believes that the description provided in the Spruce No. 1 SMCRA Permit and in the Spruce No. 1 EIS incorrectly characterizes stream resources that will be impacted, as described further below.

The project as authorized also includes compensatory mitigation to offset adverse project impacts. EPA's concerns with the November 2006 compensatory mitigation plan (CMP) submitted by the permittee will be described in Section V.C.

C. Project History

This project has a lengthy and complex regulatory history. The Spruce No. 1 Mine was originally advertised as operated by Hobet Mining Inc., a subsidiary of Arch Coal, Inc.[1] The project as originally proposed in 1998, was larger than the currently authorized project and would have directly impacted a total footprint area of 3,113 acres and 57,755 linear feet (more than ten miles) of stream (not including indirect impacts to remaining downstream waters). At that time, the Corps tendered and ultimately withdrew a nationwide permit for the project, and the permittee, Mingo Logan, advised the Corps it would submit an individual permit application. An Environmental Impact Statement was prepared for the Spruce No. 1 project by the Army Corps of Engineers Huntington District pursuant to the National Environmental Policy Act, 42 U.S.C. 4332(C). The original project application also launched events that led to the Interagency Mountaintop Mining/Valley Fills in Appalachia Programmatic Environmental Impact Statement which was finalized in October 2005 (PEIS). The PEIS is available at www.epa.gov/Region3/mtntop/eis2005.htm.

An initial 2002 Spruce No. 1 Draft Environmental Impact Statement (EIS) considered a proposed project that was similar in scope and size to the original project described above. Region III's review of the 2002 Draft Environmental Impact Statement found gaps in the analyses of the mine and related adverse environmental impacts. Region III was particularly concerned by the lack of information regarding the nature and extent of impacts to the high quality streams that would be buried under valley fills, and recommended additional evaluation to support the analysis of less environmentally damaging alternatives. EPA Region III, in a letter dated August 12, 2002, indicated the EIS contained inadequate information for public review and for decision-makers.

In 2006, a revised Spruce No. 1 Draft EIS was prepared. At that time, the project was reconfigured to reduce impacts. The Mingo Logan, revised the mine plan to eliminate construction of a valley fill in White Oak Branch, a high quality stream (see Section IV.A. below) and the project area was reduced from 3,113 to 2,278 acres with direct stream impacts reduced to 7.48 miles.

In our June 16, 2006, comment letter on the 2006 Draft EIS, EPA Region III recognized that impacts from the mine had been reduced and the quality of EIS information had improved. However, the letter also noted that EPA had remaining environmental concerns associated with the Spruce No. 1 Mine, including potential adverse impacts to water quality (specifically, the potential to discharge selenium and the known correlation between similar mining operations and degradation of downstream aquatic communities), uncertainties regarding the proposed mitigation, need for additional analysis of potential environmental justice issues, and lack of study related to the cumulative impact of multiple mining operations within the Little Coal River watershed. EPA continued to

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[1] Effective December 31, 2005, Arch Coal, Inc. transferred Spruce No. 1 Mine holdings and responsibilities to its Mingo Logan Coal Company (Mingo Logan) subsidiary.

stress its belief that corrective measures should be required to reduce environmental impacts and that other identified information, data, and analyses should be included in the final EIS.

Concerns regarding the Spruce No. 1 project were also raised by the U.S. Fish and Wildlife Service (USFWS), Ecological Services West Virginia Field Office in a letter dated May 30, 2006 from the Department of Interior, Philadelphia to the Huntington District Army Corps of Engineers. In that letter, the USFWS expressed concerns over the permittee's compensatory mitigation plan. The USFWS stated there was inadequate compensatory mitigation for the project because the assessment methodology used by the permittee to evaluate stream impacts considered only the physical characteristics of the impacted streams, without considering the equally important biological or chemical characteristics. The USFWS expressed concern the project would impact healthy, biologically functional streams and the mitigation included erosion control structures designed to convey water that would not replace the streams' lost ecological services.

The Corps issued the Spruce No. 1 Final EIS on September 22, 2006. On October 23, 2006, EPA commented on the Final EIS, noting that many of EPA's comments had not been adequately addressed. In a letter dated November 30, 2006, EPA offered its assistance to the Corps in developing a stream functional assessment protocol and willingness to work with Mingo Logan through EPA's Conflict Prevention and Resolution Center to develop a cumulative impact assessment and watershed restoration plan for the Little Coal River watershed.

Despite EPA and USFWS concerns on January 22, 2007, the Corps issued a Clean Water Act § 404 Permit (DA Permit No. 199800436-3 (Section 10: Coal River)) to Mingo Logan for the Spruce No. 1 Mine. That permit specified the Right Fork of Seng Camp Creek, Pigeonroost Branch and its tributaries, and Oldhouse Branch and its tributaries as disposal sites for the discharge of dredged and/or fill material from the Spruce No. 1 Mine.

On January 30, 2007, a number of environmental groups filed a complaint against the Corps in federal district court challenging its decision to issue the permit. That litigation was stayed for a period of time pending the U.S. Court of Appeals for the Fourth Circuit's decision in *Ohio Valley Environmental Coalition v. Aracoma Coal Co.,* 556 F. 3d 177 (4th Cir. 2009). Following that decision, the litigation related to the Spruce No. 1 permit was reactivated. The litigation was then stayed again until October 22, 2010 following Region III's publication of its Proposed Determination on April 2, 2010.

In early 2007, Mingo Logan commenced limited operations at Spruce No. 1 pursuant to their DA Permit No. 199800436-3 (Section 10: Coal River) subject to an agreement with the environmental groups who are plaintiffs in the litigation. Pursuant to that agreement, Mingo Logan has been operating in a portion of the project in the Seng Camp Creek drainage area, including construction of one valley fill (valley fill 1A). Under the agreement, Mingo Logan must give plaintiffs 20 days notice before expanding operations

beyond the area subject to the agreement, and has done so once without objection from the plaintiffs. Mingo Logan's operations in the Seng Camp Creek watershed have generated data related to impacts from the project as constructed, including discharge monitoring reports submitted to the West Virginia Department of Environmental Protection (WVDEP). These data have been reviewed by Region III.

While the litigation was pending, the scientific literature beagn to reflect a growing scientific consensus of the importance of headwater streams, a growing concern about the adverse effects of mountaintop removal mining, and concern that impacted streams cannot easily be replaced. Many of these studies are cited in this Recommended Determination. On June 11, 2009, EPA , the Department of the Army, and the Department of the Interior entered into a *Memorandum of Understanding Implementing the Interagency Action Plan on Appalachian Surface Coal Mining,* in which the agencies agreed to take steps to reduce the harmful environmental consequences of Appalachian surface coal mining. On April 1, 2010, the U.S. Environmental Protection Agency's Office of Research and Development made available for public comment two reports titled: *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields* and *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams.* On the same day, EPA also published interim guidance titled: *Guidance on Improving EPA Review of Appalachian Surface Coal Mining Operations under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order.*[2]

On September 3, 2009, Region III requested the Corps suspend, modify or revoke DA Permit No. 199800436-3 (Section 10: Coal River) for discharges associated with the Spruce No. 1 Mine. On September 30, 2009, the Corps of Engineers stated that it would not reconsider the permit authorization. As a result, Region III initiated the Clean Water Act Section 404(c) process on October 16, 2009. Region III communicated with representatives of Mingo Logan and the Corps both in person and by telephone and electronic mail on several occasions to determine whether corrective action would be taken to address Region III's concerns. On April 2, 2010, Region III published in the Federal Register a Proposed Determination to withdraw specification of Pigeonroost Branch and Oldhouse Branch pursuant to CWA section 404(c). Region III solicited public comments on the Proposed Determination and held a public hearing in Charleston, West Virginia on May 18, 2010. Region III received over 50,000 comments on the Proposed Determination. Of these approximately 70% of comment letters submitted to the docket generally supported EPA's Proposed Determination while 65% of public hearing participants generally opposed EPA's Proposed Determination.

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[2] Issuance of this guidance document is mentioned here solely for purposes of describing recent events related to EPA's understanding of impacts from Appalachian surface coal mine activities. The guidance provides a framework for EPA review of certain proposed surface coal mining applications. This Recommended Determination is based upon Region III's review of scientific and other information regarding the likely effects from the discharges to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River). Region III did not rely upon the April 1 Guidance in making its Recommended Determination.

In addition to its DA Permit No. 199800436-3 (Section 10: Coal River), the project received authorizations from the WVDEP, including authorization pursuant to the State's surface mining program approved under the Surface Mining Control and Reclamation Act of 1977 (SMCRA), 30 U.S.C. 1201-1328 (SMCRA permit), and a National Pollutant Discharge Elimination System (NPDES) permit for discharges of pollutants pursuant to Section 402 of the Clean Water Act, 33 U.S.C. 1342. WVDEP also issued a Clean Water Act Section 401 water quality certification.

IV. Characteristics and Functions of the Impacted Resources[3]

The resources that will be impacted by the Spruce No. 1 Mine include Central Appalachian headwater stream ecosystems in Pigeonroost Branch and Oldhouse Branch. Those waters have surface connection and flow to Spruce Fork, which in turn flows to the Little Coal River, and the Coal River. Because of the connectivity between headwater systems and downstream waters, Spruce Fork, the Little Coal River and the Coal River also would be likely to be impacted by discharges to Pigeonroost Branch and Oldhouse Branch. Accordingly, the characteristics and functions of the resources that will be impacted by discharges of fill material associated with the Spruce No. 1 Mine are best viewed from the perspective of the ecologic functions performed by Appalachian headwater stream ecosystems and within the context of the larger Spruce Fork sub-watershed and Coal River sub-basin.

Headwater streams play an important role in the ecosystem far beyond the mere transport of water from one point to another. In many ways, headwater streams are like the capillaries within the human circulatory system. Headwater streams form the largest network of waterbodies within the ecosystem and, as the early stages of the river continuum, provide the most basic and fundamental building blocks to the remainder of the aquatic and human environment. Appalachian headwaters provide habitat for wildlife. They also are a locus of significant interface between the river system and the terrestrial environment. Appalachian headwater streams and their wildlife inhabitants convert organic matter from the surrounding landscape (such as leaf litter) and transform it into nutrients and energy that can be transported and consumed by downstream

[3] Region III derives its understanding of the potentially impacted resources and the predicted impacts of the project from several sources. The Draft (June 2003) and Final (October 2005) Interagency Mountaintop Mining/Valley Fills in Appalachia Programmatic EIS (PEIS) represent an important inter-agency effort designed to inform more environmentally sound decision-making for future permitting of mountaintop mining/valley fills. It had a geographic focus of 12 million acres encompassing most of eastern Kentucky, southern West Virginia, western Virginia, and scattered areas of eastern Tennessee, and included the Spruce No. 1 project area and the Coal River subbasin. EPA also consulted information gathered by the WVDEP, including an assessment of the Coal River sub-basin conducted in 1997, data collected to support the 2006 Coal River sub-basin total maximum daily load (TMDL), and WVDEP and nationally available GIS data. EPA also reviewed the 2006 Spruce No.1 EIS, and other sources of data including studies conducted by EPA scientists and discharge monitoring reports generated by Mingo Logan. In addition, EPA consulted a wide range of peer reviewed studies and literature. EPA Region III also communicated with the US Fish and Wildlife Service Elkins Field Office on impacts to fish and wildlife resources in the project area. Appendices to this Recommended Determination (RD) contain more detailed specific data, analysis and an index of references.

ecosystems. They also play an important role in storing, retaining and transporting nutrients, organic matter, and sediment. In addition they perform hydrologic functions related to downstream flow regimes, moderating flow rate and temperature. "Value of Headwater Streams: Results of a Workshop" from PEIS on MTM/VF (EPA 2003; http://www.epa.gov/region03/mtntop/pdf/appendices/d/value-of-headwater-streams/headwater.pdf); Fischenich, J.C. (2006), *Functional objectives for stream restoration.* EMRRP Technical Notes Collection (ERDC TN-eMRRP-SR-52 Vicksburg).

As authorized, the Spruce No. 1 Mine would bury under valley fills or impact through construction of sedimentation ponds substantially all of Oldhouse Branch and its tributaries and a substantial portion of Pigeonroost Branch and its tributaries. Oldhouse Branch and Pigeonroost Branch support ecosystems and conditions consistent with "least degraded" conditions in the Coal River sub-basin. As such, they are valuable in and of themselves and for the functions they perform within the context of the Spruce Fork sub-watershed and the Coal River sub-basin.

A. Watershed and Stream Conditions

1. Pigeonroost Branch and Oldhouse Branch

The stream systems that are the subject of this Recommended Determination, Pigeonroost Branch and Oldhouse Branch, are healthy stream systems supporting diverse aquatic communities as measured by their benthic macroinvertebrate populations.

In a body of water, benthic macroinvertebrates are the bottom-dwelling (benthic) organisms that are large enough to be seen without the aid of microscopes (macro) and do not have backbones (invertebrate). Freshwater macroinvertebrates, such as mayflies and stoneflies, serve as indicators of ecosystem health, and play a vital role in food webs and in the transfer of energy in river systems. These organisms convert plant material into fats and proteins, food sources critical for maintaining healthy fish and amphibian populations, as well as for foraging terrestrial vertebrates such as birds, bats, reptiles, and small mammals. In this ecological niche, macroinvertebrates deliver energy and nutrients along the stream continuum. They also clean excess living and nonliving organic material from freshwater systems, a service that contributes to the overall quality of the watershed. Because of these functions, macroinvertebrates are essential organisms within the food web, supporting the health of the entire aquatic ecosystem.

Macroinvertebrates are also good indicators of watershed health and are used by West Virginia and other states in the Mid-Atlantic region and across the U.S. to assess the quality of their waters. They are good indicators because they live in the water for all or most of their life cycle. Macroinvertebrates can be found in all streams, are relatively stationary and cannot escape pollution. They also differ in their tolerance to the amount and types of pollution. Macroinvertebrate communities integrate the effects of stressors over time and some taxa (i.e., taxonomic category or group such as phylum, class, family, genus, or species) are considered pollution-tolerant and will survive in degraded conditions. Other taxa are pollutant-intolerant and will die when exposed to certain levels

of pollution. Thus, the composition of tolerant and intolerant (i.e., sensitive) communities informs scientists about the quality of the water.

In a healthy stream, one would expect to find a high diversity of benthic macroinvertebrate taxa and a large number of different taxa including taxa that are more sensitive to stressors. Using the mayfly (Insecta: Ephemeroptera) as an example, some genera of mayfly are more sensitive than others. The presence of a large number of individuals from the more sensitive mayfly genera indicates good water quality conditions. Mayflies in particular have long been recognized as important indicators of stream ecosystem health. Mayflies are a very important part of the native organisms in Appalachian headwater streams and they routinely make up between 30%-50% of the insect assemblages in certain seasons. Numerous studies demonstrate that mayfly community structure reflects the chemical and physical environment of watercourses (e.g., Barber-James et al. 2008; Bauernfeind & Moog 2000). See Appendix 1 for more detail on macroinvertebrates as indicators of water quality.

According to Morse et al. (1997) , the Central Appalachian ecoregion has many endemic and rare species of benthic macroinvertebrates in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).[4] This diversity and unique assemblage has been attributed to the unique geological, climatic, and hydrological characteristics of this region. The Spruce No. 1 Mine project area has been found to be very rich in macroinvertebrates species. Data from the PEIS, the Spruce No. 1 EIS and from the WVDEP monitoring database indicate that high macroinvertebrate diversity exists in Pigeonroost Branch and Oldhouse Branch. Data from EPA, WVDEP, and the applicant's consultants (Sturm Env. Services, BMI, Inc.) reveal that collectively, Pigeonroost Branch, Seng Camp Creek, and Oldhouse Branch contain a high number of mayfly taxa and individuals. A total of 21 genera (Table 2) have been identified from these three headwater streams indicating these systems offer high water quality and optimal habitat.

Macroinvertebrate data collected in Oldhouse Branch indicates that the quality of the macroinvertebrate community in Oldhouse Branch is in the top 5% of all streams in the Central Appalachia ecoregion. In 1999-2000, EPA collected eighty-five (85) macroinvertebrate genera in riffle complexes[5] of Pigeonroost Branch and Oldhouse Branch.

With respect to mayfly taxa, as many as nine genera have been collected in Oldhouse Branch in any one season-specific sample, with an average of seven genera across multiple samples. This observation ranks in the 95th percentile of all samples taken in the Central Appalachian ecoregion (937 samples) by WVDEP. Out of more than 4000

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[4] The orders Ephemeroptera, Plecoptera and Trichoptera (EPT taxa) contain pollution sensitive groups and are used by natural resource agencies such as West Virginia Department of Environmental Protection to assess watershed health.

[5] Riffle and pool complexes are considered special aquatic sites under 40 CFR 230.1(d) and as such the degradation or destruction of these sites is considered to be among the most severe environmental impacts covered by the 404(b)(1) Guidelines.

samples collected statewide in West Virginia, Oldhouse Branch ranks in the 90th percentile. Pigeonroost Branch contained eight mayfly genera in a season-specific sample, ranking it among the 90th percentile in the Central Appalachians and 83rd percentile statewide from among more than 4000 single-sample observations.

The data are similar for stoneflies. Data compiled from EPA, WVDEP, and the applicant's consulting firms show that Oldhouse, Pigeonroost, and Seng Camp collectively yielded 16 genera of stoneflies (Table 3). Oldhouse and Pigeonroost both had 11 genera. A single collection in Oldhouse by EPA (Spring 2000) had 9 genera of stoneflies which ranks greater than the 98th percentile of all Central Appalachian streams sampled by WVDEP (937 samples). This means that only 2% of stream samples in this ecoregion had more stonefly taxa than Oldhouse within a single sampling event. Pigeonroost Branch had as many as six stonefly genera in any one season-specific sample, ranking it at the 83rd percentile among 937 Central Appalachian streams, and 72nd percentile statewide.

Water chemistry data for Pigeonroost Branch and Oldhouse Branch also reflect healthy streams with little human disturbance. Data from WVDEP indicate that average conductivity values for the unmined streams on the Spruce No. 1 project area are very low. Based on the WVDEP dataset (2002-2003), Oldhouse Branch had an average conductivity level of 90 µS/cm, which is below that of White Oak Branch, a nearby reference-quality stream, which had an average conductivity level of 118 µS/cm. Conductivity levels described above in Oldhouse Branch and White Oak Branch indicate excellent water quality, comparable to reference quality streams for this ecoregion. Sulfate concentrations in these streams are also low (28 mg/l in Oldhouse and 24 mg/l in White Oak Branch). Pigeonroost Branch had a conductivity level of 199 µS/cm and sulfate level of 99 mg/l. The slightly elevated average conductivity and sulfate values reflect the relatively small amount of historical mining landuse in the Pigeonroost watershed.

During the December 2008 to March 2010 time frame, discharge monitoring reports submitted by the permittee indicate 15 of the 16 selenium measurements at both Pigeonroost Branch and Oldhouse Branch were below the detection limit of 0.6 µg/L. The single detection of selenium on Oldhouse Branch was 0.9 µg/L during July 2009. The single detection of selenium on Pigeonroost Branch was 1.9 µg/L during August 2009. These readings are far below West Virginia's numeric chronic water quality criterion for selenium of 5 µg/L. These levels are also significantly lower than levels demonstrated immediately downstream of adjacent mining operations, as described below.

2. The Spruce Fork Sub-watershed and the Coal River Sub-basin

The Spruce No. 1 mine is located within the larger Spruce Fork sub-watershed (12-digit hydrologic unit code (HUC) and the Coal River sub-basin (8-digit HUC) (Figure 4). Pigeonroost Branch and Oldhouse Branch flow to Spruce Fork, which in turn flows into the Little Coal River and then into the Coal River. Oldhouse Branch and Pigeonroost

Branch are important within the context of the larger Coal River sub-basin and Spruce Fork sub-watershed because they represent some of the few stream systems supporting least-degraded conditions within those watersheds.

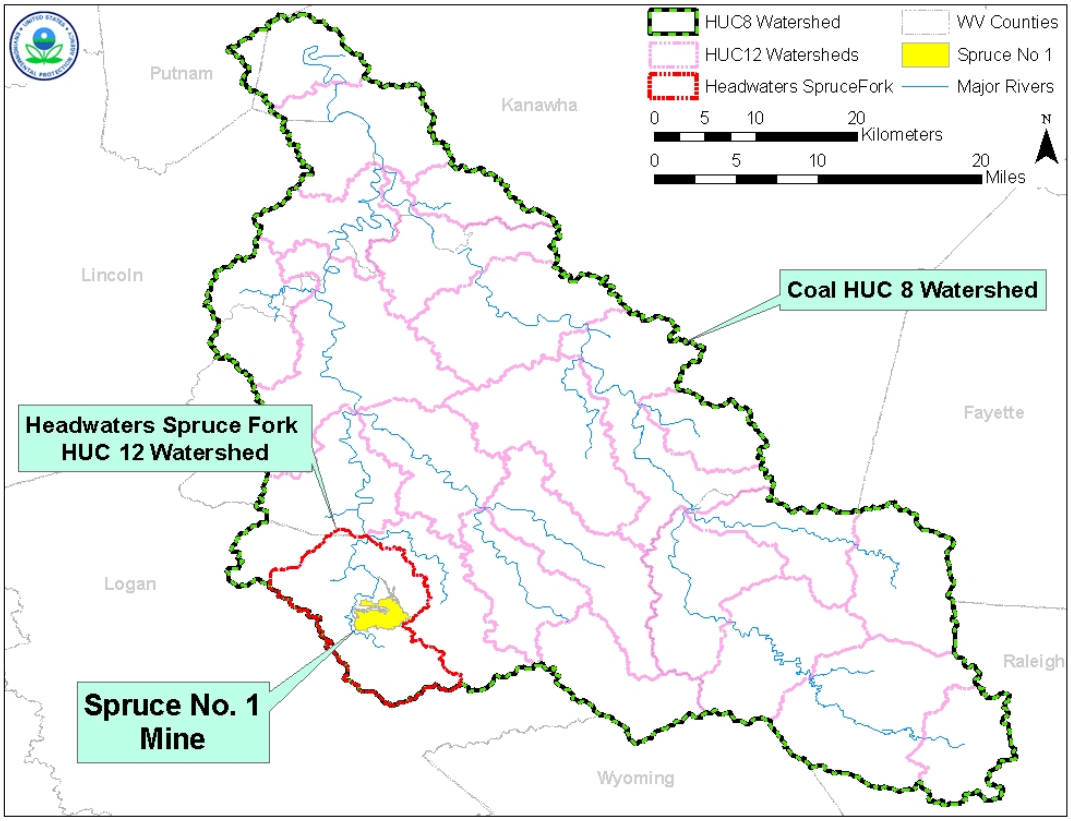

Figure 4 Spruce Fork sub-watershed (12-digit hydrologic unit code (HUC)) and the Coal River sub-basin (8-digit HUC)

The Coal River sub-basin encompasses nearly 891 square miles within West Virginia. Major tributaries within the Coal River sub-basin include Marsh Fork, Clear Fork, Pond Fork, Spruce Fork, and Little Coal River. Marsh Fork and Clear Fork join at Whitesville, WV to form the Big Coal River. Pond Fork and Spruce Fork join at Madison, WV to form the Little Coal River. Little Coal and Big Coal Rivers join to form the Coal River at Forks of the Coal, WV. The Coal River sub-basin has been impacted by past and present surface mining. Based upon the National Land Cover Database (NLCD) change product for 1992-2001 and WVDEP's Geographic Information System (GIS) mining files, more than 257 past and present surface mining permits have been issued in the Coal River sub-basin, which collectively occupy more than 13% of the land area. Some sub-watersheds in the Coal River sub-basin have more than 55% of the land occupied by surface mine permits.

The Spruce Fork sub-watershed, where the project is located, is a fourth order tributary that combines with Pond Fork to form the Little Coal River, which in turn flows into the Coal River. Spruce Fork is located in the southwestern portion of the Coal River watershed and drains approximately 126.4 square miles. The dominant landuse in the

Spruce Fork watershed is forest. Other important landuse types include urban/residential and barren/mining land. The Spruce Fork sub-watershed has been impacted by past and present surface mining activity. According to WVDEP Division of Mining and Reclamation permit maps, within the Headwaters Spruce Fork sub-watershed, where Spruce No. 1 is to be located, there are more than 34 past and present surface mine permits issued which collectively occupy more than 33% of the land area. Assuming full constructions of these projects in addition to known future surface mining permits, more than 40% of the land area of the sub-watershed will be affected.

In 1997, the WVDEP performed its first comprehensive ecological assessment of the Coal River sub-basin[6]. WVDEP assessed three major aspects of watershed health: water quality, habitat condition, and benthic macroinvertebrate community status. The subsequent report, An Ecological Assessment of the Coal River Watershed (1997), indicated that sediments, coal mining and inadequate sewage treatment were the major stressors on streams in this watershed. As a part of that assessment WVDEP stated:

> High quality streams with minimal human disturbances provide significant and even irreplaceable wildlife habitat. They also provide a tremendous recreational resource. No sites in the Coal River Watershed met the minimum criteria for reference site status. This is the first of 32 watersheds studied in West Virginia that produced no potential reference sites. Researchers conducting the EPA study on mountaintop mining, alluded to previously, have found a few small streams within the watershed that may meet the reference site criteria. The Program has since adopted one stream, White Oak Branch, (KC-10-T-22), as a reference site. Since reference sites reflect least-degraded conditions, it is vital that the WVDEP do its part in fulfilling the mission of preserving the high quality of these rare and important streams. It is also important that the agency make a concerted effort to find the apparently few remaining streams within the watershed that have not been significantly impacted by human disturbances.

White Oak Branch, referenced above in WVDEP's 1997 study, flows to Spruce Fork immediately upstream of Oldhouse Branch and Pigeonroost Branch. As noted above, WVDEP has adopted White Oak Branch as a reference site. WVDEP defines reference conditions as those conditions that "describe the characteristics of waterbody segments least impaired by human activities and are used to define attainable biological and habitat conditions. Final selection of reference sites depends on a determination of minimal disturbance, which is derived from physico-chemical and habitat data collected during the assessment of the stream sites." Reference sites are used to determine the score that represents the threshold between impaired and non-impaired sites.

Based on a comparison of their macroinvertebrate communities, Oldhouse Branch and Pigeonroost Branch are of comparable quality to White Oak Branch. Accordingly, Oldhouse Branch and Pigeonroost Branch reflect least–degraded conditions and represent

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[6] Report can be found at http://www.dep.wv.gov/WWE/watershed/wqmonitoring/Documents/EcologicalAssessments/EcoAssess_Coal_1997.pdf

some of the few remaining streams within the Coal River sub-basin that have not been significantly adversely impacted by human disturbances.

Oldhouse Branch flows into Spruce Fork immediately downstream of White Oak Branch and exhibits similar healthy biological diversity and water quality (EPA data). Using the West Virginia Stream Condition Index (WVSCI), an assessment method developed for use in West Virginia to help evaluate the health of benthic macroinvertebrate communities at the family level in wadeable streams,[7] both Oldhouse Branch and White Oak Branch scored comparably well, meaning that both were of similar quality and supporting similar aquatic communities.

Oldhouse Branch and White Oak Branch also score comparably well when the benthic macroinvertebrate community is considered at the more sensitive genus (as opposed to family) level. For instance, Oldhouse Branch shared 55 total genera (many of them pollution intolerant) with White Oak Branch (EPA data) indicating a diverse and healthy aquatic community in Oldhouse Branch similar to the high quality communities of White Oak Branch.

Pigeonroost Branch also shares many macroinvertebrate genera (many of them pollution intolerant) in common with the high quality community in White Oak Branch, indicating that the health of Pigeonroost Branch's aquatic community is similar. The WVSCI assessment of Pigeonroost indicates water quality is relatively good despite the presence of localized historic mining in the watershed. See Section IV.B.1. and Appendix 1 for more detail on macroinvertebrates at the Spruce No. 1 mine project site.

The relatively high quality of Oldhouse Branch and Pigeonroost Branch also can be demonstrated by comparison to other streams in the Spruce Fork sub-watershed that have been impacted by mining operations similar to the Spruce No. 1 Mine. Four such streams are directly northwest of the Spruce No. 1 project, on the west side of Spruce Fork, and in part, are impacted by the Mingo Logan Dal-Tex Mining Operation. Section V.B.2.a below compares the health of the relatively unimpacted macroinvertebrate communities in Pigeonroost Branch and Oldhouse Branch with the macroinvertebrate communities in streams elsewhere within the Spruce Fork sub-watershed that have been impacted by mining activity. By way of summary here, Oldhouse Branch and Pigeonroost Branch support a much healthier and more diverse assemblage of benthic macroinvertebrates than do the four comparison streams that are impacted by the Dal-Tex operation.

B. Wildlife

The ecoregion where the Spruce No. 1 project is be located (Figure 5) has some of the greatest aquatic animal diversity of any area in North America, especially for species of amphibians, fishes, mollusks, aquatic insects, and crayfishes. Salamanders in particular reach their highest North American diversity in the Central Appalachian ecoregion.

[7] For a more detailed discussion of WVSCI, see Section V.B.2.a.iii.

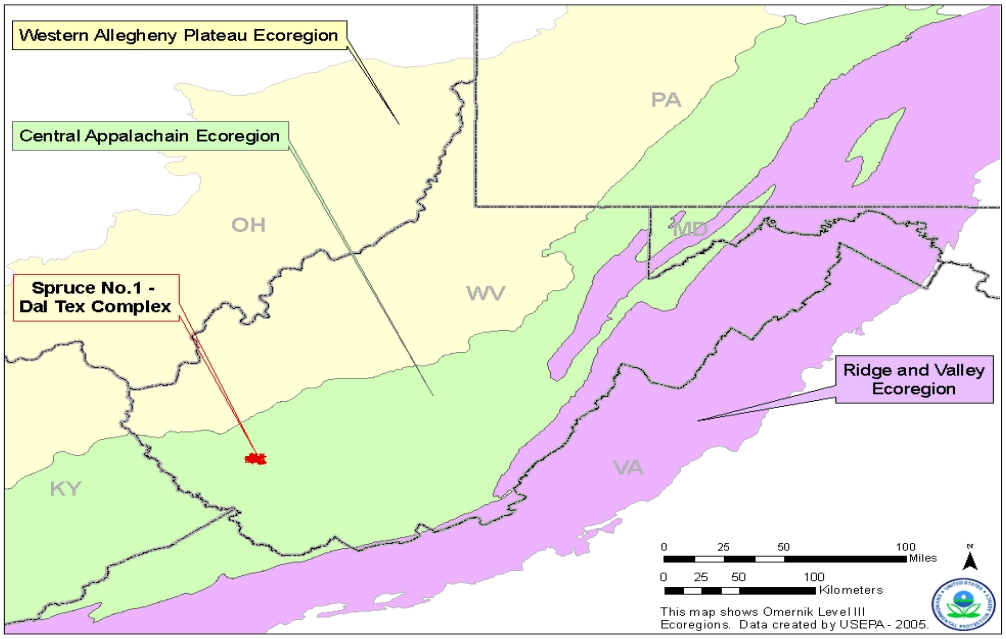

Figure 5 Central Appalachian Ecoregion

The ecoregion where the Spruce No. 1 project is located includes one of the most prominent biodiversity hot spots of rarity and richness identified by The Nature Conservancy (TNC) (Figure 6).

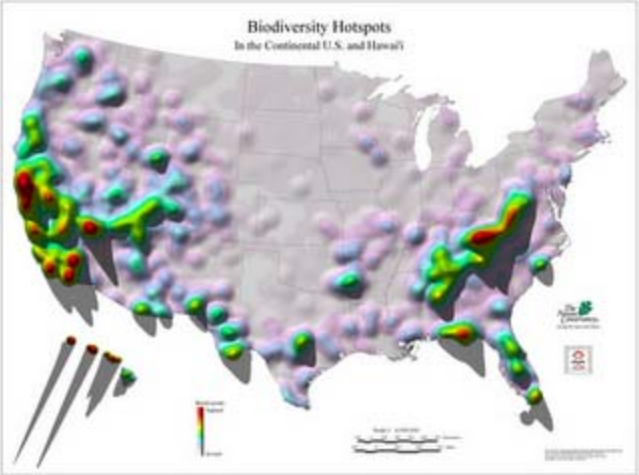

Figure 6: TNC Biodiversity Hotspots

Map adapted from Precious Heritage:
The Status of Biodiversity in the United States.
Data from State Natural Heritage Programs and their cooperators.
Map produced by TNC Eastern Conservation Science GIS, 5/19/00.
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Individual watersheds and peaks in the Appalachian chain, isolated for millions of years with benign environmental conditions, provided a perfect setting for the evolution of unique species of plants, invertebrates, salamanders, crayfishes, freshwater mussels, and fishes. These forests represent the center of the earth's salamander diversity. Not only are there numerous species, but salamanders also are incredibly abundant here, often accounting for the most vertebrate biomass in a given patch of forest (Stein et al, 2000). It has been documented that other specialized wildlife such as some neotropical migrant birds and forest amphibians rely on the natural headwater stream condition and adjacent forest types exhibited by Pigeonroost Branch and Oldhouse Branch for maintenance of their populations (Stein et al, 2000).

1. Invertebrates

As set forth above in Section IV.B.1. above, Pigeonroost Branch and Oldhouse Branch support diverse and healthy communities of benthic macroinvertebrates. In terms of its mayfly community, Oldhouse Branch ranks in the top 5% in the eco-region and the top 10% in the State. Oldhouse Branch's stonefly community ranks in the top 2% of the ecoregion. Pigeonroost Branch's mayfly community ranks among the top 10% in the co-region and the top 17 % in the State. Pigeonroost's stonefly community ranks in the top 17% in the eco-region and the top 28% third of the State.

As described above, benthic macroinvertebrates are the bottom-dwelling (benthic) organisms that are large enough to be seen without the aid of microscopes (macro), and are not equipped with backbones (invertebrate). Put simply, they are aquatic insects. In addition to serving as indicators of ecosystem health, freshwater macroinvertebrates, including mayflies and stoneflies, play a vital role in food webs and in the transfer of energy in river systems. These organisms essentially convert plant material into food sources (fats and proteins) essential for the maintenance of healthy fish and amphibian populations, and for foraging terrestrial vertebrates such as birds, bats, reptiles, and small mammals; serving as critical foodchain organisms, vital to the sustenance of healthy ecosystems. Because of their productivity and secondary position in the aquatic food chain, macroinvertebrates play a critical role in the delivery of energy and nutrients along the stream continuum. They also are instrumental in cleaning excess living and nonliving organic material from freshwater systems, a service that contributes to the overall quality of the watershed.

Macroinvertebrates are indigenous to central Appalachian streams and their naturally occurring communities are important components of stream ecosystems. Macroinvertebrates are recognized as wildlife by several organizations, including the US Fish and Wildlife Service (USFWS), USDA Forest Service, The Nature Conservancy, State Natural Heritage programs, and the West Virginia Department for Natural Resources (WVDNR). Currently, within the U.S., the USFWS lists 50 species of insects as endangered under the Endangered Species Act (ESA), and another 10 species as threatened under the ESA. Insects represent 10.4 percent of all currently-listed animals in the U.S. and 4.4 percent of all listed species, including plants (http://ecos.fws.gov/tess_public/pub/boxScore.jsp). Several dozen other insects are candidates for listing under the ESA, including the Sequatchie caddisfly (*Glyphopsyche sequatchie*), a trichopteran found in Tennessee.

The State of West Virginia also considers insects to be wildlife, and includes insects on its list of rare, threatened and endangered species. Many aquatic insects are listed, including: 12 species of stoneflies, two species of mayflies, and 73 species of dragonflies and damselflies (West Virginia Natural Heritage Program 2007). Scientists and environmental consultants who collect benthic macroinvertebrates in West Virginia must obtain a wildlife collection permit from WVDNR.

Mayflies are most popularly known among fly-fishermen, where anglers rely on the seasonal hatches of mayflies that coincide with catching trout and other game fish species. Not only do trout rely on mayflies and stoneflies, but a group of colorful benthic fishes known as Darters (Percidae) feed primarily on mayflies. A dietary study of small stream fishes in the Appalachian coalfields of Kentucky (Lotrich 1973) showed that gut contents of several darters contained mostly mayflies. Darters are an important part of the fish assemblage and many are hosts for mussel larvae. Several darter species inhabit Spruce Fork in the immediate vicinity of the project area. Table 1 identifies the mayfly genera that have been identified in the Spruce No. 1 mine permit area.

Table 1. Presence/absence of mayfly genera in the permit area.

Order	Family	Genus	Oldhouse	Pigeonroost	Seng Camp
Ephemeroptera	Ameletidae	*Ameletus*	X	X	
Ephemeroptera	Baetidae	*Acentrella*	X	X	
Ephemeroptera	Baetidae	*Baetis*	X	X	X
Ephemeroptera	Baetidae	*Diphetor*		X	
Ephemeroptera	Baetiscidae	*Baetisca*		X	X
Ephemeroptera	Caenidae	*Caenis*			X
Ephemeroptera	Ephemerellidae	*Attanella*		X	X
Ephemeroptera	Ephemerellidae	*Dannella*		X	X
Ephemeroptera	Ephemerellidae	*Drunella*	X	X	
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	X	
Ephemeroptera	Ephemerellidae	*Eurylophella*	X	X	X
Ephemeroptera	Ephemeridae	*Ephemera*	X	X	X
Ephemeroptera	Heptageniidae	*Cinygmula*	X	X	
Ephemeroptera	Heptageniidae	*Epeorus*	X	X	
Ephemeroptera	Heptageniidae	*Heptagenia*		X	
Ephemeroptera	Heptageniidae	*Maccaffertium*	X	X	X
Ephemeroptera	Heptageniidae	*Stenacron*	X		X
Ephemeroptera	Isonychiidae	*Isonychia*		X	X
Ephemeroptera	Leptophlebiidae	*Choroterpes*	X		
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	X		X

Note: Siphlonurus and Pseudocloeon reported by Sturm Env. are likely erroneous identifications. These genera have been excluded from this list.

Stoneflies (Plecoptera) also represent an important group of aquatic insects in the structure and functioning of stream ecosystems. Stoneflies also fill important trophic roles in stream ecosystems, as displayed by their detritivory (consumption of dead or decaying organic matter) and predatory functional feeding group designations. As with mayflies, stoneflies are valued and imitated by fly-fishermen and serve as an abundant food source for many salamanders and fishes. Stoneflies are primarily stenothermic, meaning they inhabit cool to cold waters which provide the higher dissolved oxygen concentrations required for their survival. Table 2 presents the stonefly genera identified in the Spruce No. 1 Mine area.

Table 2. Presence/absence of stonefly genera in the permit area.

Order	Family	Genus	Oldhouse	Pigeonroost	Seng Camp
Plecoptera	Capniidae	*Allocapnia*	X	X	X
Plecoptera	Chloroperlidae	*Alloperla*		X	
Plecoptera	Chloroperlidae	*Haploperla*	X		
Plecoptera	Chloroperlidae	*Sweltsa*	X		
Plecoptera	Leuctridae	*Leuctra*	X	X	X
Plecoptera	Nemouridae	*Amphinemura*	X	X	
Plecoptera	Nemouridae	*Ostrocerca*	X	X	
Plecoptera	Nemouridae	*Paranemoura*		X	
Plecoptera	Peltoperlidae	*Peltoperla*	X		X
Plecoptera	Perlidae	*Acroneuria*	X	X	X
Plecoptera	Perlodidae	*Isoperla*	X		X
Plecoptera	Perlodidae	*Remenus*		X	
Plecoptera	Perlodidae	*Yugus*	X		
Plecoptera	Pteronarcyidae	*Pteronarcys*	X	X	X
Plecoptera	Taeniopterygidae	*Taenionema*		X	
Plecoptera	Taeniopterygidae	*Taeniopteryx*		X	X

Note: Podmosta, Paraleuctra, Megaleuctra,and Beloneuria reported by Sturm Env. are likely erroneous identifications. These genera been excluded from this list.

2. Salamanders

The ecoregion where the Spruce No. 1 project is located contains one of the richest salamander fauna in the world (Petranka 1998, Stein et al., 2000). Nearly ten percent of global salamander diversity is found within streams in the ecoregion (Green and Pauley, 1987). Salamanders are a diverse and unique form of Appalachian wildlife that depend on forested headwater habitat and decline or disappear from surface mined areas. Many species of salamanders are aquatic or semi-aquatic and utilize headwater streams at some point in their life histories. Most of the species found in the project area are water-dependent and belong to the family Plethodontidae, the lungless salamanders, which require high moisture retaining leaf-litter, dense shade, and cool flowing streams to survive and reproduce. Typically, salamanders occupy small, high-gradient headwater streams while fish occur farther downstream.

Salamanders are an important ecological component in the mesic (medium precipitation) forests of the ecoregion and are often the most abundant group of vertebrates in both biomass and number (Burton and Lykens, 1975; Hairston, 1987). Ecologically, salamanders are intimately associated with forest ecosystems acting as predators of small invertebrates and serving as prey to larger predators (Pough et al., 1987). Some species of salamanders split their lives between forests and headwaters and depend on a close connection to move between the two (Petranka, 1998).

Moler and Franz (1987) cite the work of Burton and Likens (1975) and Gosz et al. (1978) in New Hampshire who suggest an important role for amphibians in energy cycling. Burton and Likens (1975) found that the biomass of salamanders was about double that of birds during the peak birding season and about equal to the biomass of small mammals. Gosz et al. (1978) found that salamanders and shrews were the most important vertebrates preying on the invertebrates of the forest floor. They estimated that birds consumed 6.5 times, and shrews 4.7 times, the amount of food energy consumed by the salamander community. However, because the warm-blooded birds and shrews expended 98% of their energy intake on metabolic maintenance compared to only 40% for the salamanders, salamanders contribute 4.6 (shrews) and 6.3 (birds) times as much biomass to the available prey base, making them an important component of the foodweb.

With respect to the immediate project area, stream-dwelling salamanders have been surveyed in White Oak Branch (USFWS, unpublished data, 2004). White Oak Branch had good numbers of Northern Dusky (9 adult, 7 larvae), Appalachian Seal (15 adult, 12 larvae), and Two Lined salamanders (1 adult and 15 larvae). These numbers represent densities in a 12 square meter plot that includes dry and wetted portions of the stream channel. Because Oldhouse Branch and Pigeonroost Branch are very close geographically and have similar features as White Oak Branch, salamander populations in Pigeonroost and Oldhouse Branch can be expected to be similar to those in White Oak Branch. Williams (2003) found mean densities within reference reaches of Pigeonroost, Bend Branch (another tributary of Spruce Fork), and Ash Fork (a tributary of Gauley River) at more than six salamanders per square meter. In the Williams' study, the majority of the total catch of salamanders was found in Pigeonroost.[8] Using these numbers from White Oak Branch and Pigeonroost, EPA estimates aquatic salamanders are indeed abundant (~5-6 per square meter) along stream channels in Pigeonroost Branch and Oldhouse Branch.

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[8] Williams (2003) data from the WV MTM region also showed that while more individuals were found in the lower 1st-2nd order reaches, slightly more species (8 spp.) were actually found in the upper intermittent reaches.

3. Fish

Fish communities change with watershed size and respond to gradients of physical habitat and chemistry. The fish assemblages in Pigeonroost Branch and Oldhouse Branch are typical of headwater streams, containing only a few species. The fish assemblages in Spruce Fork are in relatively good condition. Spruce Fork is a locally important rock bass and smallmouth bass fishery. These fish assemblages are not representative of pristine conditions and it is likely that some of the more sensitive species may have been historically extirpated from past anthropogenic activities, including mining.

In an analysis of fish community data from Spruce Fork, Region III assessed the small streams immediately impacted by the Spruce No. 1 permit and three reaches of Spruce Fork: 1) Upstream of Seng Camp, 2) Seng Camp to Spruce Laurel, and 3) Downstream of Spruce Laurel. Other data analyzed included data collected for the Programmatic Environmental Impact Statement (PEIS) for Mountaintop Mining/Valley Fills. (see Stauffer and Ferreri, 2002 and Fulk et al. 2003); unpublished data included in the West Virginia Department of Natural Resources database (including USEPA, WVDNR, and consulting firm data); and data from Decota Consulting (consultants for Mingo Logan) supplied to the WVDNR collecting permit program. The data consisted of samples that were intended for community assessment and were judged to have sufficient numbers of individuals to render a fair assessment. Fish community data can be difficult to analyze and oftentimes the absence of species may be due to zoogeography (how they were distributed in response to past geological events) or due to stressors over time in the watershed. Some of these stressors may still be apparent and some may not.

The fish found in Pigeonroost Branch, Oldhouse Branch, and White Oak Branch are typical of small streams in the Coal River Basin. They do not indicate impairment, nor do they indicate reference conditions. EPA compared samples collected for the PEIS in 1999 and more recent data collected by Decota Consuting from 2008 and 2009. When sampled for the PEIS, Pigeonroost Branch had been affected by drought and only blacknose dace and creek chubs were present. These species are tolerant of disturbance and are headwater species adapted to drought. White Oak Branch also was sampled for the PEIS at the same time. It too was drought-affected and contained only blacknose dace at the time of the PEIS sampling in 1999. No samples were collected in Oldhouse Branch for the PEIS.

More recent data indicates that Pigeonroost Branch also has a population of mottled sculpin, and at times smallmouth bass and stonerollers. More recent data from White Oak Branch indicates that creek chubs are also present in good numbers and mottled sculpin are rare (only 1 individual captured). Data from Oldhouse Branch indicates that blacknose dace and creekchubs are the only species present.

For the PEIS, Fulk et al. (2003) used the Mid-Atlantic Highlands (MAHA) Index of Biotic Integrity (IBI - a multi-metric index used to assess biotic health), with some minor modification, to assess the impacts of MTM/VF to fish assemblages. Using this same

index, the assemblage upstream of Seng Camp Creek ranged from fair to excellent condition.

The fish assemblage in the mainstem of Spruce Fork is in relatively good condition. Spruce Fork is a locally important rock bass and smallmouth bass fishery. Rock Bass and Smallmouth Bass are moderately sensitive gamefish species. While sampling Spruce Fork in 2010, recreational fishing was observed in the lower reaches of the stream and there was evidence of fishing in the upper reaches as well. Species present in Spruce Fork upstream and downstream of Seng Camp Creek are typical of streams of this size within the Coal River Basin and have not changed appreciably over the last 60 years.

4. Birds[9]

Many terrestrial bird species depend on the headwater streams like those of the Spruce Fork for their survival. The ecotone (transition area) between terrestrial and aquatic habitats results in diverse flora and fauna. For example, unique avifauna assemblages can be found along the riparian zone of headwater streams.

Among the many migratory birds likely to breed in the project area, there are six species that the USFWS has designated as Birds of Conservation Concern (BCC) within the Appalachian Mountains Bird Conservation Region (AMBCR). These include the cerulean, Kentucky, Swainson's and worm-eating warblers, the wood thrush, and the Louisiana waterthrush. The first five of these are also designated as BCC species within the USFWS's Northeast Region as a whole and nationally (USFWS 2008). The first four are also considered to be among the 100 most at-risk bird species in North America (Wells 2007).

The Louisiana waterthrush (*Seirus motacilla*), a neotropical migrant song bird, is considered an obligate headwater riparian songbird (an example of water-dependent wildlife) because its diet is comprised predominantly of immature and adult aquatic macroinvertebrates found in and alongside headwater streams and because it builds its nest in the stream banks. Breeding waterthrushes nest and forage primarily on the ground along medium- to high-gradient, first- to third-order, clear, perennial headwater streams flowing through closed-canopy forest. Good water quality is a key component of the species breeding habitat. Headwater streams like Pigeonroost Branch and Oldhouse Branch that support healthy macroinvertebrate communities are food sources for species such as the Louisiana waterthrush.

The Appalachian Mountain Bird Conservation Region (AMBCR), which extends from southeastern New York south to northern Alabama, is thought to support a substantial portion of the Louisiana waterthrush's breeding population, perhaps as much as 45 percent. West Virginia, the only state that lies entirely within the AMBCR, encompasses the largest contiguous area of high relative breeding abundance over the species' entire breeding range, based on North American Breeding Bird Survey (BBS) data from 1994-

[9] Much of the discussion related to avian and bat species is based upon communications with the U.S. Fish and Wildlife Service.

2003. The West Virginia population may serve as a source for populations elsewhere in the breeding range. The Louisiana waterthrush is also an area-sensitive species, requiring undisturbed forest tracts of 865 acres to sustain a population (Robbins, C.S., J.R. Sauer, RS. Greenburg**,** and S. Droege. 1989). The most effective management protocol for the Louisiana waterthrush would appear to be protection of forest tracts and water systems inhabited on both breeding and wintering areas particularly moderate- to high-gradient headwater streams, which compose 75-80% of stream length in a typical watershed.

Bird species that rely on mature forest habitats that are on the Audubon watch list as declining species and are listed as probable in the area include the Swainson warbler (*Limnothlypis swainsonii*), Kentucky warbler (*Oporornis formosus*), and Cerulean warbler (*Dendroica cerulean*).

The Cerulean warbler in particular is considered an area-sensitive species; it is thought to require large (greater than 30 sq miles) tracts of mature interior forest habitat to support stable breeding populations. This species is a canopy-foraging insectivorous neotropical migrant songbird that breeds in mature deciduous forests with broken, structurally-diverse canopies across much of the eastern United States and winters in middle elevations of the Andes Mountains of northern South America. Important among a number of breeding season constraints are the loss of mature deciduous forest, particularly along stream valleys, and fragmentation and increasing isolation of remaining mature deciduous forest. The cerulean warbler appears to be more sensitive than most other North American birds to landscape-level changes in habitat. The USFWS has designated the cerulean warbler a Species of Management Concern and a Species of Conservation Concern throughout its range. It has also been preliminarily designated by the Appalachian Mountains Joint Venture as a Species of Highest Conservation Priority within the Appalachian Mountains Bird Conservation Region, which encompasses West Virginia. The AMBCR is thought to support about 80 percent of the species' entire breeding population, and the AMBCR breeding population likely functions as a source for populations elsewhere in the breeding range.

The Acadian flycatcher (*Empidonax virescens*) is commonly encountered throughout the Central Appalachian Ecoregion, but despite the large expanse of existing forest habitat, it is primarily restricted to forested tracts with understory vegetation along small headwater streams, where it can feed on emergent aquatic insects. Spruce Fork and its tributaries meets these habitat requirements. Neotropical migrant songbirds are also often attracted to headwater streams for breeding areas because of the diversity of the habitat and the availability of emergent aquatic insects.

5. Bats

Thirteen species of bats are found in West Virginia. Most North American bats are insectivorous, which capture their prey by foraging in flight, catching flying insects from a perch, or collecting insects from plants.

Different species of bats often have distinct life history traits and behaviors. Some bats

are solitary and hang in tree foliage, attics, barns, and other protected places during the day. Other bats are colonial and cluster in caves and mine tunnels. Bats have one of the slowest reproductive rates for animals their size. Most bats in northeastern North America have only one or two pups a year and many females do not breed until their second year. This low reproductive rate is somewhat offset by a long life span, often over 20 years. The little brown bat, common in North America and in West Virginia, is the world's longest lived mammal for its size, with a maximum life-span over 32 years. During the winter, some bats migrate south in search of food, while others hibernate through the cold weather when insects are scarce. Bats that do migrate usually travel less than 200 miles, often following the same routes as migratory birds.

Species that have potential to be found in the area of south-Central West Virginia that encompasses the Spruce No. 1 Mine include the northern bat (*Myotis septentrionalis*), big brown bat (*Eptesicus fuscus*), red bat (*Lasiurus borealis*), eastern small-footed bat (*Myotis leibii*), Virginia big-eared bat (*Corynorhinus townsendii virginianus*), northern long-eared bats *(Myotis septentrionalis)* and the Indiana bat (*Myotis sodalis*).

Both the Indiana and Virginia big-eared bats are listed as endangered under the Endangered Species Act. The USFWS was also recently petitioned to list the eastern small-footed bats and the northern long-eared bats under the ESA. Five eastern small-footed bats and 16 northern long-eared bats were captured during mist net surveys conducted at the Spruce No. 1 project site in 2004, representing 7.6 and 24.2 percent, respectively, of all bats captured (U.S. Army Corps of Engineers Huntington District 2006, DEIS Spruce No. 1 Mine. Appendix M).

Indiana bats have been described as once one of the most common mammals in the Eastern United States. Between 1960 and 2004, biologists have documented a 56 percent population decline in Indiana bats. Indiana bats feed solely on emerged aquatic and terrestrial flying insects. They are habitat generalists and their selection of prey reflects the environment in which they forage. In a study in the Allegheny Mountains, activity in non-riparian upland forest and forests in which timber harvest had occurred was low relative to forested riparian areas. This evidence suggests that the forested riparian zones of the project area would be more suitable habitats for Indiana bat populations than active or restored mining sites.

Mist net surveys were conducted in the project area in 2000 and 2004, and no Federally-listed bats were captured. Although the capture of bats confirms their presence, failure to catch bats does not absolutely confirm their absence (U.S. Fish and Wildlife Service 2007, pg. 252). The project area occurs roughly half-way between known hibernacula in northeastern Kentucky and southeastern West Virginia. Since the most recent surveys at the Spruce No. 1 site, maternity roosts have been documented in central and north-central Boone County. Additionally, a juvenile Indiana bat was captured on August 9, 2010 in southwest Fayette County, indicating the presence of a maternity colony in that area.

C. Summary

Based on the foregoing, EPA Region III finds that Pigeonroost Branch and Oldhouse Branch contain important wildlife resources and habitat. The Region bases its conclusion on several factors including the similarity of Pigeonroost Branch and Oldhouse Branch to the reference quality White Oak Branch and therefore they support conditions representing some of the last remaining least degraded streams and riparian areas within the Spruce Fork sub-watershed and the Coal River sub-basin.

V. Basis for Recommended Determination

A. Section 404(c) Standards

Section 404(c) provides:

> The Administrator is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site, and he is authorized to deny or restrict the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever he determines, after notice and opportunity for public hearings, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. Before making such determination, the Administrator shall consult with the Secretary. The Administrator shall set forth in writing and make public his findings and his reasons for making any determination under this subsection.

While EPA strongly prefers to initiate the Section 404(c) process prior to issuance of a permit, Section 404(c) and EPA's implementing regulations authorize EPA to initiate the Section 404(c) process after a permit has been issued by withdrawing specification of a disposal site. See 40 CFR 231.1(a); see also definition of "withdraw specification," 40 CFR 231.2(a). In this case, consistent with Section 404, Pigeonroost Branch and Oldhouse Branch were specified as disposal sites in DA Permit No. 199800436-3.

Section 404(c) does not define the term "unacceptable adverse effect." EPA's regulations at 40 CFR 231.2(e) define "unacceptable adverse effect" as:

> Impact on an aquatic or wetland ecosystem which is likely to result in significant degradation of municipal water supplies or significant loss of or damage to fisheries, shellfishing, or wildlife habitat or recreation areas. In evaluating the unacceptability of such impacts, consideration should be given to the relevant portions of the Section 404(b)(1) Guidelines (40 CFR Part 230).

For purposes of the Spruce No. 1 mine, the relevant portions of the Section 404(b)(1) Guidelines that are particularly important for assessing the unacceptability of environmental impacts include:

- Less environmentally damaging practicable alternatives (230.10(a))

- Water quality impacts (230.10(b))
- Significant degradation of waters of the United States (230.10(c))
- Minimization of adverse impacts to aquatic ecosystems (230.10(d))
- Cumulative effects (230.11(g)); and
- Secondary effects (230.11(h))

The purpose of the Clean Water Act is to "restore and maintain the physical, chemical, and biological integrity of the Nation's waters." 33 U.S.C. 1251(a). Part of the concept of protecting the "biological integrity" of the Nation's waters is protection of the indigenous, naturally occurring community. This goes beyond protecting the function performed by various members of the aquatic community and extends to protection of the quality of the aquatic community itself. *See Alameda Water & Sanitation District v. EPA*, 930 F. Supp.486 (D. Colo. 1996).

B. Adverse impacts from specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material from the Spruce No. 1 Mine

The impacts from the specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material from the Spruce No. 1 Mine will occur through several different pathways.

First, direct impacts will occur as a result of the discharge of fill (excess spoil, minethrough, and construction of valley fills), which will bury much of Pigeonroost Branch and Oldhouse Branch and eliminate the buried ecosystems, including all wildlife living in those streams. Burial of Pigeonroost Branch and Oldhouse Branch also will eliminate habitat for wildlife that depend upon those streams. Loss of the buried portions of Pigeonroost Branch and Oldhouse Branch will impact wildlife that depend on those headwater streams for all or part of their lifecycles and adversely affect adults, juveniles, larvae, and/or eggs.

In addition, adverse impacts will occur to wildlife that live outside the footprint of the fills and sedimentation ponds. Discharges of fill material into Pigeonroost Branch and Oldhouse Branch will have the effect of removing those streams as sources of freshwater dilution and adversely affect the delivery of headwater stream ecosystem functions to downstream waters. Studies have shown a strong correlation between the construction of valley fills for surface coal mining in Applachia and significant adverse impact on downstream macroinvertebrate communities.

There is also a likelihood that the discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch will transform those areas into sources of contaminants (particularly conductivity and selenium) contributing to degradation of downstream waters. The project as authorized also has the potential to contribute to conditions that would support blooms of golden algae that release toxins that can kill fish and other aquatic life.

To evaluate the impacts of the Spruce No. 1 project, Region III has consulted the PEIS and available data and literature documenting impacts from similar projects. Region III also has examined impacts caused by the portion of the Spruce No. 1 Mine that has already been

constructed in the Seng Camp Creek watershed (specifically, Valley Fill 1A). In addition, Region III reviewed the nearby Mingo Logan Dal-Tex operation. Based on location and similarity of geology and minerals, impacts from the Mingo Logan Dal-Tex operation are likely to be a good predictor of impacts from the Spruce No. 1 Mine. This was acknowledged by the Huntington District Corps of Engineers in the Spruce No. 1 EIS, which stated: "The past and present impacts to topography, geology, and mineral resources of the previous mining along the western side of Spruce Fork are similar to the anticipated impacts of the Spruce No. 1 Mine, as mining is to occur in the same strata."

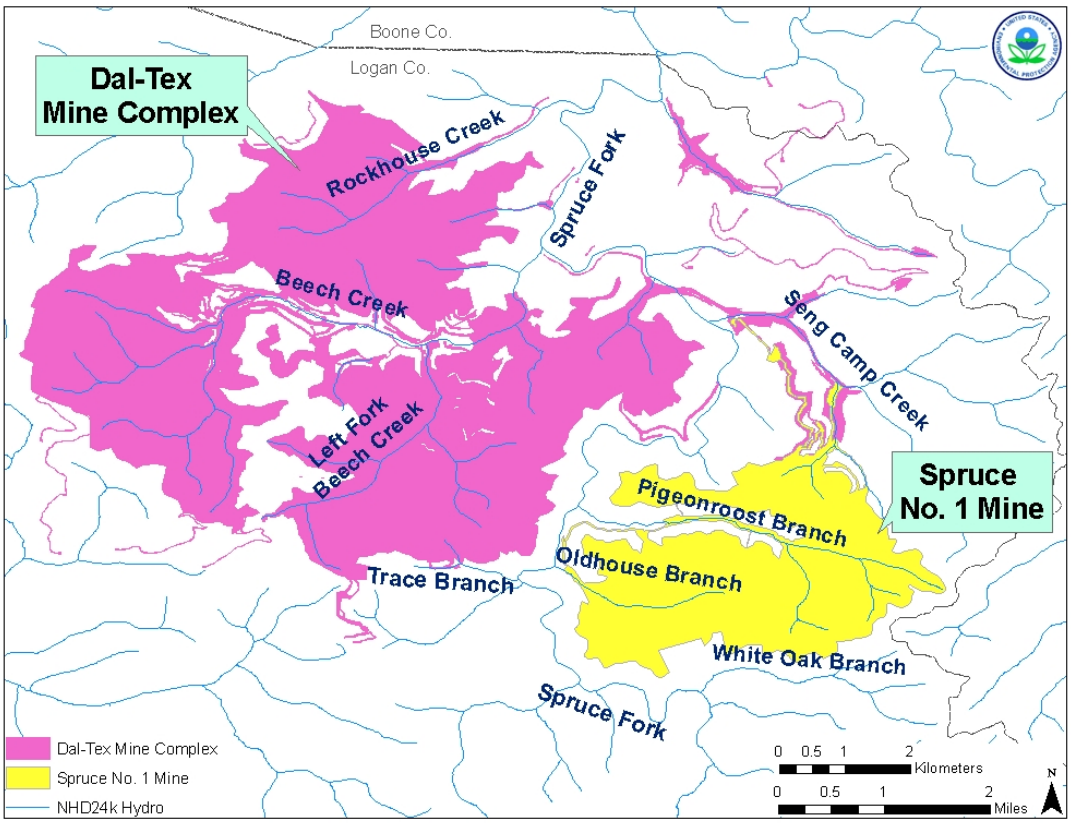


Figure 7 Spruce No. 1 Mine and the Dal-Tex Mine Operation

Region III completed a review of rock cores and corresponding cross sections for the Dal-Tex mines including the Gut Fork mine (immediately across Spruce Fork from Spruce No.1; Figure 7) and compared those to the Spruce No. 1 mine. This review, which is set forth in Appendix 4, indicates that, for the most part, the formations are repeated from the Dal-Tex mine complex to the Spruce No 1 mine location. Per the EIS, the same coal beds are to be developed for the Spruce No. 1 mine as for the Del-Tex mine. Also, these coal bed sequences are similar to those described in the literature for southern West Virginia coal bed sequences and the geologic column for the Spruce No 1 mine.

1. Effects on Water Chemistry

The Section 404(b)(1) Guidelines direct that no permit should issue if the discharge will cause or contribute to violations of applicable water quality standards or if the discharge will cause or contribute to significant degradation of the aquatic ecosystem, including but not limited to significant adverse effects on stages of aquatic life and other wildlife dependent upon aquatic ecosystems, including the transfer concentration, and spread of pollutants or their byproducts outside the disposal area. 40 C.F.R. §§230.10(b)(1) & 230.10(c). *See also* 40 C.F.R. §§ 230.31.

Adverse changes in water chemistry frequently have a corresponding impact on wildlife and fisheries that live in or depend upon the water. Potential impacts to water chemistry are considered because they may affect the native aquatic and water-dependent communities in the Spruce Fork watershed.

a. Selenium

Discharges from the Spruce No. 1 Mine Complex project are likely to increase selenium loading to the immediate receiving streams and downstream waters. The State of West Virginia has established a numeric chronic water quality criterion for selenium (5 µg/L) to protect instream aquatic life. Selenium is a naturally occurring chemical element that is an essential micronutrient, but excessive amounts of selenium can also have toxic effects. For aquatic animals, the concentration range between essential and toxic is very narrow, being only a few micrograms per liter in water. Selenium toxicity is primarily manifested as reproductive impairment and birth defects due to maternal transfer, resulting in embryotoxicity and teratogenicity in egglaying vertebrates (e.g., fish and ducks). The most sensitive toxicity endpoints in fish larvae are teratogenic deformities such as skeletal, craniofacial, and fin deformities, and various forms of edema. Embryo mortality and severe development abnormalities can result in impaired recruitment of individuals into populations (Chapman et al. 2009). A WV draft study indicates that elevated selenium concentrations in fish eggs, increased larval deformity rates and increased deformity rates in mature fish are occurring in the Mud River Reservoir, Boone County, WV due to mining activities. These adverse conditions were all associated with elevated water column selenium concentrations (WVDEP, 2009, draft).

In West Virginia, coals that contain the highest selenium concentrations are found in a region of south central West Virginia where the Allegheny and Upper Kanawha Formations of the Middle Pennsylvanian are mined (WVGES 2002). WVDEP reports that some of the highest coal selenium concentrations are found in the central portion of the Coal River watershed where significant active mining and selenium impaired streams are located, in the immediate vicinity of the Spruce No. 1 project. Selenium is discharged when surface mining activities expose selenium-bearing material that comes in contact with water and contaminated water drains from the mining area to surface waters. The sedimentation ponds that are the usual form of water treatment at mining sites generally are not effective at treating selenium before effluent is discharged from ponds to downstream waters.

To evaluate the impact of discharges into Pigeonroost Branch and Oldhouse Branch as authorized by the DA Permit, Region III has compared selenium levels in Pigeonroost Branch and Oldhouse Branch with selenium levels in waters that have been impacted by the nearby Dal-Tex operation.[10] In addition, Region III has reviewed data from discharge monitoring reports from mining outlets for the portion of the Spruce No. 1 Mine that has been constructed in the Seng Camp Creek watershed. Figure 8 shows mine outlet locations.

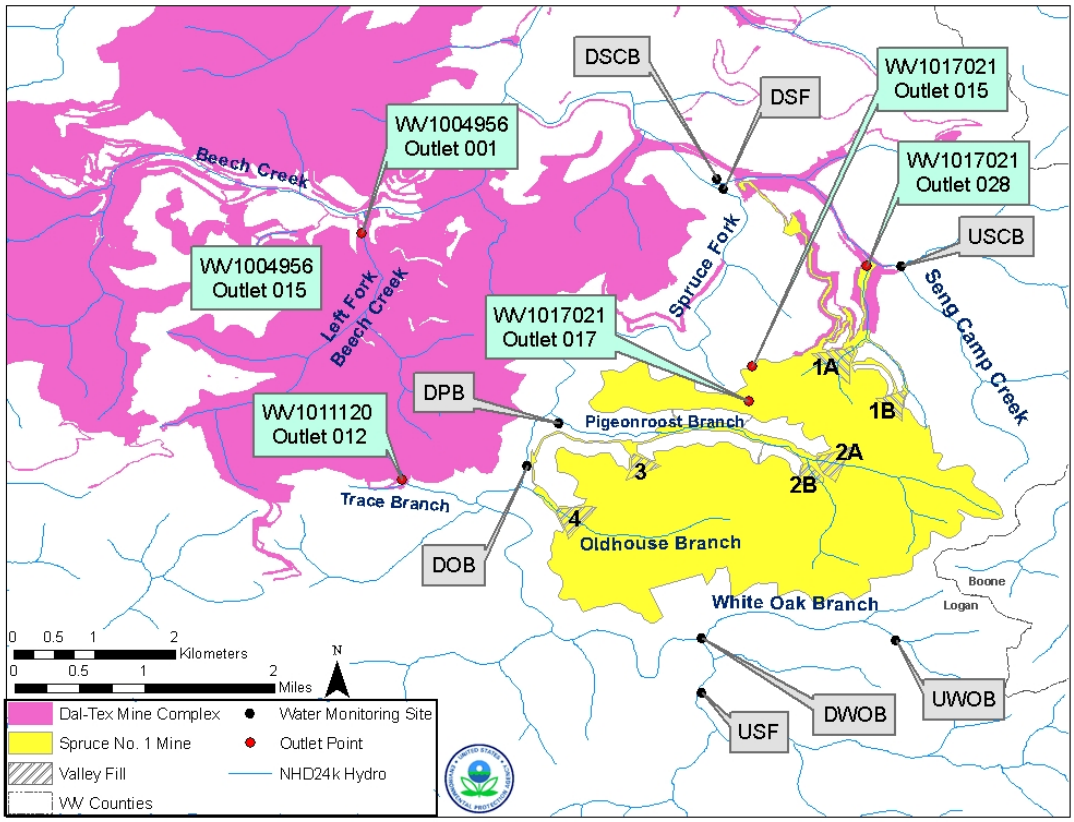


Figure 8: Dal-Tex and Spruce No. 1 Mine outlet locations.

[10] Levels of selenium in other nearby waters that have been impacted by surface coal mining activity and generally have similar geology also support a prediction that construction of the Spruce No. 1 Mine as currently authorized will result in elevated levels of selenium in downstream waters. Selenium concentrations have exceeded the Se criterion at least three times in six (6) other mined streams in the Coal River Sub-basin. These include White Oak Creek (a tributary to the Coal River), the left Fork of White Oak Creek, Seng Creek (another tributary to the Coal River); and Casey Creek, James Creek, and Beaver Pond Branch, all tributaries to Pond Fork. These elevated levels of selenium demonstrate that the geology in the area of the Spruce No. 1 mine is likely to release selenium during mining activities. See Appendix 2 for further details on selenium.

Table 3 provides a summary of selenium averages and ranges for Pigeonroost Branch and Oldhouse Branch and streams draining the nearby Dal-Tex operation (Left Fork Beech Creek, Beech Creek, and Trace Branch). The table also contains data for White Oak Branch (upstream of Spruce No. 1 as currently authorized) and Seng Camp Creek (receiving water for the portion of Spruce No. 1 that is under construction).

Summarizing the data in the following table, streams draining the nearby Dal-Tex operation have selenium concentrations exceeding the 5 ug/l chronic selenium numeric criterion. The data from the Dal-Tex mine complex do not indicate any decrease in selenium concentrations over the period of record. These data strongly suggest construction of valley fills and other discharges of fill material from the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch would likely result in discharges of elevated levels of selenium in the receiving waters and lead to significant degradation of water quality of the receiving waters and downstream waters. Such degraded water quality would be likely to impact downstream wildlife populations, including fish population

Table 3. Selenium Concentrations (ug/l) Near Spruce No. 1 Project Area

Stream Name	Subbasin	Source and time period of data					
		PEIS (2000-2001)		WVDEP (2002-2003)		WVDEP (2005-	
		Se (avg)	Se (range)	Se (avg)	Se (range)	Se (avg)	Se (ran
Average and Range of Se in Tribs to Spruce Fork that drain Spruce No. 1 project area							
White Oak Branch	Spruce Fork	<3 ND		<5 ND		NS	
Oldhouse Branch	Spruce Fork	<3 ND		<5 ND		NS	
Pigeonroost Branch	Spruce Fork	<3 ND		<5 ND		NS	
Seng Camp Creek	Spruce Fork	NS		<5 ND		NS	
Average and Range of Se in Tribs to Spruce Fork draining Dal-Tex Operation							
Beech Creek[11]	Spruce Fork	7.5	5.6-9.5	6	5.0-9.0	12.3	6.0
Left Fork of Beech Creek	Spruce Fork	22.7	15.3-31.1	22	5.0-53.0	NS	
Trace Branch	Spruce Fork	NS	NS	7	5.0-10.0	NS	
Rockhouse Branch	Spruce Fork	5.3	3.8-8.0	< 5 ND	< 5 ND	NS	

ND: Se not detected. Detection limit shown.
NS: Not sampled. Stream was not sampled for the study shown.

Graphical trends of selenium concentrations from Discharge Monitoring Report (DMR) records for January 2007 to June 2010 from three outfalls from the Dal-Tex Mine Operations are shown in the following Figures 9-11. These demonstrate that the discharges from those outfalls consistently exceed West Virginia's chronic numeric water quality criterion for selenium (5 µg/L).

[11] In the WVDEP study on selenium bioconcentration factors, selenium was also found in fish tissue in Beech Creek (average 7.55 mg/kg).

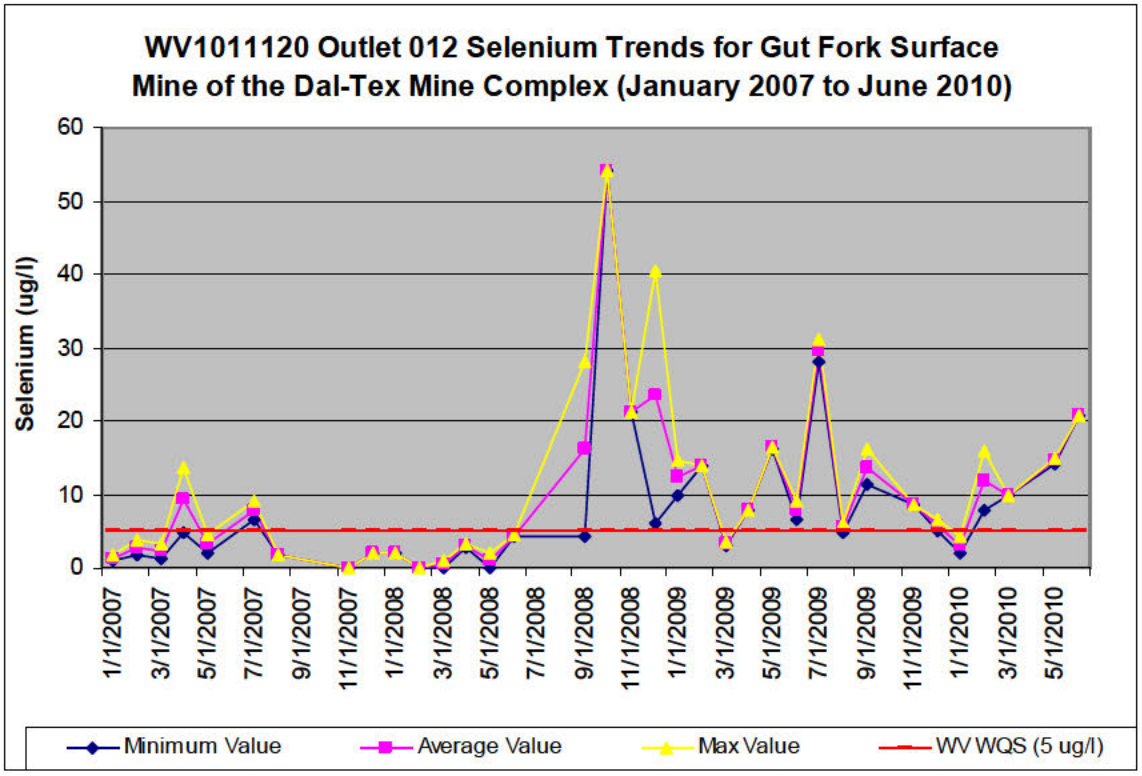


Figure 9: Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1011120 – Outlet 012 (Mingo Logan Coal Company's Gut Fork Surface Mine of the Dal-Tex Mine Complex)

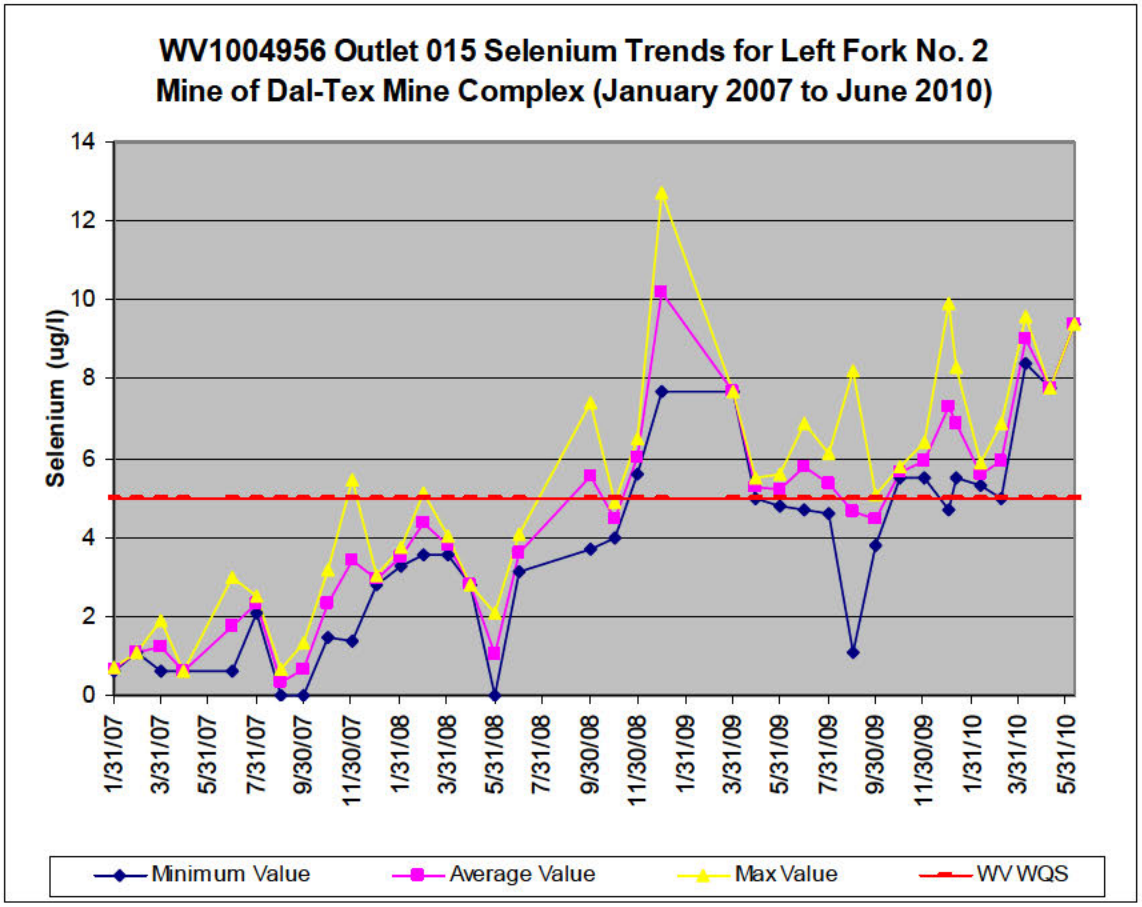


Figure 10: Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1004956 – Outlet 015 (Mingo Logan Coal Company's Left Fork No. 2 Mine of the Dal-Tex Mine Complex)

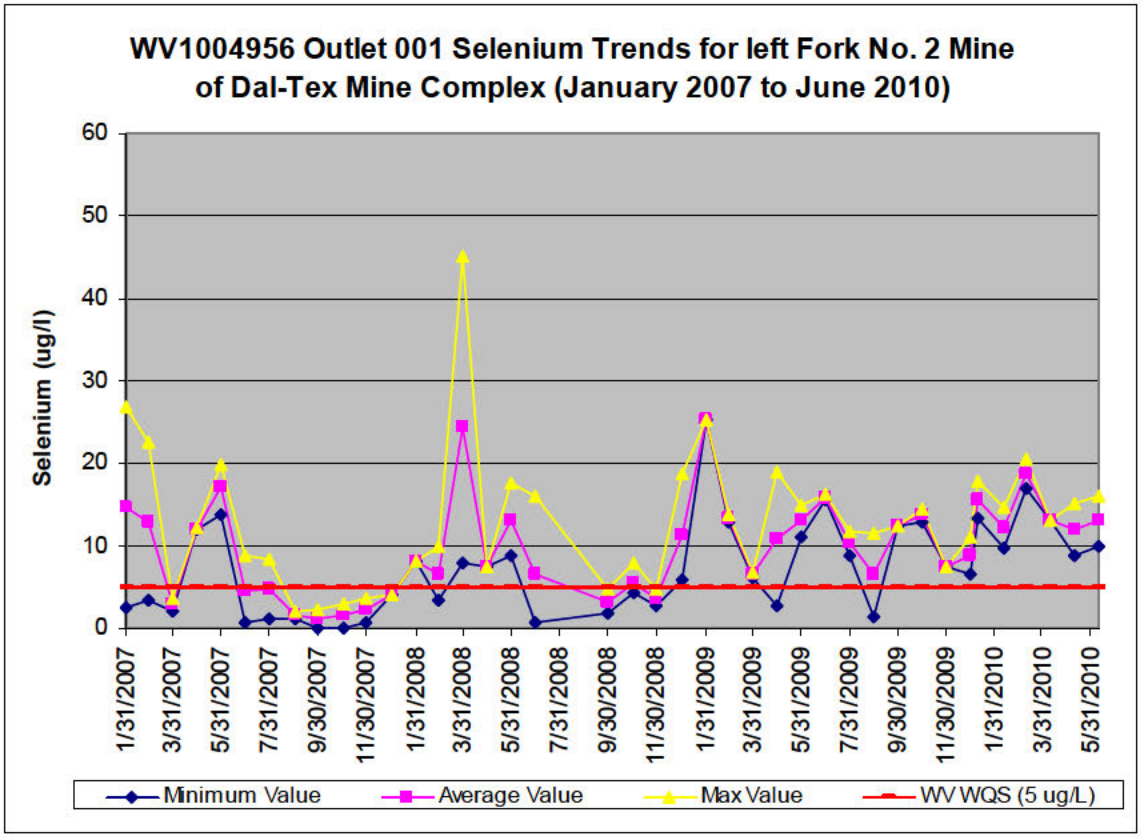


Figure 11: Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1004956 – Outlet 001 (Mingo Logan Coal Company's Left Fork No. 2 Mine of the Dal-Tex Mine Complex)

Region III also reviewed data from the portion of the Spruce No. 1 Mine that is already constructed in Seng Camp Creek (Figure 12). These data also indicate that construction of valley fills in Pigeonroost Branch and Oldhouse Branch would likely result in discharges of elevated levels of selenium. The Spruce No. 1 project has active mining in the Right Fork of the Seng Camp Creek sub-watershed. Recent NPDES DMRs for a 16 month period (December 2008 to March 2010) show that the constructed portion of the Spruce No. 1 project (Outlet 028) is discharging selenium at concentrations that exceed West Virginia's chronic numeric water quality criterion (Table 4).[12] A technical review of the submitted 16 monthly DMR records for the Spruce No. 1 Outlet 028 document the maximum values exceeded the chronic selenium water quality criteria of 5 µg/L on six occasions (December 2008, January 2009, August 2009, September 2009, February 2010, and March 2010) representing a 37.5% exceedence rate. In addition, the average monthly measurements during this same time frame for Outlet 028 exceeded the chronic water quality criterion on 4 of the 16 monthly DMR reports (December 2008, January 2009, September 2009, and March 2010) representing a 25% exceedance rate of the WV

[12] The July 2009 DMR was not provided for review.

chronic water quality criterion for selenium. Selenium concentrations in excess of the chronic criterion were also reported from Outlet 017.[13]

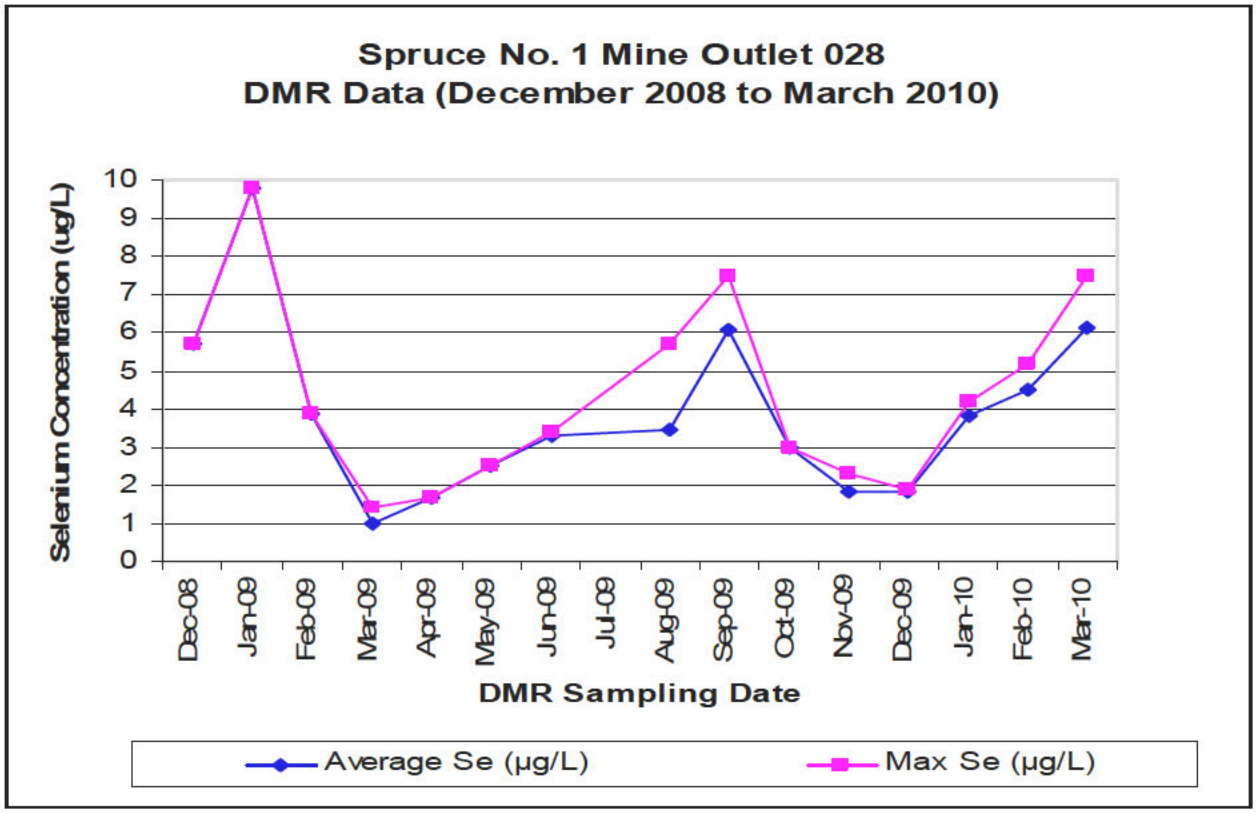


Figure 12: Selenium concentrations in discharge from outlet 028 on Spruce No. 1 Mine

[13] To the extent that commenters have stated that selenium discharges should be addressed only through the NPDES permit, the Section 404(b)(1) Guidelines provide an independent obligation to assure compliance with water quality standards (40 CFR 230.10(b)). Moreover, it is noted that the NPDES permit issued for the Spruce No. 1 project establishes effluent limitations for selenium in only three of the outfalls in the NPDES permit. The permit requires only monitoring at the remaining outfalls, including the outfalls in Seng Camp Creek discussed herein. To the extent the Company has commented that the impacts from the Dal-Tex operation are not a good predictor of selenium impacts from construction of Spruce No. 1 due to implementation of a materials handling plan at Spruce No. 1, it is noted that the materials plan as being implemented by Mingo Logan in the Seng Camp Creek watershed has not fully succeeded in preventing exceedance of the numeric water quality criterion for selenium at Outfalls 17 and 28. Moreover, the Arch corporate family, including Mingo Logan, has conceded that its efforts to control selenium at a number of its active surface coal mines in West Virginia have been unsuccessful. Arch's various subsidiaries recently have requested extensions of NPDES compliance schedules for selenium discharges at numerous facilities,further indicating challenges in meeting the WV chronic criterion.

Table 4. Total Recoverable Selenium (µg/L) for Outlets 015, 017 and 028 for NPDES Permit WV1017021, Mingo Logan Coal Company Spruce No. 1 Mine. Note: Shaded areas indicate exceedences of the selenium standard (5 µg/L).

Site Code	Site Location	Sample Date	Min Value	Ave. value	Max value
015	Outlet 015	12/31/2008	0.00	0.00	0.00
017	Outlet 017	12/31/2008	0.00	0.00	0.00
017	Outlet 017	9/30/2009	19.20	19.20	**19.20**
028	Outlet 028	12/31/2008	5.70	5.70	5.70
028	Outlet 028	1/31/2009	9.80	9.80	**9.80**
028	Outlet 028	2/28/2009	3.90	3.90	3.90
028	Outlet 028	3/31/2009	0.60	1.00	1.40
028	Outlet 028	4/30/2009	1.70	1.70	1.70
028	Outlet 028	5/31/2009	2.50	2.50	2.50
028	Outlet 028	6/30/2009	3.20	3.30	3.40
028	Outlet 028	8/31/2009	1.25	3.48	5.70
028	Outlet 028	9/30/2009	4.60	6.05	7.50
028	Outlet 028	10/31/2009	3.00	3.00	3.00
028	Outlet 028	11/30/2009	1.40	1.85	2.30
028	Outlet 028	12/31/2009	1.80	1.85	1.90
028	Outlet 028	1/31/2010	3.40	3.80	4.20
028	Outlet 028	2/28/2010	3.80	4.50	5.20
028	Outlet 028	3/31/2010	4.70	6.10	7.50

The Spruce Fork watershed upstream of Pigeonroost Branch and Oldhouse Branch has selenium concentrations elevated above the chronic water quality criterion based on the instream DMR data. See Appendix 2, Table 14. The downstream Spruce Fork (DSF) site does not have selenium concentrations above the water quality criterion. This suggests that Pigeonroost Branch and Oldhouse Branch provide clean dilution water to the mainstem of Spruce Fork (Appendix 2, Table 15). The proposed valley fills for Pigeonroost Branch and Oldhouse Branch will eliminate the freshwater dilution contributions from both of these tributaries. Based on the current during- and post-mining water quality conditions observed in Seng Camp Creek downstream of the Spruce No. 1 project, selenium values will likely also increase at both outlet points on Oldhouse and Pigeonroost Branch during and post-mining. The increased selenium concentrations combined with the elimination of the dilution from these two tributaries will likely cause the selenium concentrations in Spruce Fork to increase.

In summary, water quality from streams and discharges draining both the Dal-Tex Mine Complex and the current operational portions of the Spruce No. 1 Mine confirm EPA's concern that the Spruce No. 1 project would be likely to discharge levels of selenium exceeding the WV chronic water quality criterion for selenium (greater than 5 µg/l)

downstream of the filled streams and in Spruce Fork. [14] An important adverse impact of selenium residues in aquatic food chains is not just the direct toxicity to the organisms themselves, but rather the dietary source of selenium these organisms contribute to fish and wildlife species in the upper food web that feed on them.

b. Total Dissolved Solids/Conductivity

To understand the water quality impacts from increased total dissolved solids (TDS) and conductivity, it is helpful to understand the relationship between salinity, TDS, and specific conductivity, and the effect increases in conductivity have on native wildlife. For purposes of this action, when Region III discusses increased conductivity or TDS, we are referring to an increase in salinity in otherwise dilute freshwater, consistent with background levels in central Appalachian streams.

Salinity is the mass of salt in a given mass of water. While many of the elements that comprise mineral salts are essential nutrients, aquatic organisms are adapted to specific ranges of salinity and experience toxic effects from excess salinity.

Salinity reflects the amount of TDS in water. TDS is a measure of the combined content of all inorganic and organic substances contained in a solution in molecular, ionized or micro-granular (colloidal) suspended form and is normally reported in the units mg/l. The majority of TDS in many waters are simply salts.

Salinity is often expressed in terms of specific conductivity (hereafter referred to as conductivity). Conductivity is the ability of a solution to carry an electric current at a specific temperature (normally 25º C) and is normally reported in the units µS/cm (microsiemens per centimeter). Conductivity and TDS both increase as the concentration of ions in a solution increase and are very strongly correlated. Normally, conductivity is reported by state and federal monitoring agencies because it is an instantaneous measurement that can be collected in situ with a meter, that does not require a laboratory analysis, and that is precise and accurate. "Conductivity" refers to the measurement and resulting data; "salinity" refers to the environmental property that is being measured. Conductivity is an excellent indicator of the total concentration of all ions and is also a good predictor of aquatic life use impairment, especially in the ecoregion

[14] The concentrations of water column selenium observed at the Dal-Tex outlets and Seng Creek are significant in the fact that these concentrations have been associated with elevated fish tissue concentrations that are above the levels that cause teratogenic deformities in larval fish, leave fish with Se concentrations above the threshold for reproductive failure (4 ppm), and place birds at risk of reproductive failure through ingestion of fish with selenium concentrations greater than 7 ppm (Lemley 1997). According to the WVDEP's study on 'Selenium Bioaccumulation among select stream and lake fishes in West Virginia' (WVDEP 2009), Seng Camp had the highest average water column concentration (27.20 ppb) and a corresponding average fish tissue concentration of 8.16 ppm. While Beech Creek had a water concentration of 12.30 ppb with a corresponding average fish tissue concentration of 7.55 ppm. As outlined in the graphical trends of selenium concentrations from the DMR records for three permitted outlets for the Dal-Tex Mine Complex (WV1011120, WV1004956, WV1004956), these values are similar or greater than the Seng Camp and Beech Creek concentrations which supports our view that the corresponding fish tissue concentrations will be elevated to levels that cause fish and bird impairments.

69 in which the Spruce No. 1 project is located.

A recent study found that elevated conductivity greater than 500 µS/cm caused by alkaline mine effluents was strongly associated with high probability of degradation of native biota (Pond et al. 2008). In that study, 20 of 20 mined sites (100%) with conductivity levels greater than 500µS/cm reflected adverse impact to native macroinvertebrates using a genus-level multi-metric index, and 17 of those 20 sites (85%) reflected adverse impact to native macroinvertebrates using the family-level WVSCI index (using the less than 68 threshold). [15]

WVDEP ambient monitoring data confirm the high probability of adverse impact to aquatic life when conductivity levels are elevated to greater than 500µS/cm. WVDEP macroinvertebrate data from subecoregion 69d (the Cumberland Mountains of the Central Appalachians, the specific subecoregion where the project is located) were analyzed to determine the percentage of WVDEP sites that reflected adverse impact to aquatic life when the instream conductivity levels exceeded 500 µS/cm. This analysis indicates that a majority of the sites reflected adverse impact to aquatic life when conductivity levels were elevated above 500 µS/cm, even when accounting for the possible confounding effects of acidic pH and habitat degradation. For example, after removing low pH sites, only 100 sites out of 417 sites attained WVSCI scores greater than 68 when conductivity levels were greater than 500 µS/cm (76% of the sites reflected WVSCI scores less than 68). When the potential confounding effect of habitat degradation was completely removed (this subset includes only sites with Rapid Bioassessment Protocol habitat scores greater than 140, indicating reference quality habitat), 62% of the sites still had WVSCI scores less than 68. See Appendix 1 and 2 for further detail on macroinvertebrates and conductivity.

EPA's draft report, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (USEPA 2010a). also recognizes stream aquatic life impacts associated with conductivity. This study, which is publicly available and is undergoing external peer review by the EPA's Science Advisory Board, applies EPA's standard methodology for deriving water quality criteria to field data and concludes that genus-level macroinvertebrate impacts to the biological community occur at conductivity levels as low as 300 µS/cm.

Pond et al. 2008 showed that mayfly richness is significantly reduced to a few or zero genera, and that several stonefly and caddisfly taxa were also extirpated or reduced in abundance, when conductivity exceeds 500 µS/cm downstream of mining operations similar to Spruce No. 1. This mining-induced pattern was also documented in the eastern Kentucky coalfields (Pond 2010). Many mayfly, stonefly and caddisfly genera are extirpated from streams downstream of headwater valley fills, and this extirpation is strongly correlated to water quality degradation caused by mining. This extirpation is in

[15] As noted elsewhere, in its 2008 Section 303(d) List, WVDEP identified a WVSCI score of 68 as the lowest score at which a waterbody was considered to "fully support" aquatic life. Less than 68 indicates degradation of the aquatic life use.

addition to direct burial of these macroinvertebrates and other wildlife, as previously described. See Appendix 1 macroinvertebrates for further detail.

After evaluating confounding effects as described above, scientific evidence points to the conclusion that the extirpation of macroinvertebrate taxa documented in these studies is caused by water quality degradation and not habitat degradation. Conductivity is an excellent predictor of native taxa loss from Appalachian streams while habitat variables provide little ability to predict taxa loss. Using the WV spring null model applied to genus-level data from Pond et al. (2008), Observed/Expected (O/E) scores strongly responded negatively (R^2=0.63) to increasing conductivity. See Section V.B.2.a.ii. below for a further explanation of the Observed/Expected Index. Water quality degradation caused by elevated conductivity explained more than twice the variance in O/E scores than did RBP habitat scores (R^2=0.28), confirming that conductivity is an excellent predictor of native taxa loss from Appalachian streams. Sediment deposition, substrate embeddedness, channel alteration, riparian zone width, pH, or temperature had no significant influence on O/E scores. From this analysis it is apparent that habitat degradation offered little explanatory value in O/E variation in this dataset.[16]

Data from WVDEP indicate that average conductivity values for Pigeonroost Branch and Oldhouse Branch are very low and are consistent with dilute background conditions in central Appalachian headwater streams (Table 5). Construction of valley fills and other discharges from the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch would likely cause an increase in conductivity and TDS in receiving waters. This will have two effects: first, it will eliminate Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution to downstream waters, including Spruce Fork; and second, it will transform Pigeonroost Branch and Oldhouse Branch into sources of increased conductivity and TDS to downstream waters.

Construction of valley fills in the ecoregion in which the Spruce No. 1 Mine is located is strongly correlated with an increase in conductivity levels in downstream waters. Sedimentation ponds, which are the usual form of water treatment for surface coal mines, appear to be ineffective in removing TDS and decreasing conductivity. For example, average conductivity and sulfate levels are highly elevated in other tributaries to Spruce Fork where historical mining has occurred. Table 5 provides the following average conductivity and sulfate values for streams draining mined areas to the west of Spruce Fork in comparison with Pigeonroost Branch and Oldhouse Branch.

[16] Sites downstream of MTM in Pond et al. 2008 were located in relatively natural stream reaches in order to help control for obvious habitat effects

Table 5. Average conductivity and sulfate values for streams in project area		
Stream	**Conductivity Values**	**Sulfate Values**
Rockhouse Creek	1012 uS/cm conductivity	407 mg/l sulfate
Left Fork of Beech Creek	2426 uS/cm conductivity	1019 mg/l sulfate
Beech Creek	1432 uS/cm conductivity	557 mg/l sulfate
Trace Branch	971 uS/cm conductivity	569 mg/l sulfate
Oldhouse Branch	90 uS/cm conductivity	28 mg/l sulfate
Pigeonroost Branch	199 uS/cm conductivity	99 mg/l sulfate

Average conductivity and sulfate concentrations in the mainstem of Spruce Fork to which Pigeonroost Branch and Oldhouse Branch flow are also strongly elevated to as much as ten times above natural background levels in Oldhouse Branch. Average conductivity at almost every monitoring site on the mainstem Spruce Fork exceeded 500 µS/cm. Only one site had an average conductivity of less than 500 µS/cm, which was located upstream of the project area, upstream of Adkins Fork, and southeast of Blair, WV.

Pigeonroost Branch and Oldhouse Branch are providing freshwater dilution to Spruce Fork thereby preventing conductivity levels in Spruce Fork from becoming even more elevated. Construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch would remove sources of freshwater dilution to Spruce Fork and contribute to existing water quality degradation.

In addition to removing Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution for Spruce Fork, construction of valley fills and other discharges authorized by the permit into those waters also would likely transform Pigeonroost Branch and Oldhouse Branch into sources of elevated conductivity and TDS to downstream waters. As described in Section V.B.2.a. below, there is a strong correlation between elevated levels of conductivity and extirpation of macroinvertebrate taxa. Spruce Fork mainstem has little, if any, remaining assimilative capacity for conductivity.

Post-mining conductivity levels in Spruce Fork downstream of the project area were modeled using a watershed area weighted deterministic model with two post-mining average (500 and 1000 µS/cm) and maximum (1000 and 1500 µS/cm) conductivity values for Oldhouse Branch, Pigeonroost Branch and Seng Camp Creek. These values are conservative and likely underestimate the post-mining conductivity values. For example, when compared to Left Fork Beech Creek, which is completely mined and filled, the average and maximum conductivity values are 2425 and 3000 µS/cm. In Beech Creek, which is partially mined and filled, the average and maximum conductivity values are 1432 and 1776 µS/cm (average and maximum values based on 2002-2003 WVDEP data). In every case, since the measured average and maximum conductivity levels in Spruce Fork are currently greater than 500 µS/cm pre-mining, the modeled post-mining conductivity values are also greater than 500 µS/cm. Using the more conservative post-mining values (average 500 and 1000 µS/cm and maximum 1000 and

1500 µS/cm), we estimate that average conductivity in Spruce Fork downstream of Seng Camp Branch could increase from 555 pre-mining to 745 µS/cm post-mining and maximum conductivity could increase from 965 pre-mining to 1226 µS/cm post-mining. EPA expects that these additional conductivity increases would likely further extirpate native aquatic macroinvertebrates (wildlife) that are not tolerant to increased conductivity. See Appendix 2 for further detail on conductivity.

2. Impacts to Wildlife

a. Macroinvertebrates

As set forth in Sections IV A.1 and I.B.1 above, benthic macroinvertebrates are diverse and healthy in the Spruce No. 1 project area and represent an important component of the aquatic community in Pigeonroost Branch and Oldhouse Branch. Furthermore, because of their productivity and secondary position in the aquatic food chain, they also play a critical role in the delivery of energy and nutrients to downstream reaches (in aquatic life stages) as well as to upland terrestrial habitats (in winged adult life stages).

Construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will impact the native macroinvertebrate community in two ways. First, the macroinvertebrates that live in stream channels within the footprint of the valley fill will be destroyed. As set forth in Section V.C. below, it is not likely that the on-site stream creation proposed by the permittee as mitigation would support the quality of macroinvertebrate community that currently exists in Pigeonroost Branch and Oldhouse Branch. Second, construction of valley fills and other authorized discharges into Pigeonroost Branch and Oldhouse Branch would likely have an adverse impact on the macroinvertebrate communities in remaining downstream waters. Sensitive species of mayflies, stoneflies, and caddisflies currently inhabiting downstream waters will be impacted through increasing chemical loading of contaminants.

As set forth above, the 2006 Spruce No. 1 EIS states that impacts from the Spruce No. 1 Mine are expected to be similar to those from the Dal-Tex operation. Accordingly, conditions in streams impacted by the Dal-Tex operation will likely occur in the unfilled portions of the streams that will be impacted by the Spruce No. 1 Mine. To evaluate the impacts from the Spruce No. 1 Mine, Region III analyzed conditions in streams impacted by the Dal-Tex operation. Region III conducted three different analyses. First, Region III compared benthic macroinvertebrate collections from Pigeonroost Branch and Oldhouse Branch to benthic macroinvertebrate samples from streams that have been impacted by Mingo Logan's Dal-Tex operation. Second, Region III used an observed/expected approach. Third, Region III compared WVSCI scores in Pigeonroost Branch and Oldhouse Branch with streams impacted by the Dal-Tex operation. The following describes these three analyses.

i. Comparison of macroinvertebrate communities

To evaluate the impact of the project, EPA compared benthic collections from the Spruce No. 1 project area to Mingo Logan's Dal-Tex site (Table 1), using an equal number of

benthic samples collected at both locations. This analysis reveals that construction of valley fills and and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch would likely result in degraded macroinvertebrate communities downstream of these discharges.

Considering the number of genera collected, the relatively unimpacted Pigeonroost Branch and Oldhouse Branch contain a far greater number and diversity of macroinvertebrate genera. Collectively, 85 different genera were collected from Pigeonroost Branch and Oldhouse Branch between 1999-2000, while only 56 different genera were collected from both Beech Fork and Left Fork Beech Fork, streams that drain the inactive Dal-Tex operations.

Region III further refined its analysis to a comparison of the Ephemeroptera, Plecoptera and Trichoptera (EPT: mayflies, stoneflies and caddisflies) taxa collected. In Pigeonroost and Oldhouse combined, 42 EPT taxa were collected, while at Dal-Tex (Beech and Left Fork Beech), only 12 EPT were found. Narrowing further to mayflies and stoneflies, there were 14 mayfly genera and 12 stonefly genera in Oldhouse Branch and Pigeonroost Branch but only two relatively pollution-tolerant mayfly genera and three pollution-tolerant stonefly genera were collected in streams draining the Dal-Tex mine.. EPA also found that caddisflies were rich (14 total genera) in Pigeonroost and Oldhouse, but only seven total genera were found in Beech and Left Fork Beech downstream of the Dal-Tex mine.

As set forth above in Section IV.A., macroinvertebrates are good indicators of watershed health, and differ in their tolerance to the amount and types of pollution. Macroinvertebrate communities integrate the effects of stressors over time and some taxa (i.e., taxonomic category or group such as phylum, class, family, genus, or species) are considered pollution-tolerant and will survive in degraded conditions. Some taxa are pollutant-intolerant and will die when exposed to certain levels of pollution. Thus, the composition of tolerant and intolerant (i.e., sensitive) communities informs scientists about the quality of the water. The presence of a large number of individuals from the more sensitive genera indicates good water quality conditions, whereas the presence of a large number of tolerant genera may indicate degraded conditions.

The data described above indicates a substantial reduction in taxa diversity in the mine-impacted waters. In addition, several tolerant taxa were found in the streams draining the Dal-Tex mine that were not found in the Spruce project area further indicating degradation and adverse impact to wildlife habitat (Table 1). Some of these taxa are highly tolerant snails that typically do not occupy healthy headwater streams in the Appalachians (Lymnaeidae*, Physella, Helisoma*). Other tolerant beetles and fly larvae found at Dal-Tex but not Pigeonroost or Oldhouse also indicate biological impacts and altered environmental conditions (i.e., atypical of Appalachian headwater streams) that foster the invasion of these tolerant taxa. Table 6 compares the macroinvertebrate taxa identified in Oldhouse Branch and Pigeonroost Branch with that found in streams that have been impacted by the Dal-Tex Mine.

Table 6. List of macroinvertebrate taxa identified from Spruce project and Dal-Tex.

Order	Family	Genus	Oldhouse +Pigeonroost Spruce No. 1	Beech+Left Fork Beech Dal-Tex Mine
Oligochaeta	Oligochaeta	Oligochaeta	X	X
Nematoda	Nematoda	Nematoda		X
Proseriataoela	Plagiostomidae	*Hydrolimax*	X	
Tricladida	Planariidae	Planariidae	X	
Basommatophora	Lymnaeidae	Lymnaeidae		X
Basommatophora	Physidae	Physella		X
Basommatophora	Planorbidae	*Helisoma*		X
Coleoptera	Dryopidae	*Helichus*	X	
Coleoptera	Elmidae	*Dubiraphia*		X
Coleoptera	Elmidae	*Macronychus*		X
Coleoptera	Elmidae	*Microcylloepus*		X
Coleoptera	Elmidae	*Optioservus*	X	X
Coleoptera	Elmidae	*Oulimnius*	X	X
Coleoptera	Psephenidae	*Ectopria*	X	
Coleoptera	Psephenidae	*Psephenus*	X	X
Decapoda	Cambaridae	*Cambarus*	X	
Diptera	Ceratopogonidae	*Atrichopogon*		X
Diptera	Ceratopogonidae	*Bezzia/Palpomyia*	X	X
Diptera	Ceratopogonidae	*Dasyhelea*	X	X
Diptera	Chironomidae	*Acricotopus*		X
Diptera	Chironomidae	*Chaetocladius*	X	X
Diptera	Chironomidae	*Corynoneura*	X	X
Diptera	Chironomidae	*Cricotopus*	X	X
Diptera	Chironomidae	*Diamesa*	X	X
Diptera	Chironomidae	*Eukiefferiella*	X	X
Diptera	Chironomidae	*Metriocnemus*		X
Diptera	Chironomidae	*Micropsectra*	X	X
Diptera	Chironomidae	*Microtendipes*	X	
Diptera	Chironomidae	*Orthocladius*	X	X
Diptera	Chironomidae	*Parachaetocladius*	X	
Diptera	Chironomidae	*Parametriocnemus*	X	X
Diptera	Chironomidae	*Paraphaenocladius*		X
Diptera	Chironomidae	*Paratanytarsus*		X
Diptera	Chironomidae	*Polypedilum*	X	X
Diptera	Chironomidae	*Rheotanytarsus*	X	X
Diptera	Chironomidae	*Smittia*		X
Diptera	Chironomidae	*Stempellinella*	X	
Diptera	Chironomidae	*Stenochironomus*		X
Diptera	Chironomidae	*Stilocladius*	X	
Diptera	Chironomidae	*Sympotthastia*	X	
Diptera	Chironomidae	*Tanytarsus*	X	
Diptera	Chironomidae	*Thienemanniella*		X
Diptera	Chironomidae	*Thienemannimyia*	X	X
Diptera	Chironomidae	*Tvetenia*	X	X
Diptera	Chironomidae	*Zavrelimyia*	X	
Diptera	Empididae	*Chelifera/Metachela*	X	X
Diptera	Empididae	*Clinocera*	X	
Diptera	Empididae	*Hemerodromia*		X
Diptera	Simuliidae	*Prosimulium*	X	
Diptera	Simuliidae	*Simulium*	X	X
Diptera	Tabanidae	Tabanidae		X
Diptera	Tipulidae	*Antocha*		X
Diptera	Tipulidae	*Cryptolabis*	X	
Diptera	Tipulidae	*Dicranota*	X	
Diptera	Tipulidae	*Hexatoma*	X	

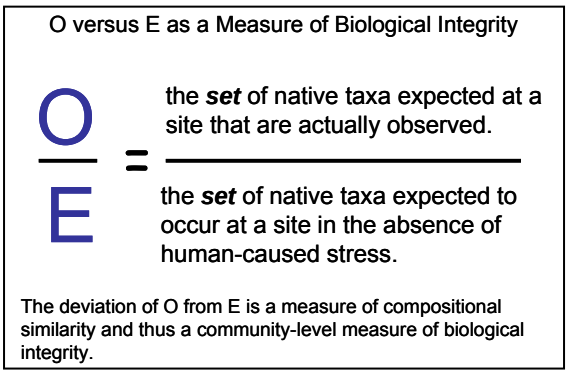
Table 6. Continued.

Continued			Oldhouse +Pigeonroost	Beech+Left Fork Beech
Order	Family	Genus	Spruce No. 1	Dal-Tex Mine
Diptera	Tipulidae	*Limnophila*	X	
Diptera	Tipulidae	*Limonia*	X	X
Diptera	Tipulidae	*Pseudolimnophila*	X	
Diptera	Tipulidae	*Tipula*	X	X
Ephemeroptera	Ameletidae	*Ameletus*	X	
Ephemeroptera	Baetidae	*Acentrella*	X	
Ephemeroptera	Baetidae	*Baetis*	X	X
Ephemeroptera	Baetiscidae	*Baetisca*	X	
Ephemeroptera	Ephemerellidae	*Drunella*	X	
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	
Ephemeroptera	Ephemerellidae	*Eurylophella*	X	
Ephemeroptera	Ephemeridae	*Ephemera*	X	
Ephemeroptera	Heptageniidae	*Cinygmula*	X	
Ephemeroptera	Heptageniidae	*Epeorus*	X	
Ephemeroptera	Heptageniidae	*Stenacron*	X	
Ephemeroptera	Heptageniidae	*Maccaffertium/Stenonema*	X	
Ephemeroptera	Isonychiidae	*Isonychia*	X	X
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	X	
Megaloptera	Corydalidae	*Corydalus*		X
Megaloptera	Corydalidae	*Nigronia*	X	X
Odonata	Aeshnidae	*Boyeria*		X
Odonata	Gomphidae	*Lanthus*	X	X
Plecoptera	Capniidae	Capniidae	X	
Plecoptera	Chloroperlidae	*Haploperla*	X	
Plecoptera	Leuctridae	*Leuctra*	X	
Plecoptera	Nemouridae	*Amphinemura*	X	X
Plecoptera	Nemouridae	*Ostrocerca*	X	
Plecoptera	Nemouridae	*Prostoia*		X
Plecoptera	Peltoperlidae	*Peltoperla*	X	
Plecoptera	Perlidae	*Acroneuria*	X	
Plecoptera	Perlodidae	*Isoperla*	X	
Plecoptera	Perlodidae	*Remenus*	X	
Plecoptera	Perlodidae	*Yugus*	X	
Plecoptera	Pteronarcyidae	*Pteronarcys*	X	
Plecoptera	Taeniopterygidae	*Taenionema*	X	
Plecoptera	Taeniopterygidae	*Taeniopteryx*	X	X
Trichoptera	Glossosomatidae	*Agapetus*	X	
Trichoptera	Glossosomatidae	*Glossosoma*	X	
Trichoptera	Goeridae	*Goera*	X	
Trichoptera	Hydropsychidae	*Ceratopsyche*	X	
Trichoptera	Hydropsychidae	*Cheumatopsyche*	X	X
Trichoptera	Hydropsychidae	*Diplectrona*	X	X
Trichoptera	Hydropsychidae	*Hydropsyche*	X	X
Trichoptera	Hydroptilidae	*Hydroptila*		X
Trichoptera	Limnephilidae	*Pycnopsyche/Hydatophylax*	X	
Trichoptera	Philopotamidae	*Chimarra*	X	X
Trichoptera	Philopotamidae	*Dolophilodes*	X	
Trichoptera	Polycentropodidae	*Polycentropus*	X	
Trichoptera	Psychomyiidae	*Psychomyia*	X	X
Trichoptera	Rhyacophilidae	*Rhyacophila*	X	X
Trichoptera	Uenoidae	*Neophylax*	X	
Tricladida	Planariidae	Planariidae	X	
		Total Distinct Taxa	85	56
		Total EPT Taxa	42	12

ii. Observed/Expected Index

In order to further predict and quantify the loss of taxa expected from construction of valley fills in Pigeonroost Branch and Oldhouse Branch as authorized, Region III applied a well-accepted and peer reviewed approach, called an Observed/Expected index (O/E) (Hawkins 2006, Van Sickle 2005) (Figure 13). O/E ratios basically represent the proportion of predicted taxa that were observed in a sample, compared to those expected in the sample, after predicting the probability that a sample site is a member of one or more fixed sets of reference site types.

Figure 13. Measure of biological integrity; O vs. E (C.P. Hawkins, Utah State Univ.).



Rather than using several reference site types, null models can be developed that assume only one set of comparable reference sites. Null models are appropriate when working in areas with relatively similar physical and regional characteristics that may have influence on the macroinvertebrate community (e.g., geology, stream slope, natural substrate, season and climate), as is the case in this application. For the WV null models, EPA first calculated the probability of capture (Pc) as the proportion of a taxon's occurrence in spring and summer at all mountain reference sites (combined ecoregions 67, Ridge and Valley, and ecoregion 69, Central Appalachians). For example, the stonefly *Leuctra* was present at 94% of mountain reference sites in spring, so its Pc value for spring is 0.94. EPA conducted this probability calculation for all non-chironomid taxa. The Pc's of all taxa with a Pc greater than 0.1 were then summed to yield the *Expected* number of taxa at a site for the given season (Table 7). Therefore, the *Expected* total number of taxa at a mountain site in spring is 20.4 and in summer is 18.7.

A site that is a perfect match to the richness of expected indigenous taxa will score 1.0, while downward deviation from 1.0 indicates increasing loss of expected taxa compared to regional reference (e.g., a score of 0.50 indicates a 50% loss of the expected taxa). Upward deviation (greater than 1.0) simply indicates that more taxa were collected than expected. (When a taxon is observed at a test site, that taxon is counted as 1 for the observed score, so if the Pc is less than 1 for that taxon, this can lead to O/E scores

greater than 1. For example, for the stonefly *Leuctra*, the Pc of capture is 0.94, so its tally for E is only 0.94, but if the taxa is observed at a site, its tally for O is 1.

We chose the 5th percentile of reference site O/E scores as a threshold to correspond to WVDEP's bioassessment threshold for assessing aquatic life support. This O/E 5th percentile was 0.64, indicating a loss of 36% of expected taxa.

The WV null model indicates that macroinvertebrate assemblages in Pigeonroost Branch, Oldhouse Branch and the upstream White Oak Branch are comparable to WVDEP mountain ecoregion reference sites and that there is adverse impact (O/E less than 0.64) to streams receiving drainage from MTM/VF operations in WV, including streams adjacent to the Spruce mine area (Tables 3 and 4). The highest O/E scores (1.18) were in Pigeonroost, Oldhouse and White Oak Branches. The lowest O/E scores (0.20) were in Beech and Left Fork of Beech Creek, both of which have been impacted by mining operations.

The model indicates that macroinvertebrate assemblages in Pigeonroost Branch and Oldhouse Branch are comparable to WVDEP mountain ecoregion reference sites. In contrast, past mining by Mingo Logan has led to the estimated extirpation of ~70% of the native expected taxa in their adjacent Dal-Tex mine operation (Table 7). It is highly likely that conditions in the unfilled portions of Pigeonroost Branch and Oldhouse Branch will follow this pattern of genus-level extirpation if valley fills are constructed in those waters as currently authorized. See Appendix 1 for for more details on O/E. and model development.

Table 7. Summary of WV O/E null model results for the Spruce No. 1 Project area. The biological impairment threshold is 0.64 (corresponding to the 5th percentile of WVDEP reference site distributions). An O/E score of ~1.0 means that the number of Observed native taxa is equivalent to the Expected number of native taxa. SD = standard deviation.

Table 7			
		Mean (SD) O/E	
	Spruce No. 1	**Dal-Tex**	
	Pigeonroost,Oldhouse, White Oak	Beech, LF Beech	Rockhouse
Spring	0.98 (0.20); n=9	0.26 (0.06);n=5	0.31 (0.10); n=3
Summer	0.85 (0.15); n=2	0.32 (0.08); n=2	0.38 (0.08); n=2
● Adjacent mined sites include LF Beech, Beech, and Rockhouse			
● The highest O/E scores were recorded in Pigeonroost, Oldhouse, and White Oak (each scored 1.18)			
● The lowest O/E scores were recorded in Beech and LF Beech on Dal-Tex (each scored 0.20)			
Based on WVDEP Mountain reference sites, on average:			
● Spruce No. 1 samples are missing ~2% of expected taxa in Spring, and ~15% in Summer			
● Dal-Tex sites are missing ~74% of expected taxa in Spring, and ~68% in Summer.[17]			
● SD for Spruce No. 1 streams had similar or better precision (SD) to the WVDEP reference model			
● SD for Dal-Tex was very low indicating that all observations consistently show missing taxa			

iii. Comparison of WVSCI scores

States routinely use macroinvertebrate assemblage data to assess compliance with their narrative water quality standards and to determine support of aquatic life. For the past several cycles of Section 303(d) lists of impaired waters, WVDEP has used a family-level multi metric index called the WV Stream Condition Index or WVSCI. The WVSCI uses six (6) component metrics to summarize and analyze family-level macroinvertebrate taxa lists. The six metrics are total number of EPT (Ephemeroptera, Plecoptera and Trichoptera or maflies, stoneflies and caddisflies) taxa, total number of taxa, percent of organisms that are EPT, percent of organisms that are Chironomidae (midges), the percent of organisms in the top two dominant taxa, and the Hilsenhoff Biotic Index. All metrics are computed at the family-level with a 200 fixed count subsample. The metrics are scored against Best Standard Values (BSVs) for the entire dataset, as a percent of the BSV and normalized to a score of 100. The average of all six metrics makes up the final WVSCI score. Simply put, the lower the score, the more degraded the macroinvertebrate assemblage. For more information on the WVSCI, go to http://www.wvdep.org/Docs/536_WV-Index.pdf.

[17] Based on EPA data (Pond et al. 2008), all mined sites lost 47% of expected taxa, on average.

Examination of the West Virginia dataset has shown that the family-level metrics used by WVDEP generally underestimate degradation of the macroinvertebrate community impairment of aquatic life uses as compared to more sensitive genus-level indices due to the coarse level of taxonomy. Despite this lower sensitivity, bioassessments using WVSCI have documented adverse impacts to aquatic life due to mining in streams on mined sites near the project area

EPA sampled several streams within the Spruce Fork watershed for the Mountaintop Mining/Valley Fill Programmatic Environmental Impact Study (PEIS) (Green et al. 2000; Bryant et al. 2002). These assessments indicate that the unmined streams within and near the project area, including White Oak Branch, Oldhouse Branch and Pigeonroost Branch were high quality streams that fully support the aquatic life use, based on the family-level WVSCI and water quality data (see Appendix 1 and 2). The streams located in the historically MTM/VF mined areas located nearby (Rockhouse Branch, Beech Creek, and the Left Fork of Beech Creek) had WVSCI scores that would indicate they did not fully support aquatic life. These EPA data indicate that the aquatic life in streams on the project area (i.e., Oldhouse Branch and Pigeonroost Branch) would be likely degraded to the conditions exhibited in the Beech Creek and Rockhouse sub-watersheds after they are mined.

WVDEP data and assessments confirm that the aquatic life is adversely impacted not only in the nearby mined streams, but further downstream, on the mainstem of Spruce Fork, Pond Fork and the Little Coal River (see Appendix 1). The adverse impacts in the mainstem of Spruce Fork, Pond Fork, and the Little Coal are likely due to a combination of stressors, including mining and residential stressors. (WVDEP 1997).

Construction of valley fills, sediment ponds, and other discharges into Pigeonroost Branch and Oldhouse Branch as authorized by the DA Permit No. would be likely to export additional contaminants (conductivity) to Spruce Fork. Due to the sensitivity of native macroinvertebrate wildlife to elevated and increasing levels of conductivity, these contaminants are likely to hinder the maintenance or recovery of these biological communities.

b. Salamanders

As stated above, the ecoregion where the Spruce No. 1 project is located has one of the richest salamander fauna in the world. Impacts from the activities authorized as part of the project will have a significant adverse impact on this wildlife group located within the project area. Based on literature values (Williams 2002) for mean densities within reference reaches of Pigeonroost Branch, Bend Branch (another tributary of Spruce Fork), and Ash Fork (a tributary of Gauley River) and a 2004 USFWS study in White Oak Branch, EPA estimates aquatic salamander density in Pigeonroost Branch and Oldhouse Branch at ~5-6 per square meter along stream channels. Approximately seven acres of stream channel would be filled in Pigeonroost Branch and Oldhouse Branch by the project as currently authorized which means that more than 200,000 stream-dwelling

salamanders would be buried by the currently authorized valley fills. It is not expected that stream salamanders will return to the site due to the burial of their existing habitat and the inadequacy of proposed mitigation to replace the habitat required by these wildlife. Gingerich (2009) found no expected stream salamanders inhabiting 3-20 yrs old sediment ditches (5 out of 5 mines) on West Virginia MTM areas. Furthermore the USFWS has indicated that, to its knowledge, it has not been demonstrated that salamanders return to surface-mined areas and achieve densities similar to those that occurred prior to mining.

Since salamanders represent the main vertebrate predator in these headwater streams, and will be eradicated under the project, EPA believes that a key component of the aquatic food web would be likely to be lost from the aquatic ecosystem within Pigeonroost Branch and Oldhouse Branch portions of the Spruce No. 1 mine area.

According to the USFWS, adverse impacts to salamanders as a result of construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will not be localized to the area to be filled. Because construction of the valley fills and other discharges are very likely to increase conductivity and selenium levels in the downstream receiving waters (See Section V.B.1 above), salamanders that are not directly buried and killed beneath the fills are also likely to be impacted; directly via exposure to these contaminants and perhaps indirectly via impacts of contaminants on food sources. (Patnode, et al. 2005) Such impacts are likely to occur as far downstream as elevated conductivity, selenium or other contaminants persist, and to affect any salamanders that spend some part of their life in the aquatic environment or in immediately adjacent riparian terrestrial habitats. These impacts would likely be exacerbated by the loss of fresh water dilution from Pigeonroost and Old House Branch.

USFWS also indicated that while range-wide populations of common species may not be significantly impacted, the salamander communities in individual headwater systems behave essentially as isolated populations because there is limited interaction (immigration and emigration) with communities in adjacent watersheds (Dr. Thomas Pauley, Marshall University and personal communication with Jim Zelenak USFWS WV Field Office). Therefore, the populations within the watersheds that will be impacted by fill (the footprints of the valley fills and the downstream toxicity in the form of elevated conductivity, selenium, and potentially other contaminants), and are very likely to be significantly impacted.

Furthermore, as set forth in Section V.B.2.c.i. below, construction of valley fills and other discharges into Pigeonroost Branch and Oldhouse Branch has the potential to contribute to conditions that would support blooms of golden algae *(Prymnesium parvum)*, which can produce a toxin that is highly toxic to aquatic life and was associated with an extensive aquatic life kill of both fish and lungless salamanders in Dunkard Creek in West Virginia in September 2009.

c. Fish

As described in Section IV.B.3. above, the fish assemblages in Pigeonroost Branch and Oldhouse Branch are typical of headwater streams, containing only a few species. The fish assemblages in Spruce Fork are in relatively good condition. While some studies have documented adverse impacts to fish communities associated with surface coal mining, based on the fish community in Spruce Fork downstream of the Dal-Tex operation, it appears that the fish within Spruce Fork are fairly tolerant of increases in conductivity and total dissolved solids. Nevertheless, increases in conductivity and total dissolved solids and construction of sediment ponds associated with valley fills authorized in Pigeonroost Branch and Oldhouse Branch will create conditions considered favorable to the growth of golden algae (*Prymnesium parvum)*, which has caused large aquatic life kills. Fish also would be likely to be exposed to increases in selenium concentrations, which could lead to bioaccumulation in fish tissues and to reproductive effects (see Section V.B.1.a. above). Because of the potential to promote the growth of golden algae and because of the likely increased exposure to selenium, Region III concludes that construction of valley fills in Pigeonroost Branch and Oldhouse Branch would be likely to have an adverse effect on the fish population in those waters and in Spruce Fork.

i. Potential to promote growth of golden algae

Construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch as currently authorized are likely to contribute to instream conditions in or near Spruce Fork that may support the growth of golden algae (*Prymnesium parvum),* which releases toxins that kill fish and other gill-breathing aquatic organisms. *P. parvum* is a haptophyte (flagellated) algae now distributed worldwide. This algae has been known to North America since the 1980's (Baker et al., 2007) and has since become established in many Texas and Oklahoma rivers and reservoirs. *P. parvum* is responsible for Harmful Algal Blooms (HAB's) that have killed millions of fish in Texas and Oklahoma, and has been implicated in kills from North Carolina to Arizona.

P. parvum has also been associated with an extensive and severe aquatic life kill, which destroyed thousands of fish, mussels and other aquatic life in Dunkard Creek, West Virginia and Pennsylvania in September 2009. At the time of the Dunkard Creek aquatic life kill, biologists reported observations of thousands of dead fish, mussels and salamanders. Mud puppies (an aquatic salamander that lives its entire life underwater) crawled out of the water and onto rocks and the shoreline in an attempt to escape from the toxic water. Field biologists observed numerous individuals as dried up carcasses on rocks and along the shoreline. Fish were observed avoiding the mainstem of Dunkard Creek by practically "stacking –up" in the mouths of tributaries, subjecting themselves to feeding by blue heron rather than remaining in the toxic water of mainstem Dunkard Creek. The identification of *P. parvum* in 2009 in Dunkard Creek was the first identification of this invasive aquatic species in the Mid-Atlantic States.

The factors that are most closely associated with supporting growth of *P. parvum* are believed to be:

1. Proximity to a known source of *Prymnesium parvum*.
2. TDS in high enough amounts to support *P. parvum* (estimated to be between 500 and 1000 mg/L (conductivity 714-1428 µS/cm).
3. Nutrients of great enough amount to initiate a bloom of *P. parvum*
4. pH greater than 6.5. Risk increases with increasing pH.

Areas of habitat that are pooled (large beaver dams, natural residual pools, or manmade ponds)

EPA believes that the Spruce No. 1 project is likely to increase the likelihood that all five factors are met within the Spruce Fork sub-watershed, as outlined below.

1) Proximity to Known Source: P. parvum was identified (in very high numbers) in Cabin Creek of the Kanawha drainage, only 25 miles over the ridge to the East. Because this algae can easily move with waterfowl, the risk of introducing *P. parvum* in the Spruce Fork drainage is high.

Although not currently found in Spruce Fork, WVDEP has identified Spruce Fork as a "water of concern" because of its potential (due to already high levels of TDS/conductivity) to support *P. parvum* blooms consistent with the factors shown above.

2) *High TDS:* The lower TDS limits for the growth of *P. parvum* appears to be ~500 mg/l TDS, or ~700µS/cm conductivity for the ion mixtures typical of alkaline mine drainage. Recent data indicate that growth of *P. parvum* increases 2-3 fold when conductivity increases from 500 µS/cm to 1000 µS/cm (unpublished data, WVDEP, 2010). The waters draining the nearby Dal-Tex Mine operation have conductivity levels greater than these values. Many of the sampling sites on the mainstem of Spruce Fork, Pond Fork and the Little Coal River also have conductivity levels exceeding these endpoints. Other waters of concern near the Spruce No. 1 project include the Little Coal River and West Fork/Pond Fork

As described in SectionV.A, construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch would be likely to increase levels of TDS/conductivity in Spruce Fork, thus creating conditions more favorable to *P. parvum*.

In addition, DA Permit No. 199800436-3 (Section 10: Coal River) authorizes construction of numerous sedimentation ponds in Pigeonroost Branch and Oldhouse Branch. These will create areas of pooled habitat more favorable to *P. parvum.* During low flows, when conductivity is highest, flow is lowest, increasing the possibility that blooms could occur in very slow moving residual pools within the channel.

3) *Suitable Nutrient Levels:* Nutrients in the Spruce Fork are of similar availability to Dunkard Creek and other watersheds with *P. parvum* algae present (e.g. Whitely Creek, PA). Phosphorous in Spruce Fork was over 100 µg/L on two sampling occasions during the PEIS.

4) *High pH:* Discharges from Spruce No. 1 are likely to be alkaline, consistent with pH of discharges from Dal-Tex and other operations, etc. etc.

5) *Existence of Pooled Habitats*: Pooled habitats with little to no flow are common in streams like Spruce Fork in low flow conditions of September and October, when TDS is highest.

ii. Increased exposure to selenium

As set forth in Section V.B.1.a, construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch would be likely to result in elevated levels of selenium in receiving waters. While selenium is a naturally occurring chemical element that is an essential micronutrient, excessive amounts of selenium can also have toxic effects on fish. Selenium toxicity is primarily manifested as reproductive impairment and birth defects due to maternal transfer, resulting in embryotoxicity and teratogenicity in egglaying vertebrates (e.g. fish and ducks). The most sensitive toxicity endpoints in fish larvae are teratogenic deformities such as skeletal, craniofacial, and fin deformities, and various forms of edema. Embryo mortality and severe development abnormalities can result in impaired recruitment of individuals into populations (Chapman et al. 2009). A WV draft study indicates that elevated selenium concentrations in fish eggs, increased larval deformity rates and increased deformity rates in mature fish are occurring in the Mud River Reservoir, Boone County, WV due to mining activities. These adverse conditions were all associated with elevated water column selenium concentrations (WVDEP, 2009, draft).

In summary, construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch would likely result in increased instream levels of selenium that can have toxic effects on fish.

iii. Other potential impacts to fish

A number of studies have documented adverse impacts to fish communities associated with surface coal mining. It is important to consider basin size when assessing the potential effects of valley fills because small streams (less than10 km^2) have shown effects to the fish assemblage while larger streams have not (e.g., Fulk et al. 2003). As noted by Fulk et al. (2003) using fish indices like the Mid-Atlantic Highlands Index of Biotic Integrity (MAHA IBI) of McCormick et al. (2001) is problematic in small streams that are species depauperate (limited diversity) because the index is greatly affected by the addition or subtraction of one or two individuals of a different species. Nevertheless, Fulk et al. did analyze small streams in their report and found significant differences in

total IBI scores between mined and unmined streams. This difference was attributed to changes in cyprinid species richness and the percent of the assemblage composed of benthic invertivores. There was no significant difference in percent cottids (sculpin).

Some studies have shown that mountaintop mining for coal and construction of valley fills has had a harmful effect on the composition of stream fish communities (Fulk et al., 2003, Stauffer and Ferreri, 2002). Comparison of streams without mining in the watershed and sites downstream of valley fills in Kentucky and West Virginia indicate that streams affected by mining had significantly fewer total fish species and fewer benthic fish species than streams without mining in the same areas (Stauffer and Ferreri, 2002).

Fulk et al. (2003) used the Mid-Atlantic Highlands Index of Biotic Integrity (IBI - a multi-metric index used to assess biotic health) to analyze fish data from 27 streams in West Virginia. In their study, Fulk et al. (2003) classified streams (no mining in the watershed, mountaintop mining in the watershed, sites downstream of valley fills, and sites with both mining and residential development in the watershed) and compared fish assemblage health among stream classes. The study showed that assessment scores from the sites downstream of valley fills were significantly lower than scores from sites without mining in the watershed, indicating that fish communities were degraded in sites downstream of valley fills. Sites with residences in addition to mining, however, scored similarly to the unmined sites.

Sites that were sampled in Spruce Fork for the PEIS were classified as "filled with residences." Sampling data in the Spruce Fork sub-watershed downstream of the Dal-Tex operation scores similarly to filled residential sites in the PEIS, There is no difference between filled residential sites and unmined sites in the PEIS.

In summary, there remains the potential that construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch have the potential to promote the growth of golden algae and increase exposure to selenium. For these reasons, Region III concludes that construction of valley fills and other discharges authorized into Pigeonroost Branch and Oldhouse Branch would be likely to have an adverse effect on the fish population in those waters and in Spruce Fork.

d. Water-dependent birds

Loss of headwater streams from the project would be likely to impact water dependent birds, such as the Louisiana waterthrush, that require forested headwater streams for foraging on insects and nesting by elimination of the headwater areas associated with Pigeonroost Branch and Oldhouse Branch.

The Louisiana waterthrush has been designated by USFWS as a Bird of Conservation Concern (BCC) within the Appalachian Mountains Bird Conservation Region (AMBCR) that may be impacted by Mountaintop Mining – Valley Fills (MTM-VF).

According to USFWS, the Louisiana waterthrush is an area-sensitive riparian-obligate species that nests and forages along headwater streams of intact interior forests; it relies for breeding success on the diverse and productive assemblage of aquatic insects supported by healthy headwater systems (Mattson et al. 2009). Studies indicate that breeding territory density and occupancy were reduced along streams where benthic macroinvertebrate communities had been degraded due to anthropogenic land uses and acidification. Lower breeding territory densities occurred along streams impacted by acid mine drainage more so than along circumneutral streams. Similarly, some indices of benthic macroinvertebrate integrity were higher where breeding Louisiana waterthrushes were present than areas from which they were absent. Stream reaches where breeding birds were detected had a greater proportion of pollution-sensitive benthic macroinvertebrates than reaches where they were not detected supporting the concept that good water quality is a key component of the species breeding habitat.[18] Management for this species has focused on protecting core wooded riparian habitat, including establishment of undisturbed riparian forest cover, and preservation and improvement of water quality to ensure aquatic insect biomass and diversity.

For water-dependent wildlife, like the Loiusiana waterthrush, preservation of large tracts of forest containing headwater streams is needed for the conservation of this species in the central Appalachians. The waterthrush is particularly vulnerable to degradation of water quality and aquatic insect communities (Mattsson and Cooper 2006, Mulvihill et al. 2008).

3. Summary

In summary, construction of valley fills, sedimentation ponds, and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) to Pigeonroost Branch and Oldhouse Branch would eliminate headwater stream systems that support some of the last remaining least-degraded conditions within the Coal River sub-basin, destroy (through burial) diverse and healthy wildlife communities and habitat within those headwater stream systems. In addition, the discharges would likely convert previously healthy, functioning headwater streams into sources of contaminants to downstream waters that would likely adversely affect wildlife in those downstream waters. These impacts likely will cause significant degradation of the Nation's waters as described in 40 C.F.R. 230.10(c), particularly within the context of of the mine-impacted Coal River sub-basin and Spruce Fork sub-watershed. As set forth in Section V.C.

[18] In addition to stream pollution from anthropogenic land uses, elevated predator numbers from landscape-scale forest fragmentation and the loss of riparian forest canopy could also negatively impact future population levels of the Louisiana waterthrush. Ongoing impacts associated with landscape disturbances, including defoliation, increased stream temperatures, and compositional shifts in benthic macroinvertebrate communities, also could reduce populations in the AMBCR. Therefore, measures of Louisiana waterthrush distribution and reproduction may be useful indicators of both stream and forest ecosystem integrity.

below, Region III has determined that the compensatory mitigation plan for this project would be unlikely to compensate adequately for the impacted resources or to reduce the impacts described above to an acceptable level.

C. Mitigation is not likely to ffset anticipated impacts

The Section 404(b)(1) Guidelines require that the permit authorize only the least environmentally damaging practicable alternative. 40 C.F.R. 230.10(a). In addition, no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem. 40 C.F.R. 230.10(d). Thus, impacts must be first avoided and then minimized It is only after practicable and appropriate steps have beeen taken to to avoid and minimize impacts that compensatory mitigation to offset unavoidable adverse impacts to aquatic resources authorized by Clean Water Act Section 404 permits and other Department of the Army (DA) permits may be considered.

Analysis by Region III indicates that there appear to be alternative configurations that would avoid much of the discharges to Pigeonroost Branch and Oldhouse Branch. Because the scope of this Recommended Determination is limited to withdrawal of specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material in connecton with the Spruce No. 1 Mine, Region III takes no position at this time as to whether the alternatives that Region III has identified would be likely to result in acceptable or unacceptable effects on wildlife or satisfy the Section 404(b)(1) Guidelines.

If constructed as authorized the Spruce No. 1 Mine will result in direct impacts (through discharge of dredged and/or fill material) to approximately 35,368 linear feet (about 6.6 miles) of stream in Pigeonroost Branch and Oldhouse Branch. The impacts from these discharges are discussed in Sections V.A. & V.B. above.

While Region III recognizes that the project includes mitigation efforts (including stream creation and enhancement of existing streams) to compensate for unavoidable adverse impacts, Region III is concerned that known compensatory mitigation techniques would be unlikely to replace the high quality resources in Pigeonroost Branch and Oldhouse Branch. Additionally, Region III believes that the current mitigation plan does not adequately account for the quality and function of the impacted resources.

The Compensatory Mitigation Plan (CMP) submitted by Mingo Logan describes on-site and off-site, in-kind mitigation. On-site compensation would include the restoration of 7,132 linear feet of stream segments temporarily impacted by the sedimentation ponds, and the creation of 43,565 linear feet of on-bench stream channel within the project area. Off-site compensation includes stream enhancements to Spruce Fork and Rockhouse Creek through a combination of physical, aquatic habitat, and stream stabilization improvements. Finally, the CMP proposes to direct surface water flow from the project area in existing drainage ways to promote the development of more defined channels, thus creating 26,625 linear feet of streams.

Both EPA and the USFWS have regularly identified problems with the mitigation techniques that are part of the CMP for the Spruce No. 1 Mine. Region III's comments on the 2006 draft and final EISs for the Spruce No. 1 Mine expressed concern that the compensatory mitigation plan did not fully mitigate all adverse impacts and was inadequate in terms of its lack of functional assessment and concerns whether headwater stream creation would in fact replace impacted resources Region III emphasized the importance of headwater stream functions that would be lost and likely not replaced, particularly by conversions of existing drainageways to streams as described in the CMP. In their December 4, 2001, letter the USFWS expressed similar concerns that the proposed mitigation was unlikely "to provide sufficient mitigation for permanent stream and riparian habitat loss and for the losses of the functions and values of the stream to aquatic species in the fill footprint and to the downstream ecosystem."

As discussed below, the project fails to include all appropriate and practicable steps to minimize and compensate for the project's adverse impacts on the aquatic ecosystem as required by 40 CFR 230.10(d). Further, EPA Region III believes that the anticipated level of adverse impacts associated with the Spruce No. 1 Mine will not be adequately offset by the required compensatory mitigation.

1. Proposed mitigation likely will not replace high quality resources in Pigeonroost Branch and Oldhouse Branch

There is no evidence in the peer-reviewed literature that the type of stream creation included in the CMP will successfully replace lost biological function and comparable stream chemistry to high quality stream resources, such as Pigeonroost Branch and Oldhouse Branch. Studies have demonstrated that replacement of streams is among the most difficult and frequently unsuccessful forms of mitigation. Even if stream structure and hydrology can be replaced, it is not clear that replacing structure and hydrology will result in true replacement of functions, especially the native aquatic community and headwater functions. Based upon these studies, the Corps and EPA have stated:

> "We recognize that the scientific literature regarding the issue of stream establishment and re-establishment is limited and that some past projects have had limited success (Bernhardt and others 2007). Accordingly, we have added a new paragraph at 33 CFR 332.3(e) (3) [40 CFR 230.93(e) (3)] that specifically notes that there are some aquatic resources types that are difficult to replace and streams are included among these. It emphasizes the need to avoid and minimize impacts to these 'difficult-to-replace' resources and requires that any compensation be provided by in-kind preservation, rehabilitation, or enhancement to the extent practicable. This language is intended to discourage stream establishment and re-establishment projects while still requiring compensation for unavoidable stream impacts in the form of stream corridor restoration (via rehabilitation), enhancement, and preservation projects, where practicable."[19]

[19] EPA recognizes that the effective date of the regulations governing compensatory mitigation that were promulgated at 73 Fed. Reg. 19594 (April 10, 2008) is June 9, 2008, and therefore those regulations do not

Furthermore, the USFWS frequently has stated that, "we continue to believe that it is not possible to fully replace the critical aquatic and terrestrial ecosystem functions of healthy headwater streams," and that USFWS "is not aware of any scientific support for the concept that . . . ditches can be considered biologically equivalent to, or even rough approximations of, flowing streams."

The streams of Pigeonroost and Oldhouse Branch have been shown to exhibit high water quality and high functioning capacity. Given the difficulty of stream re-establishment to mitigate for impacts to streams in general, Region III believes it is even more unlikely that high value streams such as these can be replaced by on-site stream creation techniques involving conversion of sediment ditches. EPA Region III believes that the mitigation for the Spruce No. 1 project is unlikely to offset the anticipated impacts to an acceptable level.

2. The compensatory mitigation plan is based upon a misclassification of the impacted resources

The starting point for an adequate compensatory mitigation plan is accurate characterization of the impacted resources. Region III believes that the compensatory mitigation plan is based upon a misclassification of impacts to perennial and intermittent streams, thereby resulting in an insufficient baseline from which to design adequate stream compensation.

Overall, through onsite visits and biological data collection, Region III conservatively estimates that, within the mine footprints of Right Fork Seng Camp, Pigeonroost, and Oldhouse Branch, over five miles of stream (~27,000 feet) are perennial. This is in contrast to the DA Permit estimation of 165 feet of perennial waters within the entire project area. This misclassification has a critical impact upon the type of mitigation that would be required to offset these impacts. The resource type plays an important role in the types of expected aquatic communities, the degree in which each resource provides structure and function, and the amount of organic matter and nutrients (and contaminants) ultimately retained or loaded to receiving streams. This misclassification means that the compensatory mitigation plan does not properly account for, and therefore would not offset the full range of adverse impacts related to the project. A more detailed description of EPA's analysis of stream type is described in Appendix 3.

3. The compensatory mitigation plan lacks an adequate functional assessment

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apply to DA Permit No. 199800436-3 (Section 10: Coal River). Nevertheless, the above-quoted statement, taken from the preamble to those regulations, summarizes scientific research and literature that is applicable to consideration of the likely efficacy of the compensatory mitigation proposed for the Spruce No. 1 Mine.

In addition to being based on a misclassification of resource type, the CMP also is based upon an inadequate functional assessment of the impacted resources. Compensatory mitigation must replace the aquatic resource function lost or adversely affected by authorized activities. Therefore, to ensure that the functions are being replaced, the compensatory mitigation must create/restore streams that are capable of sustaining comparable biological, communities and chemical and physical characteristics of the streams that have been eliminated by the mining activity.

The CMP utlized an assessment method referred to as the Stream Habitat Unit (SHU) method to calculate mitigation debits and credits. This assessment entails a combination of linear lengths of impact, habitat assessment scores, and stream hydrological status[20]. The SHU as presented in the CMP only accounts for the physical aspects of stream condition and fails to account for the interrelationship of water chemistry and biological resources in stream functioning.

The USFWS expressed this concern in regard to the CMP:

> "The Stream Habitat Unit (SHU) assessment methodology selected by the applicant only considers the physical characteristics of the stream. It does not include biological or chemical characteristics of the stream. Without those attributes, the assessment does not meet the requirements of a "functional" assessment. The Service recommends that the applicant use an assessment method that incorporates biological and chemical, as well as habitat, characteristics to determine the true function of the stream."

The basis for the SHU as presented by the CMP is based on the premise that stream habitat (HAV as scored by EPA's RBP Habitat Assessment) accounts for the total ecological "currency" at the site. This premise has been demonstrated to be flawed. Studies (for example, Fritz et al., 2010) have found no correlation between functional measurements and RBP Habitat Assessments. More importantly, there was no use of existing water chemistry or biological resource measurements factored into the SHU's ecological currency of the sites. This shortcoming underscores the need for a more thorough investigation of impacts and mitigation offsets.

Since the permittee applied the SHU methodology, which has no functional component, to describe the streams, the compensatory mitigation plan only addresses the physical elements of the streams. As a result of this EPA believes the current CMP does not adequately account for or replace the functional components of the lost streams. Region III does not believe that increased ratios of intermittent or ephemeral streams offsets this inadequacy. While DA Permit No. 199800436-3 (Section 10: Coal River) refers to biological success criteria, the permit terms do not clearly require the replacement of lost

[20] Even though the Corps did not finally rely solely on the SHU for mitigation requirements, the Corps did not categorically prevent the permittee from using this approach as a basis for its mitigation plan, and thereby allowing Mingo Logan to use this approach to help justify their mitigation performance and success criteri ***a.***

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biological function and comparable stream chemistry to meet adequate compensatory mitigation success criteria.

4. Conversion of erosion control channels would be unlikely to successfully replace the impacted resources

Based on observations of other on-bench SMCRA drainage or erosion control ditches (Kirk 1999; Green et al. 2000, and Gingerich 2009), the CMP's proposed conversion of these ditches is unlikely to successfully replace the impacted resources, alone or in concert with other proposed mitigation contained in the CMP. Over 50% of the linear stream length in the Spruce mitigation plan relies on conversion of ono-bench SMCRA drainage or control ditches. On-bench sediment ditches are a consequence of SMCRA-required Best Management Practices (BMPs) to control runoff. Data show that water quality in these types of sediment ditches in the MTM region is typically highly degraded as a result of water in these ditches percolating through mine spoil. Even when the sediment ditches are enhanced for benthic substrata and riparian vegetation, such as through adding boulder clusters every 500-1000 feet, resulting water quality will likely be so degraded that the ditches will not meet or exceed pre-mining water chemistry baselines.

As described previously, degraded water chemistry (such as the addition of conductivity and selenium as a result of water percolation through mine spoil) typically results in degraded biological communities. As a result of this degraded water chemistry, these created waterbodies would be unlikely to support the healthy and diverse biological communities that they are intended to replace. These created streams would be considered degraded and would be unlikely to successfully replace Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution and healthy biological communities and function, either alone or in concert with other proposed mitigation contained in the CMP.

A more detailed discussion of on-bench sediment ditches for mitigation is provided in Appendix 3.

5. The CMP does not account for the loss of ecological services of headwater streams

Another compelling problem with the Spruce No. 1 CMP is the separation of the ecological elements into single, separate aspects of the ecology with limited treatment of the interconnectedness of the entire ecosystem. The forested slopes and coves located within the Spruce No. 1 project area are drained by a dendritic mosaic of ephemeral, intermittent and perennial headwater streams and water courses. The watershed is inextricably linked with the stream system that drains it. The overwhelming bulk of the organic matter that sustains the stream biota in Spruce Fork is a function of the upstream environment.

In a pre-mined condition receiving streams are recipients of allochthonous (i.e., material originating from outside of the stream system) material and water inputs (i.e., surface, subsurface and groundwater) from the surrounding forested communities. The post-mined environment, however, creates severely altered conditions in stream courses that are not destroyed by valley fills. Those alterations include:

a. Elimination of water and processed organic material from former upstream tributaries that will be under valley fills.

b. Altered contributions of water and allochthonous material from the surrounding upland watershed. This is due to the altered character of the soil and vegetation communities in a post-mine environment.

c. Altered hydrograph with new flow regimes that markedly depart from that under which the streams have evolved.

d. Altered timing, temperature and chemical composition of post-mine discharges of water to receiving streams.

Mountaintop mining and associated valley fills profoundly alter the contributing watershed. Effectively the new landscape widely departs from that within which the stream network has evolved. The subsequent ecosystem is an entirely new system. Assumptions that much of the structure and function of the pre-mined conditions can be recaptured with mitigation are very optimistic and highly speculative.

In summary, Region III believes that it is unlikely that the adverse impacts associated with the Spruce No. 1 project as authorized would be offset by the mitigation described in the CMP.

D. Summary

In summary, Region III believes that Spruce No. 1 Mine would eliminate the entire suite of important physical, chemical and biological functions provided by the streams of Pigeonroost Branch and Oldhouse Branch including maintenance of biologically diverse wildlife habitat. Region III maintains that impacts to these functions at the scale associated with this project will result in significant degradation (40 CFR 230.10(c)) of the Nation's waters, particularly in light of the extensive historic stream losses in the Spruce Fork and Coal River watersheds. Region III does not believe the potential impacts of these stream resources can be adequately mitigated to reduce the impacts to an acceptable level by the compensatory mitigation described in the CMP.

VI. Other Considerations

As set forth above, Region III has determined that the impacts from the discharges to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) described in Section V would be likely to have an unacceptable

adverse effect on wildlife that will not be offset by the compensatory mitigation plan. This section identifies other, additional considerations that are of concern to the Region but are not part of the basis for our conclusion that the impacts would be likely to have an unacceptable adverse effect.

A. Impacts From Activities Dependent Upon Specification of Pigeonroost Branch and Oldhouse Branch as Disposal Sites for the Construction of Valley Fills and Sedimentation Ponds for the Spruce No. 1 Mine

To the extent that discharge of excess spoil to areas outside jurisdictional waters and other mining-related activites, such as deforestation, necessarily depend upon specification of Pigeonroost Branch and Oldhouse Branch for construction of valley fills and sedimentation ponds for the Spruce No. 1 Mine, Region III has considered those impacts.

1. Migratory Birds

Approximately 2,278 acres of deciduous forests will be destroyed by the Spruce No. 1 Mine. Among the many migratory birds likely to breed in the project area, there are six species that the USFWS has designated as Birds of Conservation Concern within the Appalachian Mountains Bird Conservation Region that may be impacted by Mountaintop Mining – Valley Fills. These include the cerulean, Kentucky, Swainson's and worm-eating warblers, the wood thrush, and the Louisiana waterthrush. The water-dependent Louisiana waterthrush was discussed in Section V.B.2.d above. The other five avian species are also designated as BCC species within the USFWS's Northeast Region as a whole and nationally (U.S. Fish and Wildlife Service 2008). The first four are also considered to be among the 100 most at-risk bird species in North America (Wells 2007).

Cerulean and worm-eating warblers are also both area-sensitive species that rely on large blocks of intact, mature, interior forest habitats to support productive breeding populations. The cerulean warbler breeding population is thought to have declined by about 75% over the past 45 years – the most dramatic decline of any North American warbler monitored by the Breeding Bird Survey (Sauer et al. 2005). Both species are threatened by the loss and fragmentation of these habitats (U.S. Fish and Wildlife Service 2007, Wells 2007). Deforestation associated the Spruce No. 1 Mine may adversely impact their breeding populations (Weakland and Wood 2005, Wells 2007).

The project also could impact other bird species that rely on mature forest habitats. Bird species that rely on mature forest habitats that are abundant in the Appalachian region are Kentucky warblers in the understory; and wood thrush, Swainson's warbler, Acadian flycatcher, and ovenbirds in mesic hardwoods. These and many other avian species are all impacted by forest fragmentation and habitat loss, such as that which would occur in connection with the Spruce No. 1 mine. Spatial analyses of the effect of Appalachian mountaintop mining on interior forest indicate that the loss of interior forest is 1.75-5.0 times greater than the direct loss of forest due to mountaintop mining. Investigators

concluded that the loss of Appalachian interior forest is of global significance due to the rarity worldwide of large expanses of temperate deciduous forest.

The Spruce No. 1 Mine will impact mature forested habitat, over a substantial timeframe, replacing the impacted areas with reclaimed areas dominated by grasses and herbaceous species. Many reclaimed areas such as those expected at Spruce No. 1 show little or no regrowth of woody vegetation even after 15 years. The PEIS found significant differences in bird populations between forested and reclaimed sites, namely the loss of the above-mentioned species, and subsequent replacement by more opportunistic grassland species. Also, the loss of the healthy headwater areas of Spruce Fork will reduce the feeding and foraging areas available to specialist bird species in this ecoregion. This reduction in available habitat could potentially impact their viability in the Spruce Fork watershed and the larger ecoregion.

In recent communications with Region III (August 2010) in regards to EPA's Proposed Determination on the Spruce No. 1 Mine the USFWS indicated its belief that past selective logging in some parts of the project area would not preclude use of the site by forest interior species of migratory birds or that birds currently using the project area during the breeding season will be unaffected by the mine and associated valley fills. The USFWS evaluated the terrestrial habitats of the project area and concluded that construction of the mine was likely to impact migratory birds via the loss and fragmentation of forest habitat, decreasing habitat heterogeneity, increasing isolation of populations, and increasing exposure to nest predators and parasites (U.S. Fish and Wildlife Service 1998).

The USFWS expressed concerns specific to bird populations within the Coal River Sub-basin related to adverse impacts of the Spruce No. 1 Surface Mine. These concerns included …"direct loss of habitat and direct and indirect loss of food resources, for forest interior and riparian-obligate species of migratory birds, including six species the Service considers Birds of Conservation Concern (i.e., cerulean, Kentucky, Swainson's, and worm-eating warblers; Louisiana waterthrush; wood thrush)" (USFWS, 2008).

The USFWS also continues to believe that construction of the Spruce No. 1 Surface Mine will adversely impact these and other forest-breeding migratory birds. The valley fills will result in the permanent loss of headwater streams that may be used by Louisiana waterthrushes. The USFWS indicates they are unaware of peer-reviewed research that suggests that these birds will simply relocate to an adjacent, unimpacted watershed and have comparable survival and reproductive success. The downstream increases in conductivity, selenium and perhaps other contaminants are also likely to adversely affect those waterthrushes not excluded by the direct impacts of the fill via impacts to their food base. In some freshwater food webs, selenium has bioaccumulated to four times the level considered toxic, which can expose birds to reproductive failure when they eat fish or insects with high selenium levels.

While the work of the Appalachian Regional Reforestation Initiative (ARRI) shows substantial promise for better reclamation of mined lands, it has not been demonstrated

that these reclaimed areas will generate and sustain forests that provide habitat characteristics and qualities comparable to those of native forest. For these reasons, the USFWS believes that construction of the Spruce No. 1 Surface Mine is likely to result in permanent and/or long-term loss of breeding habitats important to several migratory bird species of conservation concern.

2. Bats

Large-scale mountaintop removal/valley fill mining has been identified among the threats to bat species in the region according to information supplied to EPA by the USFWS. Loss of the bat's habitat, foraging areas, and food sources – in conjunction with recently identified concerns related to white-nose syndrome – may result in unacceptable adverse impacts to these wildlife resources.

As set forth in Section IV.B.5., it is possible that Indiana bats could occur in or near the project area, and that they could be impacted by the loss of forest habitat associated with the Spruce No. 1 Mine and by the loss of headwater streams, riparian areas and associated aquatic and terrestrial insects, as well as by the downstream degradation of these resources likely to be caused by the project.

In addition to Indiana bats, the USFWS was recently petitioned to list two other bat species, the eastern small-footed bat and northern long-eared bat, under the Endangered Species Act (Center for Biological Diversity 2010). Like Indiana bats, these two species are susceptible to population-level impacts from White Nose Syndrome (WNS), which has devastated some populations of eastern bats. Both species occur in the vicinity of the Spruce No. 1 Surface Mine, and both were captured during mist net surveys at the project site. Five eastern small-footed bats and 16 northern long-eared bats were captured during mist net surveys in 2004, representing 7.6 and 24.2 percent, respectively, of all bats captured (U.S. Army Corps of Engineers 2006, Appendix M). Given the rapid spread and potentially dramatic effects of WNS, the potential exists that even more bat species could decline to the point that listing under the ESA will be warranted.

If WNS affects West Virginia bats as it has bats in other states, and if large die-offs occur, it will further complicate the already complex challenge of conserving bat species. Previous mining and logging activities and forest loss have also been identified as having adverse affects on bat populations. Commonly used reclamation techniques, many of which are designed to minimize erosion and provide backfill stability, are incompatible with re-establishment of trees necessary for successful roosting by bats. Such reclamation techniques have the potential to further stress bat populations.

B. Environmental Justice Concerns

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EPA has this goal for all communities and persons across this Nation. Executive Order 12898

directs: "To the greatest extent practicable…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations…"

According to the 2000 United States Census, Spruce No. 1 is located in a census block group which contains 335 people. A census block group is a geographical unit used by the U.S. Census Bureau (Bureau) which is between a census tract and a census block in size and scale. It is the smallest geographical unit for which the Bureau publishes data. Census block groups generally contain between 600 and 3,000 people, with a target size of 1,500 people.

Spruce No. 1 is located in a census block group where the average per capita income is $15,411. This is over $6,000 less than the national average of $21,587 and over $1,000 less than the West Virginia state average of $16,477. The average median family income is also almost $13,000 less than the national average of $52,029. Moreover, 24% of the residents of Logan County live below the poverty line which also exceeds state and national averages.

Region III notes that the Corps included a discussion of environmental justice in the Spruce No. 1 EIS, however, as noted in EPA's comment letters in June and October 2006, the Region III remains concerned that the Corps did not fully consider and address the potential for disproportionately high and adverse effects on this population. EPA's environmental justice analysis indicates that there may be a disproportionately high and adverse impact on the low income population affected by the mining activity. Additionally, EPA remains concerned that the local community did not have the necessary information, or the opportunity, to meaningfully participate in the EIS process. Specifically, EPA is concerned the community was not informed when changes were made to different aspects of the mine project during the permitting and EIS process and therefore was not able to meaningfully comment on the final aspects of the mine.

Consideration of these issues in the context of authorizing the significant disturbance associated with construction of valley fills associated with the Spruce No. 1 Mine should include a characterization of the status of residents near the site and the conditions they face including any effects relating to the proximity of the blasting zone, locations of discharges of fill material, truck traffic, noise, fugitive dust, and habitat loss. Information concerning sources of drinking water for the effected populations (including municipal water supplies and private sources of drinking water including streams and/or wells) also should be considered.

The cultural implications of mountain top mining also were not sufficiently considered. The mountains affected by Spruce No. 1 are viewed as a cultural resource by many residents. In many cases the mountains have helped define their society and influence their daily lives. For example, the mountain ridges of southern West Virginia have for over two centuries been viewed largely as a "commons," where local residents have

gathered wild medicinal herbs such as American Ginseng (*Panax quinquefolius*) and Goldenseal (*Hydrastis Canadensis*). In many cases, collection of these wild herbe provide much needed extra income to local communities during times of unemployment or economic hardship (Baily 1999, Hufford, 1997). Removing these mountains may have profound cultural changes on the residents in the area so it is important that cultural impacts be considered as well.

It is important that consideration be given as to whether the types of impacts described above will extend over a broad area or will be concentrated in particular areas. Detailed maps outlining the residential areas in relation to these activities may help accomplish this. It is also important that the effects be considered both independently and cumulatively. Considering the effects cumulatively provides the most realistic "snapshot" of what the community will be facing when the project reaches fruition. Having this information readily available will help engage the affected communities during public outreach and ensure that they can be meaningfully involved.

EPA considers action pursuant to section 404(c) within the scope of the policy directive of Executive Order 12898. A section 404(c) action has the potential to affect human health or the environment of low-income or minority populations. Accordingly, EPA includes environmental justice concerns when undertaking an action pursuant to section 404(c). In this case, Region III conducted a public hearing on May 18, 2010 and received comments both orally and in writing. Region III has considered that members of the community expressed concern about loss of jobs and tax revenue (supporting local communities and schools) in the event that EPA's Section 404(c) action would preclude any activities currently authorized at the Spruce No. 1 Mine. At the same time, Region III also has considered that members of the community have expressed concern regarding the adverse environmental and cultural aspects of the project described above. EPA also has received a petition from a variety of stakeholders raising concerns related to environmental justice issues associated with mountaintop mining.

In order to satisfy Executive Order 12898, EPA has considered whether there is a "…disproportionately high and adverse human health or environmental effects…" from its regulatory action. The scope of the inquiry for purposes of EPA's environmental justice analysis is directly tied to the scope of the regulatory action that EPA is taking. In the context of a Clean Water Act Section 404(c) action, EPA is authorized to prohibit, restrict, or deny specification (or withdraw specification) of the discharge of dredged or fill material at defined sites in waters of the United States whenever it determines that use of such sites for disposal would have an unacceptable adverse impact on "municipal water supplies, shellfish beds, fishery areas (including spawning and breeding areas), wildlife, or recreational areas."

Accordingly, EPA has considered its environmental justice analysis in the context of this Recommended Determination under Section 404(c) action the potential effects prohibiting the discharge will have on the municipal water supplies, shellfish beds, fishery areas, wildlife and recreational areas (i.e., 404(c) resources) of the project site. EPA also considered whether those effects, if any, of EPA's 404(c) action on the 404(c)

resources will have a "disproportionately high and adverse human health or environmental [effect]" on "minority populations and low-income populations" of the project area.

EPA concludes, to the greatest extent practicable, after performing the EJ analysis contemplated in Executive Order 12898, and incorporating public comment, thatthis Recommended Determination under 404(c) in and of itself or if incorporated within any Final Determination, will not have a disproportionately high and adverse human health or environmental effect on the low-income and minority populations of the project area. EPA notes that the scope of this Recommended Determination is limited to withdrawal of specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for the discharge of dredged and/or fill material for the construction of valley fills and sediment ponds associated with the Spruce No. 1 Mine as currently authorized. This action neither prohibits nor authorizes coal mining.

C. Public Health

As interest in the overall environmental and human health effects from mountain top mining has been increasing, a growing body of research has suggested that health disparities are not uniformly distributed across the Appalachian region but are concentrated in areas, like the Spruce No. 1 Mine project area, where MTM activity takes place. Region III has conducted a preliminary review of existing literature on health impacts from MTM. The studies reviewed by Region III sought to evaluate whether associations between MTM and health exist. These studies do not provide direct assessments of environmental air and water quality in mining areas in relation to individual exposures and health outcomes. This more comprehensive research, including environmental chemical analyses and biological monitoring, would require significantly greater study than is appropriate for this Recommended Determination.

However, the results of these associational studies identify significant correlations between MTM activity and a variety of health disparities. These study findings indicate that health disparities are elevated in Appalachian coal mining regions for mortality rates for chronic respiratory, cardiovascular, and kidney disease, and for some forms of cancer including lung cancer. These studies by their nature could not and do not establish any causal linkage between MTM and these elevated rates of adverse health effects, but because they point to significant associations between MTM and elevated rates of adverse health impacts, the results warrant more research using rigorous epidemiological methods. The existing body of literature suggests that various negative health outcomes are not the result of a single exposure, but may reflect chronic exposures to multiple environmental contaminants, both air and/or water, which will vary for each individual.

The studies noted the following:

• Residents of areas in which coal mining activities take place have higher risk of cardiovascular disease (CVD) (OR=1.22, 95% CI 1.14-1.30), angina or coronary heart disease (CHD) (OR=1.29, 95% CI=1.19-1.39), and heart attack (MI) (OR=1.19, 95% CI

= 1.10-1.30) after adjusting for smoking, alcohol, gender, education, race, income, physician supply, and metropolitan status.

• Lung cancer mortality is higher in heavy coal-mining areas, followed by all other areas of Appalachia and the nation ($p<.001$) after accounting for covariates of gender, education, poverty, race, urban status, smoking, southern states, and Appalachian country.

• Total chronic heart, respiratory, and kidney disease, and kidney disease mortality rates were significantly higher in coal mining areas of Appalachia than non-coal mining areas.

• Among West Virginia adults, residential proximity to heavy coal production was associated with poorer health status and with higher risk for cardiopulmonary disease, chronic lung disease, hypertension, and kidney disease, after controlling for covariates (Spruce No.1 mine is in an area characterized by heavy coal production.

• Distance-weighted, at-risk population coal mining exposure measure was significantly correlated to cancer mortality in WV. For total cancer and three cancer-type subgroups, exposure was correlated after controlling for smoking rates. The variables had positive spatial autocorrelation and were spatially dependent. All components of mining (injection, preparation plants, impoundments, and mining sites) were related to one or more cancer types.

• Volume of coal mining significantly related to hospitalization risk for hyptertension (odds increased 1% for each 1462 tons of coal) and COPD (odds increased 1% for each 1873 tons of coal) controlled for age, gender, insurance, co-morbidities, county poverty, county and social capital.

• The heaviest coal mining areas of Appalachia had the poorest socioeconomic conditions. Before adjusting for covariates, the number of excess annual age-adjusted deaths in coal mining areas ranged from 3,975 to 10,923, depending on years studied and comparison group.

• Living in proximity to mining areas increases the odds of low birth weight. In mining areas, odds of low birth weight are increased by 14 to 16% depending on the amount of mining as compared to areas with no coal mining.

• Ecological integrity was inversely related to age-adjusted cancer mortality rates (total $p<.01$; digestive, breast, and respiratory $p<.01$; urinary $p<.05$), controlled for poverty, access to health care providers, urbanization, education, smoking. Ecological integrity was significantly related to mining and cancer mortality and mining was significantly related to total cancer mortality.

D. Cumulative Impacts

Fundamental to the Section 404(b)(1) Guidelines "is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." 40 C.F.R. § 230.1(c).

The Section 404(b)(1) Guidelines (at 40 C.F.R. § 230.11(g)) also direct that factual findings be made regarding cumulative impacts on the aquatic ecosystem and that those findings be considered in determining whether the discharge complies with the foregoing restriction. To that end, the Section 404(b)(1) Guidelines describe the factual finding that must be made with respect to cumulative impacts as follows:

> *Determination of cumulative effects on the aquatic ecosystem.* (1) Cumulative impacts are the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems.

For purposes of this analysis, Region III has considered cumulative impacts to the Coal River sub-basin (891 mi^2) and the Spruce Fork sub-watershed (126.4 mi^2) if the Spruce No. 1 Mine is constructed as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) and other reasonably foreseeable (proposed and authorized but not constructed) surface mining projects within the Coal River sub-basin are constructed. This cumulative effects analysis also takes into consideration the past and present mining projects within the sub-basin and sub-watershed, and the extent to which they have affected the current baseline conditions within the sub-basin and sub-watershed (see Figure 14).

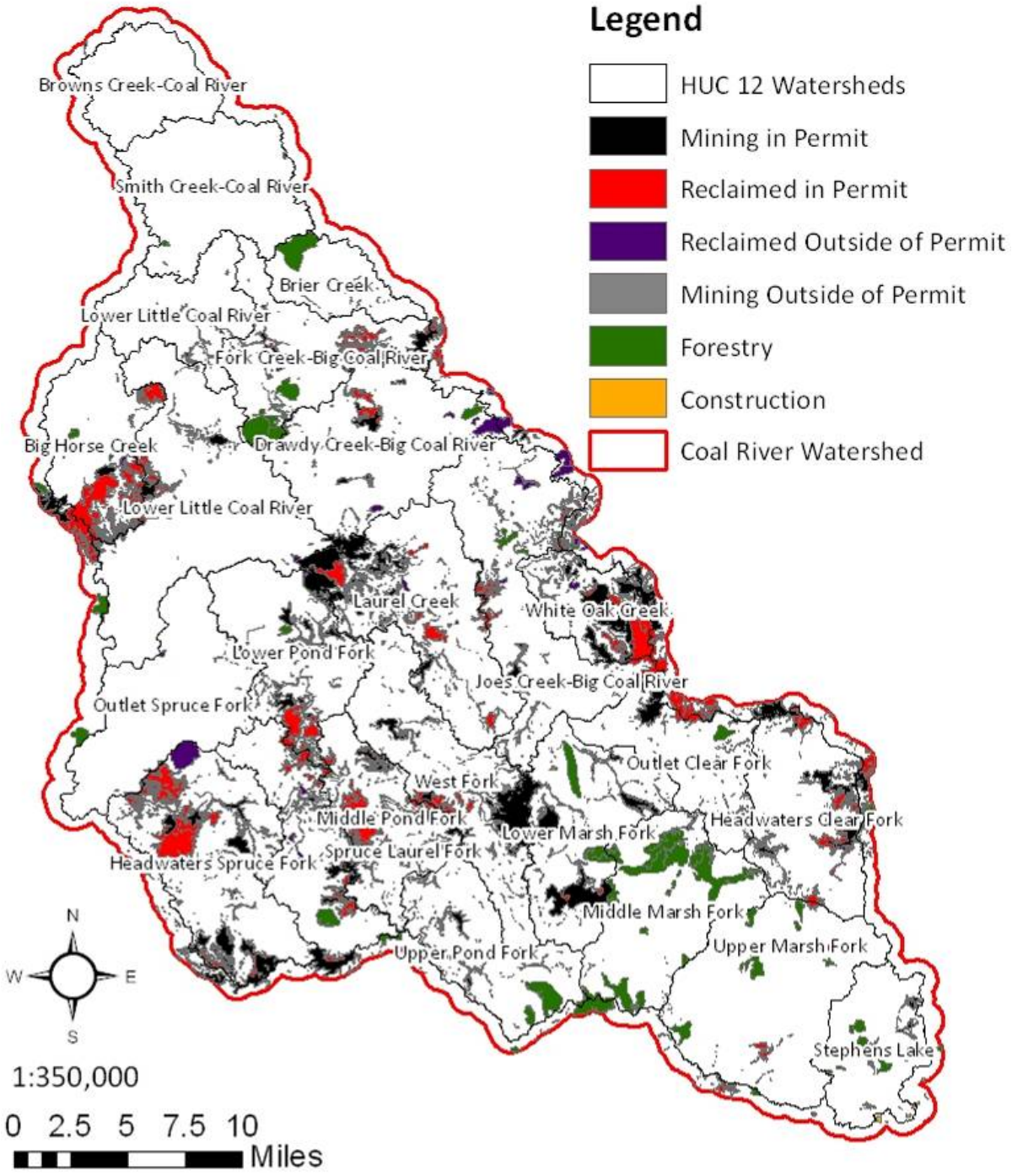


Figure 14: Illustration of the types of disturbance currently found in the Coal River sub-basin.

As has been described in Section IV.A.2., the Coal River sub-basin and the Spruce Fork sub-watershed are already impacted by mining activity. Based upon the National Land Cover Database (NLCD) change product for 1992-2001 and WVDEP's GIS mining files, more than 257 past and present surface mining permits have been issued in the Coal River sub-basin, which collectively occupy more than 13% of the land area (see Figure

13). In the Spruce Fork sub-watershed, more than 34 past and present surface mine permits have been issued, which collectively occupy more than 33% of the land area. The proposed project will affect an additional 2,278 acres (3.56 mi^2), which is equivalent to approximately 2.8% of the Spruce Fork sub-watershed. This percentage of land cover affected by surface mines will continue to increase in the Coal River sub-basin, as additional projects are proposed and authorized.

A 1997 WVDEP ecological assessment of the Coal River sub-basin indicated that because the sub-basin is becoming increasingly impaired due to stressors such as mining, there is a need to protect the remaining quality resources, highlighting the need to "[l]ocate and protect the few remaining high quality streams in the Coal River watershed.…" Pigeonroost Branch and Oldhouse Branch, two of the streams directly affected by the proposed action, are high quality resources that support an exceptionally high number of mayfly taxa, both within the Central Appalachian Region and statewide (see Appendix 1). By directly impacting these streams, which serve as refugia for aquatic life and potential sources for recolonizing nearby waters, the proposed action will be likely to have a significant cumulative effect on the aquatic ecosystem integrity in the sub-basin.

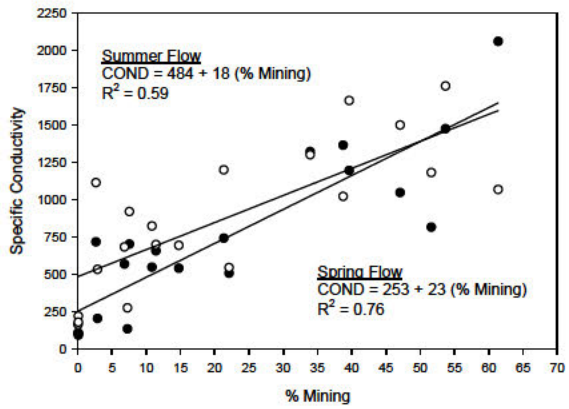
EPA is aware of at least 11 additional mining operations either proposed or authorized but not constructed in addition to Spruce No.1 in the Coal River sub-basin. Construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) along with these additional projects in the Coal River Sub-basin, if constructed, would directly impact approximately 29.4 miles of stream channels, and would be likely to have significant secondary and cumulative effects on downstream waters in the Coal River sub-basin. Impacts from these projects can be expected to include reduced freshwater dilution, reduced headwater stream functional inputs, increased discharges of pollutants from the valley fills, including total dissolved solids (TDS) and selenium, and the potential to contribute to existing impairments within the Spruce Fork watershed and the Coal River sub-basin.

The Little Coal watershed contains 98 miles of impaired streams (33% of the streams in the watershed), and the Coal River sub-basin has 743 miles of impaired streams (30% of the streams in the sub-basin). WVDEP has listed these stream segments for selenium and biological impairment. The additional fills associated with the proposed action, in combination with past and present mining by the applicant and other mining in the sub-basin, will likely cause or contribute to significant cumulative adverse impacts to the stream resources in the Coal River sub-basin, and will likely contribute to current water quality impairments within the sub-basin.

Preliminary results from current research based upon WVDEP data show a strong correlation between the percentage of a watershed that is disturbed by mining activity and downstream conductivity levels (see Figure 15).

Coal River Watershed

Relationship between % Mining and Conductivity



Thresholds

Cond	% M_sp	% M_su
300	**2**	---
500	**12**	**1**
750	**23**	**15**
1000	**34**	**30**

*Analyses based on mining only sites; Equations do not differ significantly.

Figure 15: Coal River Watershed: Mining and Conductivity

Levels of conductivity on the mainstem of Spruce Fork, Pond Fork and the Little Coal River exceeded 500 µS/cm almost every time WVDEP sampled these sites in 1997, 2002-2003, 2005 and 2008. The US Army Corps of Engineers Huntington District also reported conductivity values as part of the baseline water quality for Spruce Fork upstream and downstream of the proposed project area in the EIS for the proposed project (U.S. Army Corps of Engineers Huntington District 2006, DEIS Spruce No. 1 Mine). The DEIS reported that the minimum, average and maximum conductivity levels for Spruce Fork upstream of the propose project area were 112, 656 and 1130 µS/cm at that time, indicating that on average the conductivity in Spruce Fork was already elevated greater than 500 µS/cm, and maximum conductivity levels exceeded twice that level.

Because construction of the Spruce No. 1 project and 11 additional mining operations would increase the percent of the sub-basin that is impacted by mining activity, it can be expected that these water quality effects will likely be exacerbated by these additional mines. EPA believes that the Spruce No. 1 project, in conjunction with the other mining operations either under construction or proposed for the Coal River sub-basin, will be likely to contribute to the significant cumulative loss of aquatic resources and degradation of water quality.

VII. Conclusions and Recommended Determination

Based on the foregoing analyses and upon consideration of the public comments received in response to Region III's Proposed Determination, Region III has determined that discharges of dredged and/or fill material to Pigeonroost Branch and Oldhouse Branch for the purpose of constructing the Spruce No. 1 Surface Mine as currently authorized by

DA Permit No. 199800436-3 (Section 10: Coal River) would likely have unacceptable adverse effects on wildlife. DA Permit No. 199800436-3 (Section 10: Coal River) authorizes construction of valley fills and sedimentation ponds and other discharges into Pigeonroost Branch and Oldhouse Branch that will bury approximately 6.6 miles of high quality headwater streams. Pigeonroost Branch and Oldhouse Branch support diverse and healthy biological communities comparable with conditions in nearby White Oak Branch, recognized by WVDEP as supporting least-degraded, reference quality conditions. Pigeonroost Branch and Oldhouse Branch represent streams within the larger Spruce Fork sub-watershed and Coal River sub-basin that remain relatively free of water quality degradation. As such, Pigeonroost Branch and Oldhouse Branch are valuable in and of themselves and within the context of the Spruce Fork sub-watershed and Coal River sub-basin.

As currently authorized the DA Permit discharges to Pigonroost Branch and Oldhouse Branch would bury wildlife that live in those streams or within the footprint of the valley fills and minethrough areas. Other wildlife will lose important headwater stream habitat on which they depend for all or part of their lifecycles.

Wildlife impacts from the activities authorized by the permit will not be limited to direct burial of wildlife. Burial of Pigeonroost Branch and Oldhouse Branch would likely result in effects to downstream waters and downstream wildlife caused by the removal of functions performed by the buried resources and by transformation of the buried areas into sources that contribute contaminants to downstream waters. In addition, currently authorized discharges to Pigeonroost Branch and Oldhouse Branch would be likely to contribute to conditions that would support blooms of golden algae that release toxins that kill fish and other aquatic life would likely contribute to conditions that would support blooms of golden algae that release toxins that kill fish and other aquatic life.

Particularly in light of the high quality of the impacted resources, it is unlikely that the CMP for the project would offset these impacts. The proposed on-site created streams will be unlikely to replace the physical, chemical, and especially biological functions of Pigeonroost Branch and Oldhouse Branch.

For these reasons, I find that discharges to Pigeonroost Branch and Oldhouse Branch as currently authorized by DA Permit No. 199800436-3 (Section 10: Coal River) would be likely to have unacceptable adverse effects on wildlife.

Region III notes that, in addition to the adverse effects that form the basis of this Recommended Determination, there are other impacts about which Region III continues to have concerns. To the extent that discharge of excess spoil outside jurisdictional waters, deforestation, and other activities associated with the project depend upon specification of Pigeonroost Branch and Oldhouse Branch as disposal sites, adverse impacts on wildlife would likely result from those dependent activities. In addition, impacts from the project will contribute to cumulative impacts from multiple surface mining activities in the Coal River sub-basin. Region III continues to be concerned regarding environmental justice issues.

Accordingly, pursuant to Section 404(c) of the Clean Water Act and its implementing regulations at 40 C.F.R. Part 231 and for the reasons set forth herein, it is my recommendation that the specification embodied in DA Permit No. 199800436-3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material for construction of the Spruce No. 1 Surface Mine be withdrawn.

Dated: September 24, 2010

Shawn M. Garvin
Regional Administrator
EPA Region III

- Deer hunting is the most popular hunting and fishing-related public use on the refuges. Hunting programs also offer opportunities to take dove, waterfowl, rabbits, squirrels, raccoons, other fur bearers, turkey, and feral swine. Large portions of the refuges are accessible by all-terrain vehicles on designated trails, which are only available for hunting and fishing purposes.
- Waterfowl hunting is the second most popular hunting and fishing-related public use on the refuges. Records obtained through hunter use card returns on Panther Swamp NWR indicate that approximately 1,000 people hunt waterfowl each year depending on waterfowl abundance which is dependent on available rainfall, backwater flooding and riverine sources for food and rest areas. The proposed pump project will result in reductions in spring flooding, which will reduce the quality and quantity of waterfowl habitat during the remainder of the year. This would cause waterfowl to disperse to other locations on and off the affected area of the refuge. Hunters will then seek alternate areas causing a negative impact to waterfowl hunting on the NWR and the local economy.
- Fishing is the third most popular hunting and fishing-related public use on the refuges. There are numerous lakes and streams suitable for fishing on the refuges, and boat ramps are available on Panther Swamp NWR. In 2007, 3,000 visits were associated with fishing within the affected area of Panther Swamp NWR. Most of this is subsistence angling by economically disadvantaged people in the local area. Further degradation of the fishery anticipated as a result of the proposed project would reduce quality fishing opportunities on Panther Swamp NWR dramatically impacting local anglers.

The FWS fully anticipates that the proposed project's adverse impacts to fish and wildlife habitat values on the four NWR's in the Yazoo Backwater Area would adversely impact visitation and recreational opportunities, as well as environmental education and interpretation opportunities at these refuges – particularly as examples of remaining intact Lower Mississippi Alluvial Valley bottomland hardwood ecosystems. Although EPA does not cite impacts to recreation as a basis for this Final Determination, it is likely that these impacts would be significant.

B. Environmental Justice

In recognizing that minority and/or low-income communities frequently may be exposed disproportionately to environmental harms and risks, EPA is committed to protecting these burdened communities from adverse human health and environmental effects, consistent with Executive Order 12898 (EO), "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Feb. 11, 1994)." The main provision of EO 12898 states that "To the greatest extent practicable and permitted by law,…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (EO 12898, Section 1-101).

During its NEPA review of the Yazoo Backwater Area Project, the Corps included an environmental justice (EJ) analysis, conducted pursuant to EO 12898, in the FSEIS (FSEIS, Appendix 8 – Problem Identification/Socio-Econ Profile/Environmental Justice). Because EO 12898 directs agencies to implement its provisions "consistent with, and to the extent permitted

by, existing law" (EO 12898, Section 6-608), the scope of an EJ analysis is directly tied to the statutory and regulatory authority for the federal agency action. When the Corps reviews a project to determine whether to grant authorization under CWA section 404, it conducts a broad "public interest review" based on an evaluation of the "probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest" (33 CFR 320.4). In addition, under NEPA, the Corps examines the environmental effects, including human health, economic and social effects, of the project (33 CFR 230.1 and 230.4; 40 CFR 1508.8 and 1508.14).[25] Thus, in conducting its EJ analysis for the Yazoo Backwater Area Project the scope of the Corps' authority was broad and it considered a wide range of environmental, social and economic factors.

The Corps' EJ analysis discusses the general demographics of the project area, potential flood protection and potential economic development that could accrue from the project within communities with potential EJ concerns. EPA commends the Corps for including the EJ analysis in the FSEIS. However, the Corps EJ analysis may convey a message to members of communities with potential EJ concerns that specific flood control and economic development benefits will follow the completion of the project. Given the communities' expectations of the benefits of the project, EPA believes that it is appropriate to discuss the proposed benefits of the project that EPA believes may not be realized.

The Corps has not demonstrated which surrounding communities will be protected and which will remain subject to flooding after the project is completed. Since publication of the FSEIS, the Corps has provided EPA with Corps flood maps and GIS data indicating the location of structures within the 10-, 50-, and 100-year floodplains of the project area. According to the Corps' maps, most structures within the sparsely populated project area will not be protected from future flooding while a portion of the structures will benefit from the project. However, the maps do not include elevation information, structure type (i.e., residence, business, farm building, garage, etc.), whether the structures are habitable, and if so occupied or vacant, or what proportion of these structures are owned/occupied by residents with potential EJ concerns. Without the inclusion of the relative proximity of susceptible minority and/or low-income populations to the floodplains, it is impossible to know whether any such communities will be protected against 1-year, 2-year, or 100-year floods.

The Corps has not fully analyzed the impact of this project on potential economic development in communities with potential EJ concerns. According to the FSEIS, the primary economic benefits that may accrue from this project are from increased agricultural production. However, the primary agricultural beneficiaries have declined over 50 years from 2,913 farmers who owned 140 acres each to 192 farmers who own 2,036 acres each. While farm land use has increased in the area, earnings and overall contribution to the local economy have declined from 42 percent in 1969 to 17.4 percent by 2000 (FSEIS, Appendix 8, Table 8-23). The substantial decrease in small farms and farmers and the increased mechanization and industrialization within the project area may impact farm ownership and farm employment opportunities for members of communities with potential EJ concerns. Moreover, instead of resulting in additional farming jobs, post-project farm employment may continue to decrease due to greater opportunities for

[25] The requirements of NEPA do not apply to EPA when taking an action under 404(c). See CWA section 511(c)(1).

intensified farming and increased access to drier land, which may further promote the use of greater mechanization.

In the Proposed Determination, EPA Region IV raised concerns that the FSEIS did not address potential adverse impacts to populations that depend on subsistence fishing and/or hunting. EO 12898 states that "[i]n order to assist in identifying the need for ensuring protection of populations with differential patterns of subsistence consumption of fish and wildlife, Federal agencies, whenever practicable and appropriate, shall collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence" (EO 12898, Section 4-4).

The project sponsor's comments on EPA's Proposed Determination and Recommended Determination stated that the Yazoo Backwater Area is sparsely populated and very few people rely on subsistence hunting or fishing. The Corps stated that it does not believe that the proposed project would adversely impact subsistence fishing and/or hunting as it relates to communities with potential EJ concerns. Recent studies conclude that subsistence fishing and hunting in the Mississippi Delta is conducted by members of communities with potential EJ concerns (Brown, Xu and Toth 1998). EPA notes that those practices could be affected by the proposed project's adverse impacts on the areas' fisheries and wildlife resources. Brown and Toth (2001) state that "[t]he rich natural resource base of the [MS] Delta is accessed extensively and in some cases intensively by local residents." Brown and Toth also state that white subsistence fishers in the Mississippi Delta eat over 100 pounds of fish a year, while African American subsidence fishers may consume fish at even greater numbers. As evidence of current subsistence fishing and/or hunting, EPA received comments from FWS; conservation organizations (e.g., American Rivers, Gulf Restoration Network, National Wildlife Federation, National Audubon Society, etc.); and private citizens, stating that low-income and minority residents in the Yazoo Backwater Area rely on fish and other wildlife, taken from the project area, to supplement their food sources and income and can be classified as subsistence fishers and/or hunters. FWS stated "[i]n 2007, 3,000 visits were associated with fishing within the affected area of Panther Swamp NWR [in the Yazoo Backwater Area]. Most of this is subsistence angling by economically disadvantaged people in the local area. Further degradation of the fishery anticipated as a result of the project is expected to reduce quality fishing opportunities on Panther Swamp NWR and this will have a dramatic impact to the local anglers." Given EPA's conclusion above that the proposed project would significantly degrade critical habitat for over 50 species of fish and other wildlife in the Yazoo Backwater Area and the impacts to the wetlands, fish and wildlife resources cannot adequately be mitigated, it is likely the project could adversely impact minority and/or low-income populations that depend on the Yazoo Backwater Area's natural resources for subsistence.

The project sponsor contends that, because the studies cited above were based on surveys made prior to the issuance of a fish advisory by the Mississippi Department of Environmental Quality in June of 2001, none of the data can be applied to the use of subsistence fishing by minorities today. The 1998 and 2001 studies on subsistence fishing and hunting in the Mississippi Delta provide evidence that subsistence fishing by minorities has historically occurred and support EPA's conclusion, based on comments received from the FWS and several conservation

organizations and individuals that subsistence fishing does in fact occur presently in the Yazoo Backwater Area.

Again, EPA commends the Corps for including the EJ analysis in the FSEIS for the proposed project; however, EPA believes the Corps has not demonstrated the project would provide the proposed benefits of flood protection and economic development, specifically to members of communities with potential EJ concerns in the Yazoo Backwater Area. Additionally, when determining the project would benefit members of communities with potential EJ concerns, the Corps did not examine whether the proposed project would adversely impact minority and/or low-income populations that depend on the Yazoo Backwater Area's natural resources for subsistence.

Like the Corps, EPA has met with the members of local communities with potential EJ concerns and listened to their concerns and expectations regarding the Yazoo Backwater Area Project. The members of communities with potential EJ concerns with whom EPA met expressed a strong belief, based on the proposed benefits touted by the project sponsor, that the project would protect their homes and property against flooding and bring economic development, jobs, and a return of residents to the area. However, as noted above, these project benefits have not been demonstrated. EPA is very sensitive to the importance of providing improved flood protection for the people living and working in the project area, which includes minority and low-income populations. Although EPA's section 404(c) determination would effectively prohibit the construction of the pumps as proposed, the Agency continues to believe there are alternatives that can provide improved flood protection or mitigation of flood damage to the communities within the Yazoo Backwater Area and EPA remains fully committed to participating in discussions with other federal and state agencies, and the public, to identify a solution for reducing flood damages in the Yazoo Backwater Area.

An EPA action pursuant to CWA section 404(c) should also consider the EJ impacts of the Agency's action under EO 12898. Given the Agency's commitment to environmental justice, during the section 404(c) process it examined, to the greatest extent practicable and permitted by law, any "disproportionately high and adverse human health or environmental effects" that may result from undertaking a 404(c) action in the context of the Yazoo Backwater Area Pumps Project.

The federal agency action that EPA is reviewing in the context of EO 12898 in this case is EPA's utilization of section 404(c) to preserve the fish and wildlife resources of the Yazoo Backwater Area by protecting important habitat. In the context of section 404(c), review of the Agency's action under EO 12898 is unique since EPA is not the permitting authority.

As stated above, the scope of an EJ analysis is directly tied to the statutory and regulatory authority for the federal agency action. Under CWA section 404(c), EPA is authorized to prohibit, restrict, or deny the specification of a defined area as a disposal site for the discharge of dredged or fill material into waters of the United States only when it determines that the discharge would have an unacceptable adverse effect on "municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas." Thus, when EPA examines whether there are any "disproportionately high and adverse human

health or environmental effects," in the context of a section 404(c) action, EPA examines the potential effects prohibiting the discharge will have on the "municipal water supplies, shellfish beds and fishery areas, wildlife and recreational areas" ("404(c) resources") of the project site. EPA then examines whether those effects, if any, of the section 404(c) action on the 404(c) resources will have a "disproportionately high and adverse human health or environmental [effect]" on "minority populations and low-income populations" of the project area.

Applying the analysis above, EPA examined the potential effects of prohibiting the proposed project on the 404(c) resources that are located in the Yazoo Backwater Area and what effect that would have, if any, on members of communities with potential EJ concerns. EPA's section 404(c) action, by prohibiting the project, is preventing any impact to the 404(c) resources. With no project and no unacceptable adverse effect on the 404(c) resources, there are no disproportionately high and adverse human health or environmental effects on the minority or low-income populations of the project area.

As stated above, EPA has questions on whether there would be substantial economic development or flood control benefits that would specifically go to members of communities with potential EJ concerns in the Yazoo Backwater Area. However, even if there were, economic development and flood control are outside the scope of 404(c) and thus outside the scope of EPA's EJ review under EO 12898. EPA's authority under 404(c) is limited to prohibiting, restricting, or denying the specification of any defined area as a disposal site for the discharge of dredged or fill material into waters of the United States only when it determines that the discharge would have an unacceptable adverse effect on 404(c) resources. A section 404(c) review does not involve a balancing of environmental benefits against non-environmental costs, such as the benefits of the foregone project (see 44 FR 58078). EPA wants to make clear that while economic development and flood control are outside the scope of section 404(c), and thus an EJ review conducted in the context of section 404(c), the Agency acknowledges the importance of providing improved flood protection to all community members in the project area, including members of communities with potential EJ concerns. As previously stated, EPA remains fully committed to participating in discussions with other federal and state agencies, and the public, to identify a solution for reducing flood damages in the Yazoo Backwater Area.

For the reasons stated above, EPA concludes that its section 404(c) determination will not have a disproportionately high and adverse human health or environmental effects on minority or low-income populations of the project area.

C. Project Alternatives

The FSEIS evaluates ten alternatives, including four alternatives with combined structural and nonstructural features, one completely structural alternative, four primarily nonstructural alternatives, and the "no action" alternative. The completely structural alternative (Plan 3 in the FSEIS) and all of the combination alternatives (Plans 4 through 7) include a 14,000 cfs pump station. They vary with respect to pump-on elevation (i.e., between 80 and 91 feet, NGVD), nonstructural features (except for Plan 3), and operational plans for the Steele Bayou control

Frank Borsuk/R3/USEPA/US
11/03/2010 08:51 AM

To Carrie Traver
cc David Rider, Greg Pond, Louis Reynolds, Margaret Passmore, Regina Poeske
bcc borsuk.frank
Subject Lemly reference clarification -- Re: it's friday, it must be time for...Spruce References!

Carrie:

The 2006 Lemly reference is actually 2007 as supplied by Dave Rider.

Frank

p.s. I am reviewing Lemly again to verify.

Carrie,

I placed a Lemly reference on the G:Share/References for Carrie. I don't remember if it was one that we need but it does have many of his references listed.

I tried to upload it to the connector but received an error and could not complete the upload.

Lemly, A. Dennis; A Procedure for NEPA Assessment of Selenium Hazards Associated With Mining
Environ Monit Assess (2007) 125:361-375

Dave

Frank Borsuk, Ph.D.
Aquatic/Fisheries Biologist
Freshwater Biology Team
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Please visit our website at http://epa.gov/reg3esd1/3ea50.htm

Carrie Traver | It was good to meet you Wheeling folks this we... | 10/29/2010 04:41:08 PM

From: Carrie Traver/R3/USEPA/US
To: Greg Pond/R3/USEPA/US@EPA, Margaret Passmore/R3/USEPA/US@EPA, Frank Borsuk/R3/USEPA/US@EPA, Louis Reynolds/R3/USEPA/US@EPA
Cc: David Rider/R3/USEPA/US@EPA, Regina Poeske/R3/USEPA/US@EPA
Date: 10/29/2010 04:41 PM
Subject: it's friday, it must be time for...Spruce References!

It was good to meet you Wheeling folks this week! I hope to see you in WV sometime soon.

Obviously, you didn't have any time to send references this week; I just wanted to let everyone know where we are. To summarize, here's what I will need to wrap up the reference portion:

These are on the reference list, but I need a copy:

- USFWS unpublished data 2005 (about White Oak Branch survey) (p30)

- Green, J., & Passmore, M. (1999). *Field survey report: an estimate of perennial stream miles in the area of the 1997 proposed Hobet Mining Spruce No. 1 Mine* . US Environmental Protection Agency. Wheeling, WV.

- Vesper, D., Roy, M., & Rhoads, C. L. (2008). Selenium distribution and mode of occurrence in the Kanawha Formation, southern West Virginia, U.S.A. *International Journal of Coal Geology, 73* , 237-249.

I don't have these on the reference list, so I need full citations and/or copies, if possible:

- Lemley 2006 Appendix 2 (p43)

- WV 1999 Appendix 3 (p2)

- Webster & Benfield 1986 (p 10) **(Greg supplied this to HQ)**

Greg--if you get that Wright reference in Appendix 1 straightened out with HQ, let me know.

Thanks for the response!
Carrie

Carrie Traver
USEPA Region 3
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1650 Arch Street - 3EA30
Philadelphia, PA 19103
215-814-2772
traver.carrie@epa.gov

John Pomponio/R3/USEPA/US
11/04/2010 01:28 PM

To "Michael Dunn"
cc "Jeffrey Lapp", "John Forren", "Stefania Shamet"
bcc
Subject Fw: Discussion Document for MTM Call on 11.5.10

I'd like to meet on this Monday pm. Please help set it up
Sent by EPA Wireless E-Mail Services
John Pomponio

----- Original Message -----
From: John Pomponio
Sent: 11/04/2010 01:26 PM EDT
To: Amy Caprio
Subject: Re: Discussion Document for MTM Call on 11.5.10
Thanks Amy
Sent by EPA Wireless E-Mail Services
Amy Caprio

----- Original Message -----
From: Amy Caprio
Sent: 11/04/2010 01:16 PM EDT
To: Michael Dunn; John Pomponio; Jeffrey Lapp; Jon Capacasa; Evelyn MacKnight; Francisco Cruz
Subject: Discussion Document for MTM Call on 11.5.10
Per your request Mike

Amy

Executive Assistant
U.S. EPA Region III
1650 Arch Street (3DA00)
Philadelphia, PA 19103

p: 215.814.2156
e: caprio.amy@epa.gov

----- Forwarded by Amy Caprio/R3/USEPA/US on 11/04/2010 01:15 PM -----

From: Shawn Garvin/R3/USEPA/US
To: Amy Caprio/R3/USEPA/US@EPA
Date: 11/04/2010 01:14 PM
Subject: Fw: Discussion Document for 5:00 MTM Conference Call
Sent by: Janice Donlon

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11/04/2010 04:13 PM

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Manganese Bioconcentration in Aquatic Insects: Mn Oxide Coatings, Molting Loss, and Mn(II) Thiol Scavenging

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Streams below mountaintop removal-valley fill coal mining operations often have elevated Mn concentrations, but it remains unclear if Mn plays a role in biodiversity reduction. We examined various aspects of aqueous Mn interactions with aquatic insects exposed to environmentally relevant Mn concentrations, revealing complex behavior. First, Mn accumulation rates varied widely among 9 species. A significant percentage of total Mn accrued (mean 74%, range 24−95%) was associated with the cuticle, predominantly in the form of Mn-oxides, and to a lesser degree Mn(II). Mn II is also absorbed into tissues, possibly through calcium transporters. Increased ambient calcium concentrations decreased both adsorbed and absorbed Mn accumulation from solution. Though species showed similar Mn efflux rate constants (0.032−0.072 d^{-1}), the primary mode of Mn loss was through molting. Both adsorbed and absorbed Mn is lost during the molt. Subcellular compartmentalization studies revealed an overwhelming tendency for internalized Mn to associate with the heat stable cytosolic protein fraction. After short dissolved Mn exposures, intracellular glutathione and cysteine levels were markedly reduced relative to controls. These findings suggest that Mn exposure results in transient physiological stress in aquatic insects which is likely relieved, in part, during the molting process.

Introduction

Manganese is the 12th most common element in the Earth's crust, yet it is not commonly studied in freshwater ecosystems relative to other transition metals such as zinc, copper, cadmium, and mercury (the 24th, 26th, 72nd, and 73rd most common elements in the earth's crust, respectively (*1*)). Much work has focused on Mn in sediments; however, Mn in cobble bottomed streams is surprisingly understudied and perhaps overlooked in situations where it co-occurs with more toxic elements. Manganese is a common constituent of ore and coal mining and smelting related discharges and other industrial effluents. Our interest in Mn stems from its occurrence at relatively high concentrations below mountaintop removal - valley fill (MTM-VF) coal mining operations in Appalachia (*2, 3*).

The environmental chemistry of Mn is complex. At neutral to mildly alkaline aerobic conditions, such as those found in Central Appalachian coal mining areas, Mn is expected to occur in both Mn(II) and Mn(IV) oxidation states (*4*). Mn(II) is considered to be the most bioavailable form, particularly while occurring as the free ion Mn^{2+}. Mn(IV) occurs as relatively insoluble oxide precipitates under aerobic conditions and can be visible as dark coatings on stream bottoms and on the cuticles of stream insects (*4*). Importantly, the oxidation of Mn(II) to Mn(IV) can be carried out by several species of bacteria and fungi, which often occurs more rapidly than abiotic oxidation (*5*−*7*).

It is increasingly recognized that ecological conditions in streams below MTM-VFs are typically poor (see review (*8*)), and field studies show that aquatic insect diversity is decreased as a function of mining impact, with mayfly genera being particularly affected (*2, 3, 9, 10*). Changing hydrology (*10*−*12*) and degraded water quality (*3*) are often thought to be potential causes. Water quality concerns include elevated pH (*3*) and elevated concentrations of dissolved solids (*8*), selenium (*13*), and manganese (*2*). Pond et al. (*3*) report that average dissolved Mn concentrations in mine-impacted streams were more than 5-fold higher (mean 113.4, range 6.5−853 μg Mn L^{-1}) than those in streams unaffected by mining (mean 20.9, range <5−55 μg Mn L^{-1}). Mine effluent directly discharged into streams can contain Mn concentrations ranging up to 4−5 mg L^{-1}. One field study found a negative correlation between richness of Ephemeroptera, Plecoptera, and Tricoptera (EPT) taxa and Mn concentration (*2*), though interpretation of these findings is confounded by the presence of other water chemistry parameters (e.g., total dissolved solids) that are well outside of typical regional values. It therefore remains unclear whether these elevated Mn concentrations contribute to degraded ecological conditions in MTM-VF affected streams.

Aquatic insects dominate stream ecosystems and play important roles in ecosystem function as a link between the base of the food web (e.g., algae, bacteria) and higher order consumers (e.g., fish, birds). In general, bioassessment (survey) methods that focus on insect communities cannot determine which stressors are most responsible for ecological impairment. Moreover, stream insects are generally not well represented in toxicity databases (*14*) and may not be adequately represented by standard invertebrate toxicity models (e.g., daphnids) that either do not occur in streams or do not share fundamental physiological traits. As we are unaware of any laboratory studies focused upon aquatic insects and Mn, this paper represents a first step toward understanding Mn bioaccumulation and physiological responses in stream insects and is a starting point for future investigations.

Here we explore Mn bioaccumulation kinetics from solution in a variety of field collected aquatic insects. We use Michaelis−Menten type kinetic experiments to examine Mn transport in the caddisfly *Hydropsyche betteni* and compare dissolved uptake and efflux rates in common Southern Appalachian stream insects. We assess the influence of calcium concentration on Mn accumulation. We further quantitatively discriminate between Mn adsorbed to insect cuticles (predominantly as oxides) and Mn incorporated into tissues. The subcellular compartmentalization of Mn is compared among several species, and the effect of Mn exposure on thiol status is examined. Together, these studies provide a framework for understanding the potential effects of Mn on stream insects.

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Methods and Materials

Insect Collection and Handling. Insect larvae were field collected using a D-frame kicknet on several dates in 2009 and 2010 from two sites in North Carolina (Basin Creek and Eno River) and transported back to the lab in a cooler containing river water and substrate (cobbles). Insects were sorted in the lab, and voucher specimens were preserved in ethanol for species verification. Live animals from each collection were allowed to acclimate in American Society for Testing and Materials (ASTM) artificial soft water (ASW) (48 mg L^{-1} $NaHCO_3$, 30 mg L^{-1} $CaSO_4 \cdot 2H_2O$, 30 mg L^{-1} $MgSO_4$, and 2 mg L^{-1} KCl) for at least twenty-four hours with aeration in a walk-in cold room at 11.5 ± 1.0 °C and a 12:12 h light: dark photoperiod.

Manganese Kinetics in Multiple Species. We compared dissolved Mn uptake kinetics in several common Appalachian species - *Ephemerella dorothea*, *Drunella cornutella*, *Maccaffertium pudicum*, *Epeorus vitreus*, *Acroneuria carolinensis*, *Pteronarcys* sp., and *Hexatoma* sp. collected from Basin Creek (Wilkes County, NC) in June, 2009. Five individual larvae from each species (except *Pteronarcys* where $n = 3$, and *D. cornutella* where $n = 10$) were used. A solution with a nominal Mn concentration of 25.6 μg L^{-1} in ASW was spiked with ^{54}Mn (total activity =0.0632 MBq L^{-1}) as $^{54}MnCl_2$ (1.4 ng L^{-1} Mn), with the remainder of Mn added as stable $MnCl_2$. The pH was adjusted to 7.7 using 0.1 N NaOH. To ensure that replicates received identical exposure regimes, bulk solutions were prepared and distributed to individual 50 mL HDPE beakers. Each larva was placed into individual beakers with 40 mL of solution with aeration and a piece of Teflon mesh as substrate. At 2, 4, 6, and 8 h each animal was assayed *in vivo* for radioactivity using a Wallac Wizard gamma counter. After 8 h, each larva was weighed, and those exhibiting significant Mn accumulation (*E. dorothea*, *D. cornutella*, *M. pudicum*, *A. carolinensis*, *Pteronarcys* sp.) were exposed for an additional 24−48 h to accumulate sufficient radioactivity for subsequent 10 day depuration experiments (see the Supporting Information). (For molting loss methods and results see the Supporting Information.)

Dissolved Manganese Uptake in H. betteni. To examine dissolved Mn uptake, *Hydropsyche betteni* were field collected from the Eno River (Orange County, NC) on January 30 and February 25, 2009. Animals collected in January were individually exposed to 10.2, 25.6, 64, 160, and 400 μg Mn L^{-1} (0.19, 0.47, 1.17, 2.91, and 7.28 μM) in 50 mL HDPE beakers containing a total volume of 40 mL ASW with ^{54}Mn radiotracer (0.0646 MBq L^{-1}). February exposures were to a lower range of Mn concentrations: 0.26, 0.66, 1.64, 4.10, and 10.2 μg L^{-1} (4.77, 11.92, 29.82, 74.56, and 186.39 nM) with ^{54}Mn radiotracer (0.0608 MBq L^{-1}). Solutions were adjusted to pH 7.6−7.7. Animals were exposed as described above. Each concentration was represented by five replicates, with each replicate consisting of a single larva. After 1, 3, 6, 9, and 24 h of exposure, the animals were removed, rinsed with clean ASW, assayed *in vivo* for radioactivity, and then returned to their exposure containers. To ensure that manganese concentrations remained consistent, exposure water was renewed after the 9 h time point. After 24 h, the animals were rinsed with clean ASW and weighed. Larvae from the 25.6, 64, 160 μg L^{-1} (0.47, 1.17, and 2.91 μM) exposures were frozen and stored at −20 °C. Insects from the 10.2 and 400 μg L^{-1} (0.19 μM and 7.28 μM) treatments were individually placed into 500 mL beakers containing clean ASW for depuration studies (see the Supporting Information).

Manganese uptake rates were calculated for each individual at each exposure concentration. The mean of 5 replicate slopes was taken as the uptake rate at a given concentration and Michaelis−Menten kinetic parameters, V_{max} and K_m, were calculated using GraphPad Prism 5.0 software.

Adsorbed Manganese Oxide Determination. Insects were collected from the Eno River, NC on January 13, 2010 (*Cheumatopsyche* spp., *Maccaffertium modestum*, and *Isonychia* spp.) and from Basin Creek on January 28, 2010 (*Cheumatopsyche* spp., *Diplectrona modesta*, *Rhyacophila fuscula*, mixed *Leptophlebiid* species, mixed *Maccaffertium* species, *Acroneuia abnormis*, *Malirekus hastatus*, and *Acroneuria carolinensis*). The insects were exposed to 100 μg Mn L^{-1} with ^{54}Mn as a radiotracer as described above (total activity = 0.0629 MBq L^{-1}) and assayed daily for radioactivity. On day four, they were counted and subjected to an ascorbate rinse (see the Supporting Information). Animals were assayed again for radioactivity, and percent Mn lost during the rinse was calculated. Selected species from Basin Creek with substantial radioactivity measured after this rinsing procedure were used for subcellular fractionation experiments (see below).

Calcium Competition. To examine the influence of Ca^{2+} concentrations on dissolved Mn accumulation in insects, we exposed larvae collected from Basin Creek to 24.2 μg Mn L^{-1} with ^{54}Mn as a radiotracer (total activity = 0.0637 MBq L^{-1}) under four conditions. ASTM recipes for very soft (VSW), moderately hard (MHW), and very hard (VHW) waters were prepared in addition to the base very soft water recipe with additional Ca (VSW+Ca) added (as $CaSO_4$) such that total Ca content matched the VHW treatment (Table S1). *Acroneuria* spp., *Ephemerella dorothea, Drunella cornuta*, and *Maccaffertium pudicum* were exposed to Mn under each ambient Ca condition for 24 h. After 24 h of exposure, animals were rinsed with DI water, assayed for radioactivity, and then ascorbate rinsed to remove Mn oxide precipitates. Insects were assayed again for radioactivity, weighed, and frozen at −20 °C.

Subcellular Fractionation. Cheumatopsyche spp., *Diplectrona modesta*, *Maccaffertium* spp., *Acroneuria abnormis*, *Acroneuria carolinensis*, and *Malirekus hastatus* from Basin Creek were used to determine the subcellular compartmentalization of Mn within insect tissue. Single animals were homogenized in 8 mL of phosphate buffer (pH = 7.4). The fractionation scheme was a slightly modified version of Wallace et al. (*15*) and described elsewhere for insects (*16, 17*). Fractions obtained were cell debris (including cuticle chitin), organelles, microsomes, heat-denatured proteins (HDP), and heat-stable proteins (HSP) and are reported on the basis of recovered Mn.

Thiol Analysis. *Hydropsyche betteni* were collected from the Eno River on September 02, 2009. Animals were exposed to Mn at concentrations of 0 (control), 5, 50, or 500 μg Mn L^{-1} for four days. For each treatment there were three replicates consisting of 2−3 insects each. After exposure, animals were rinsed with DI water, weighed, and frozen at −20 °C. They were homogenized in 10 mM N-ethylmaleimide (NEM) with 1 μM reserpine in water at a mass (mg) to volume (μL) ratio of 1:19. Samples were centrifuged to remove debris, and the supernatant was analyzed using an LC-MS for concentrations of reduced and oxidized glutathione and cysteine. Methods were adapted from ref *18* and described elsewhere (*19*). *Cheumatopsyche* spp. and *Maccaffertium modestum* collected from the Eno River on January 13, 2010 were also used for thiol analysis. Animals were exposed a typical environmental concentration of 100 μg Mn L^{-1} for four days and then frozen at −20 °C. For each species, there were three replicates for both control and Mn exposures, with 2−3 insects per replicate. They were prepared for analysis as described above.

Statistics. Graphs and statistical analysis were completed using GraphPad Prism (Version 5.0) software. Discrepancies from controls were determined using *t* tests ($\alpha = 0.05$). V_{max} and K_m values were determined by using a best-fit Michaelis−

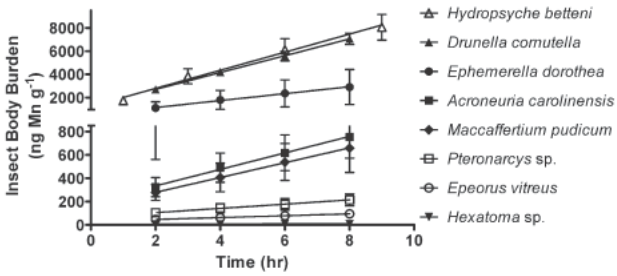

FIGURE 1. Manganese body burdens (ng Mn g^{-1} wet weight) as a function of exposure time for insects exposed to 25.6 μg Mn L^{-1}. Data points (n = 5 except *Drunella* where n = 10 and *Pteronarcys* where n = 3) are mean ± standard deviation. The slope of each line represents the accumulation rate.

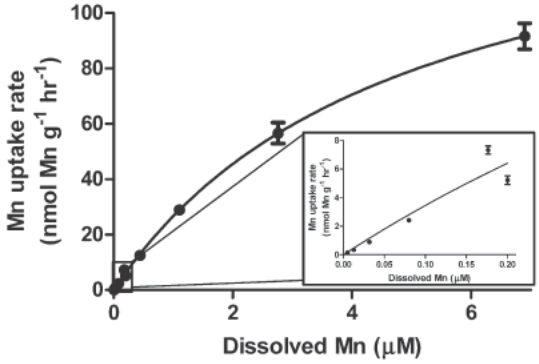

FIGURE 2. Michaelis–Menten modeling of Mn uptake rates (mean ± standard deviation; n = 5) in *Hydropsyche betteni* as a function of Mn exposure concentration (r^2 = 0.9955). Inset is the linear portion of the curve, showing data from Mn concentrations of 0.26 to 10.2 μg L^{-1} (4.77 to 186.4 nM).

Menten function in Prism. Unless otherwise noted, all values are given as mean ± standard deviation.

Results

Manganese Accumulation. Aqueous Mn accumulation rates ranged over 3 orders of magnitude across several species exposed to 25.6 μMn L^{-1}. The caddisfly *H. betteni* and the ephemerellid mayfly *D. cornutella* had the fastest accumulation rates of Mn from solution during short-term exposures, 780 and 725 ng Mn g^{-1} h^{-1}, respectively (Figure 1). The tipulid *Hexatoma* sp. and the heptageniid mayfly *E. vitreus* had negligible accumulation from solution. The remaining insect species were intermediate in Mn accumulation: another ephemerellid mayfly *E. dorothea* and the heptageniid mayfly *M. pudicum* had accumulation rates of 299 and 64 ng Mn g^{-1} h^{-1}, respectively (Figure 1). Stonefly species *A. carolinensis* and *Pteronarcys* sp. had accumulation rates of 71 and 18 ng Mn g^{-1} h^{-1}, respectively (Figure 1).

Manganese accumulation rates across a wide range of concentrations (0.26–400 μg L^{-1}; 4.77 nM–7.28 μM) followed a Michaelis–Menten type kinetics pattern in *H. betteni*. Estimates of maximal transport rate (V_{max} = 8.58 ± 0.25 μg Mn g^{-1} h^{-1} (156.1 ± 4.6 nmol Mn g^{-1} h^{-1}), r^2 = 0.9955) and affinity (K_m = 266.7 ± 15.0 μg L^{-1} (4.86 ± 0.27 μM Mn)) (mean ± standard error) suggest that total Mn accumulation rates in this species are extremely rapid (Figure 2). This finding suggests that Mn transport in *H. betteni* occurs via a low affinity, high capacity transport system. We found no evidence for a complementary high affinity, low capacity transport system at concentrations as low as 0.26 μg L^{-1} (4.769 nM) (Figure 2, inset).

As these initial experiments with *H. betteni* did not discriminate between absorbed (true uptake) and adsorbed Mn accumulation, they should be interpreted as total accumulation and not true transport. Since all larvae used in these experiments (excluding those used in efflux studies as described in the Supporting Information) were archived (frozen), we were able to use ascorbate rinses to "correct" for surface adsorption of Mn oxides. On average, 41.9% of total radioactivity in *H. betteni* was removed with this rinsing process, representing loss of surface adsorbed metal.

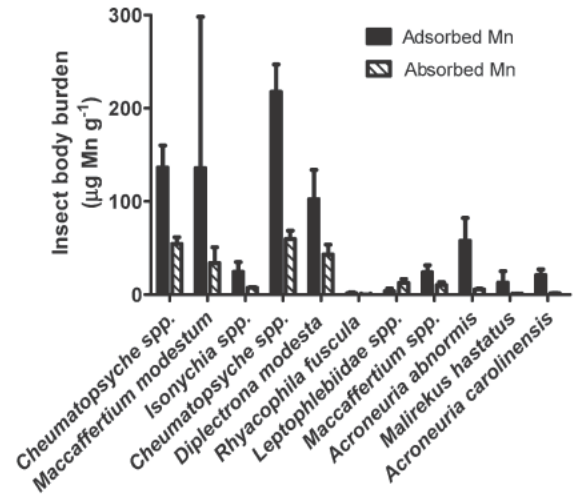

FIGURE 3. Mean (±standard deviation) body burden (μg Mn g^{-1} wet weight) of adsorbed and absorbed Mn in several species exposed to 100 μg/L for 4 days. Bar sets 1–3 represent animals collected from the Eno River, NC on January 13, 2010. Subsequent bars represent insects collected from Basin Creek, NC on January 28, 2010. (See Table 1 for subcellular compartmentalization data for absorbed Mn in selected taxa.)

We further compared the relative contribution of surface adsorption (as Mn oxides) and internalized (i.e., absorbed) Mn to total Mn body burdens after aqueous exposures to 11 species (Figure 3). On average, species (n = 11) lost 74 ± 21.7% of their radioactivity after rinsing. *M. hastatus* lost the largest percentage of Mn, 95 ± 1.23%, while mixed *Leptophlebiid* species only lost 24 ± 16.4% of their accumulated Mn. Thus, significant Mn associated with insects seems to be in the form of Mn oxide coatings on the cuticle.

Influence of Water Chemistry on Mn Absorption and Adsorption. Because calcium concentrations can be elevated in mine-impacted streams, animals were exposed to 24.2 μg Mn L^{-1} under various ionic strengths and Ca concentrations. In general, both Mn absorption and adsorption decreased with increasing ionic strength and Ca concentrations (Figure 4). For *Acroneuria* spp., Mn oxide accumulation after 24 h was significantly decreased from controls (VSW) by 84.4 (p = 0.0026) and 80.1% (p = 0.0225) in VHW and VSW+Ca treatments, respectively (Figure 4a). Post ascorbate rinse, internalized Mn accumulation was significantly decreased by 53.2 (p = 0.0127) and 60.3% (p = 0.0346) in VHW and VSW+Ca treatments, respectively (Figure 4a). Though not statistically significant, adsorbed Mn on *Drunella cornuta* was highest in VSW relative to the other treatments (Figure 4c), but absorbed Mn burdens were significantly decreased in VHW and VSW+Ca treatments by 53.1 (p = 0.0023) and 59.9% (p = 0.0002), respectively (Figure 4c). Mn oxide formation on *Maccaffertium pudicum* was reduced significantly by exposure in VHW and VSW+Ca treatments, with burden reductions of 77.2 (p = 0.0005) and 76.2% (p = 0.0013), respectively (Figure 4b). The same trend was observed for absorbed Mn in *M. pudicum*, but the differences were not statistically significant (Figure 4b). Adsorbed Mn body burdens were significantly reduced by 64.7 (p < 0.0001), 72.4 (p < 0.0001), and 42.7% (p < 0.0001) in *Ephemerellid dorothea* exposed to MHW, VHW, and VSW+Ca treatments, respec-

TABLE 1. Percent of Recovered Mn Found in Each of Five Subcellular Fractions (Cell Debris, Organelles, Microsomes, Heat-Denatured Proteins, and Heat-Stable Proteins) for Six Insect Species[a]

species	% cell debris	% organelles	% microsomes	% heat-stable protein	% heat-denatured protein	total body burden (μg g^{-1})	% recovered	*n*
Cheumatopsyche spp.	26.6 ± 1.3	24.0 ± 6.7	9.4 ± 4.7	38.4 ± 9.8	1.5 ± 0.3	59.7 ± 12.6	80.2 ± 6.7	2
Diplectrona modesta	26.7 ± 5.1	16.5 ± 5.1	6.7 ± 5.9	48.2 ± 5.6	2.0 ± 0.4	43.0 ± 26.0	82.1 ± 6.6	6
Maccaffertium spp.	6.1 ± 2.4	1.8 ± 0.8	1.3 ± 0.6	90.1 ± 2.5	0.7 ± 0.5	10.3 ± 7.9	85.3 ± 4.3	6
Acroneuria abnormis	29.1 ± 18.5	3.5 ± 2.2	1.9 ± 0.7	62.2 ± 20.7	3.3 ± 2.3	5.6 ± 2.4	90.4 ± 2.0	6
Malirekus hastatus	13.3 ± 1.7	3.8 ± 1.1	1.9 ± 0.7	78.7 ± 1.9	2.2 ± 0.4	1.4 ± 0.5	85.7 ± 6.4	3
Acroneuria carolinensis	23.4 ± 15.1	3.6 ± 2.0	2.9 ± 1.4	65.7 ± 18.4	4.3 ± 2.8	1.5 ± 0.8	89.8 ± 5.8	6

[a] Values given as mean ± standard deviation.

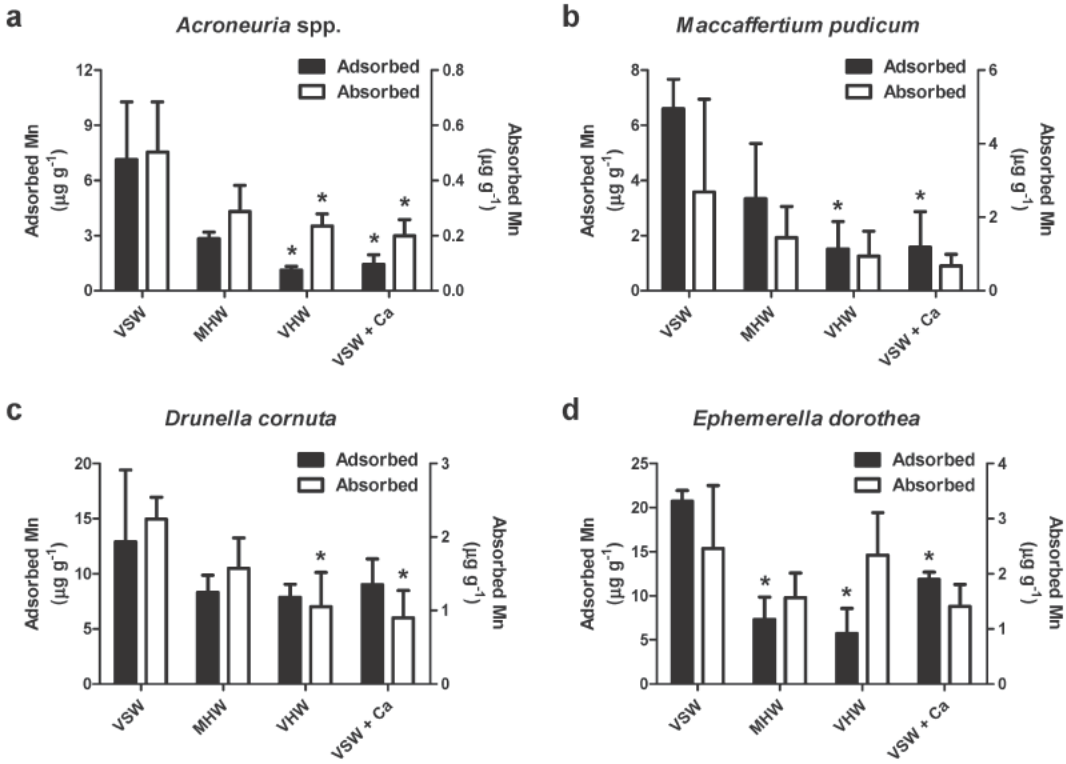

FIGURE 4. Mean adsorbed (black bars, left *y*-axis) and absorbed (white bars, right *y*-axis) manganese tissue concentrations in four insect species after 24 h dissolved exposures (24.2 μg Mn L^{-1}) in varying water chemistry conditions. VSW = very soft water; VSW+Ca = very soft water plus calcium; MHW = moderately hard water; VHW = very hard water. Tissue concentrations are presented on a wet weight basis (mean ± standard deviation).

tively (Figure 4d). No significant trends were observed for internalized Mn accumulation in this species (Figure 4d).

Manganese Elimination. Because bioaccumulation of metals from solution is a function of both uptake and efflux, we examined Mn loss kinetics in six stream insect species. Manganese elimination was modest in each species tested, with efflux rate constants ranging from 0.032 day^{-1} in *H. betteni* to 0.072 day^{-1} in *E. dorothea* (Figure S1).

Interestingly, although the loss of Mn was relatively slow in all species, we observed the apparent loss of nearly all accumulated Mn during the molting process, with the lost Mn recovered in the shed exuvia. Discrepancies between larvae and adult tissue Mn body burdens have also been found in field collected samples. Analysis of mayflies from the Clinch River (CR) and the Little Emory River (LER) in Tennessee show that nymphs had mean body burdens of 975 and 1215 μg Mn g^{-1} dry weight, respectively. However, adults collected from the same sites contained means of only 3.017 and 2.933 μg Mn g^{-1} dry weight (Figure S2). Exuvia from the subimago to imago molt collected from CR and LER showed mean Mn concentrations of 24.01 and 5.472 μg Mn g^{-1} dry weight, respectively (Figure S2), but exuvia from the larval to subimago molt were unable to be recovered.

Although we found that a significant portion of total accumulated Mn was present in the oxide form that could be rinsed from the cuticle with a reducing agent, many species still accumulated substantial internalized Mn concentrations (Figure 3). Subcellular fractionation studies revealed that the cytosol was a major sink for Mn bioaccumulation. The mean percentage of Mn associated with the cytosol across all species was 68.6 ± 18.7% and ranged from 39.9 ± 10.1% (in *Cheumatopsyche* spp.) to 90.8 ± 2.6% (in *M. modestum*). However, within the cytosol, the distribution of Mn between HDP and HSP fractions was remarkably consistent across species and heavily skewed toward the HSP fractions (Table 1). Manganese associated with HSP averaged 96.2 ± 1.8% of the total cytosolic content in these six species. The HSP fraction is thought to be dominated by small peptides, thiols such as glutathione and cysteine, and metallothionein-like proteins (*20*).

To test whether Mn exposure influenced thiol status in insect tissues, we examined reduced glutathione (GSH)

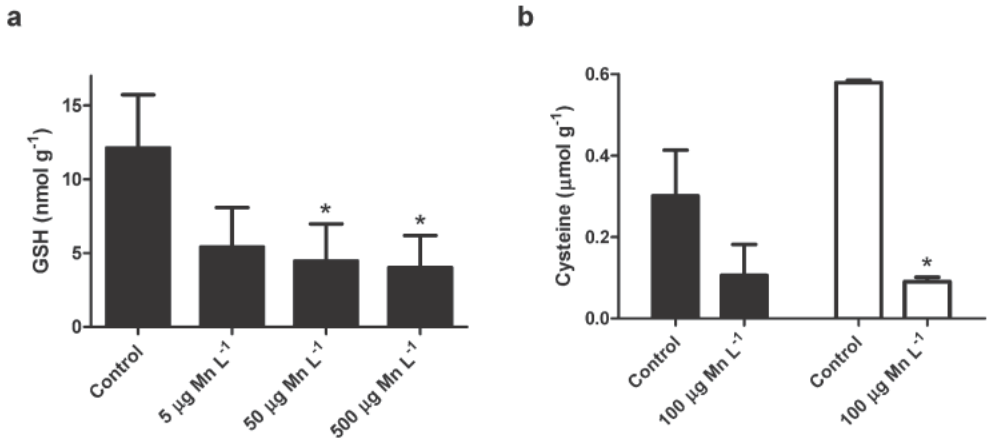

FIGURE 5. Thiol analysis. a) Concentrations (nmol GSH g^{-1} wet weight) of reduced glutathione in *H. betteni* exposed to Mn for four days. b) Concentrations (μmol cysteine g^{-1} wet weight) of cysteine in *Cheumatopsyche* spp. (black bars) and *Maccaffertium modestum* (white bars) exposed to Mn for four days. Values given as mean ± standard deviation.

concentrations in *H. betteni*. Exposure to dissolved Mn for 4 days resulted in a 55.4% decrease in GSH concentration ($p = 0.0603$) at 5 μg Mn L^{-1} and a 63.2% ($p = 0.0393$) and 66.8% ($p = 0.0288$) decrease in GSH at 50 and 500 μg Mn L^{-1}, respectively (Figure 5a). Oxidized glutathione (GSSG) concentrations in this experiment were below quantification limits.

Follow up studies revealed a significant effect of Mn exposure on cysteine and cystine concentrations. After four days of exposure to 100 μg Mn L^{-1}, cysteine levels were decreased 64.9% ($p = 0.0674$) in *Cheumatopsyche* spp. and 84.4% ($p < 0.0001$) in *M. modestum* (Figure 5b). Similarly, cystine concentrations in *Cheumatopsyche* spp. and *M. modestum* decreased by 75.6% ($p = 0.0083$) and 44.1% ($p = 0.0205$), respectively. Peak areas revealed similar responses to Mn exposure in GSH concentrations, but problems with standards did not allow us to rigorously quantify GSH in this experiment.

Discussion

Manganese is a relatively common, yet poorly studied element in freshwater ecosystems. As we were unable to find any Mn experimental work specifically related to aquatic insects, this paper represents a first step in understanding Mn interactions in this important faunal group. Our studies reveal that Mn interactions with aquatic insects are multifaceted and complex.

Manganese accumulation from solution ranged 3 orders of magnitude across several common insect taxa. This finding is not surprising given similar variability observed for different insect species with other metals such as Cd (*16*) and Zn (*21*). However, it is intriguing that taxa with relatively fast Mn uptake rates (e.g., *Hydropsyche, Ephemerella*) are also those with generally fast transport rates of Cd and Zn (*21*). This finding suggests that each of these elements may perhaps be transported by a common transport system - possibly involved in Ca transport.

Detailed kinetic experiments with *H. betteni* revealed a large capacity to accumulate Mn from solution. The large V_{max} and K_m suggests a high capacity, low affinity transport system. We found no evidence of a second transport system in play at very low ambient Mn concentrations. However, we only performed these detailed kinetics studies under artificial soft water conditions. Ascorbate rinses (but not EDTA alone) suggest that most Mn associated with the cuticle was in the form of Mn oxides. Additionally, the Mn oxide specific dye Leucoberbelin Blue verified that Mn oxides were not forming in the water or container walls during these experiments but were obvious on cuticles. This finding leads us to speculate that differences in oxide production may be related to distinctive microbial communities residing on the cuticle of various insect species. Some species (e.g., *Hexatoma* sp.) did not seem to cultivate any surface bound oxides, whereas others (e.g., *M. hastatus*) had as much as 94.8% of their total Mn body burdens as surface bound oxides.

Increasing Ca concentrations profoundly decreased both absorbed and adsorbed Mn accumulation, which is consistent with decreased Mn toxicity at increased water hardness levels (*22–24*). Paired with our finding that Mn is transported via a high capacity but low affinity system, our results support former studies that Mn^{2+} transport can occur through channels meant for other divalent cations, such as Ca^{2+} (*25, 26*). Future studies should examine the influence of dissolved Mn concentrations on Ca ion uptake and regulation.

Manganese efflux rate constants were relatively consistent across species, but molting was the primary means by which Mn is eliminated from tissues. During efflux experiments larvae that molted lost the vast majority of their total Mn body burdens -considerably more than could be removed by ascorbate rinses alone. This finding is in agreement with Cid et al. (*27*), where considerable Mn loss after molting was described in the European mayfly (*Ephoron virgo*) in nature. Our own exuvia analyses from *Hexegenia* sp. corroborates the finding that many different aquatic insects shed internalized and surface-bound Mn during the molt process.

Manganese sequestration in the exoskeleton has been observed in the calcified body parts of crustaceans, which also lose a substantial amount of accumulated Mn during the molting process (*28*). Absorbed manganese can be transferred through the ectoderm to the cuticle, which would decrease the internalized metal pools. This partitioning may be a detoxification mechanism or a means to harden or fortify the cuticle or certain cuticular tools such as mandibles (*29–31*). Thus there is some precedent for physiological processes in place that allow insects to shuttle Mn to the cuticle. Practically, this molting loss makes traditional bioaccumulation modeling approaches (e.g. refs *32* and *33*) insufficient for Mn and also suggests that field-based values of Mn tissue concentrations in insects should be interpreted with caution.

Despite extensive surface binding, several species still accumulated an appreciable amount of Mn in tissues, with ≥90% of internalized Mn found in the HSP fraction of the cytosol. Conventionally, this fraction is thought to contain detoxified metal (*15*) since molecules such as metallothionein and glutathione are found here. It may be that small peptides

or thiols play a role a transporting Mn to the cuticle during the molting process, though we have no direct evidence of this.

Relatively short and ecologically relevant Mn exposures resulted in marked decreases in thiol concentrations. For example, we found decreased concentrations of GSH in *H. betteni* exposed to as low as 50 μg Mn L^{-1}, consistent with previous studies finding decreased GSH after Mn exposure (*34*). We also found reduced cysteine concentrations in *Cheumatopsyche* spp. and *M. modestum* after Mn exposure. These intracellular thiols play important roles in managing the cell's redox state. The strong association of Mn with the HSP fraction coupled with the substantial reduction in the free concentrations of thiols following Mn exposure provides some evidence for Mn acting as a direct thiol scavenger in aquatic insects. Brief dissolved Mn exposures did not affect the total antioxidant activity of insect homogenates (as measured by the Cayman Chemical kit which uses the oxidation of 2,2′-azino-di-[3-ethylbenzthiazoline sulfonate by metmyoglobin). However, previous reports have shown that Mn exposure decreased total antioxidant status in rat brain, the effects of which can be lessened by cysteine addition (*35*). As we have yet to examine chronic or dietary Mn exposures, the observation that Mn exposure reduces free thiol concentrations is alarming, especially considering that Mn often co-occurs with other metals and contaminants which may act as pro-oxidants (e.g. ref *19*).

Together these studies provide a first glimpse of Mn interactions with aquatic insects. We show highly variable transport rates of dissolved Mn among species and highlight the important process of Mn oxide formation on the cuticles of different insect species. We provide unequivocal evidence of Mn loss during the molting process and show a strong interaction of Mn with heat stable cytosolic proteins and thiols - the latter of which may constitute a significant physiological stressor. Yet several issues remain unclear and require further study. For example, it remains unknown whether surface Mn oxide coating affects insects' ability to exchange gases or salts with the surrounding water. Moreover, it is unclear whether dietary Mn (as either Mn(II) or Mn-oxides) is bioavailable or associates with thiols. Thus there is much to learn about Mn interactions with this important group of ecological indicators.

Acknowledgments

The authors appreciate the taxonomic assistance of William Crouch and Eric Fleek, NC DENR. Norm Glassbrook provided thiol analyses. Lingtian Xie prepared exuvia samples for analysis. Gerald LeBlanc, Justin Conley, Monica Poteat, Kyoung Sun Kim, and Nick Cariello and anonymous reviewers provided valuable editorial comments. This work was supported by US EPA (83425501-0) and the College of Agriculture and Life Sciences, NCSU.

Supporting Information Available

Details of water chemistries, taxonomic information, elimination rates, ascorbate rinses, and molting loss are provided. This information is free of charge via the Internet at http://pubs.acs.org.

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ES1022043

Supplemental materials

Table 1. Salt additions for solutions of water with varying hardness. Values are given in mg L^{-1} of DI water.

Type	$NaCO_3$ (mg/L)	$CaSO_4 \cdot 2H_2O$ (mg/L)	$MgSO_4$ (mg/L)	KCl (mg/L)
Very soft	12	7.5	7.5	0.5
Very soft + Ca	12	240	7.5	0.5
Moderately hard	96	60	60	4
Very hard	384	240	240	16

Table 2. Taxonomic data and summary information for species used. Mass is given as the mean ± standard deviation of the wet weights in µg.

Order:family	*Genus species*	Experimental variables	[Mn] (µg L^{-1})	Exposure Duration (hours)	Mass (µg)
Ephemeroptera:Ephemerellidae	*Ephemerella dorothea*	Accumulation rates	25.6	8	4.4 ± 0.5
		k_e	25.6	240	4.4 ± 0.5
		Ca competition	24.2	24	4.0 ± 1.3
	Drunella cornutella	Accumulation rates	25.6	8	6.0 ± 1.5
		k_e	25.6	240	6.0 ± 1.5
	Drunella cornuta	Ca competition	24.2	24	4.5 ± 1.4
Ephemeroptera:Heptageniidae	*Maccaffertium pudicum*	Accumulation rates	25.6	8	15.4 ± 7.0
		k_e	25.6	240	15.4 ± 7.0
		Ca competition	24.2	24	21.5 ± 10.0
	Maccaffertium modestum	Adsorbed oxide quantification	100	96	16.4 ± 3.3
		Thiols	100	96	38.9 ± 7.7
	Maccaffertium spp.	Adsorbed oxide quantification	100	96	40.0 ± 19.5
		Subcellular fractionation	100	96	40.0 ± 19.5
	Epeorus vitreus	Accumulation rates	25.6	8	17.8 ± 6.5
Ephemeroptera:Leptophlebiidae	*Leptophlebiid* spp.	Adsorbed oxide quantification	100	96	5.5 ± 3.0
Ephemeroptera:Isonychiidae	*Isonychia* spp.	Adsorbed oxide quantification	100	96	26.8 ± 11.0
Trichoptera:Hydropsychidae	*Hydropsyche betteni*	V_{max} and K_m	0.26 - 400	24	35.8 ± 5.5
		Thiols	5 - 500	96	52.6 ± 11.8
	Cheumatopsyche spp.	Adsorbed oxide quantification	100	96	6.4 ± 2.3
		Subcellular fractionation	100	96	6.4 ± 2.3
		Thiols	100	96	54.8 ± 5.0
	Diplectrona modesta	Adsorbed oxide quantification	100	96	19.0 ± 8.2
		Subcellular fractionation	100	96	19.0 ± 8.2
Trichoptera:Rhyacophilidae	*Rhyacophila fuscula*	Adsorbed oxide quantification	100	96	25.2 ± 9.8
Plecoptera:Perlidae	*Acroneuria carolinensis*	Accumulation rates	25.6	8	29.1 ± 13.5
		k_e	25.6	240	29.1 ± 13.5
		Adsorbed oxide quantification	100	96	123.8 ± 78.1
		Subcellular fractionation	100	96	123.8 ± 78.1
	Acroneuria abnormis	Adsorbed oxide quantification	100	96	114.1 ± 61.1
		Subcellular fractionation	100	96	114.1 ± 61.1

	Acroneuria spp.	Ca competition	24.2	24	38.0 ± 43.9
Plecoptera:Perlodidae	*Malirekus hastatus*	Adsorbed oxide quantification	100	96	103.7 ± 17.5
		Subcellular fractionation	100	96	103.7 ± 17.5
Plecoptera:Pteronarcyidae	*Pteronarcys* sp.	Accumulation rates	25.6	8	184.6 ± 18.9
		k_e	25.6	240	184.6 ± 18.9
Diptera:Tipulidae	*Hexatoma* sp.	Accumulation rates	25.6	8	97.2 ± 14.2

Methods

Manganese efflux

The acquisition of sufficient radioactivity in larvae exposed to relatively low (0.1864 μM) and high (7.281 μM) Mn concentrations allowed us to test the premise that efflux rate constants are independent of tissue concentrations. Following 24 hours of exposure to these concentrations, *H. betteni* larvae were added to individual beakers containing 500 mL of clean reconstituted soft water. The animals and their surrounding water were assayed daily for radioactivity for 10 days. The water was changed on day four of depuration. The efflux rate constant (k_e) was determined using the equation:

$$C_t = C_i \times e^{-ket}$$

Where:

C_i = Mn concentration in the animal at time 0 (μg Mn g^{-1} wet weight)

C_t = Mn concentration in the animal at time t (μg Mn g^{-1} wet weight)

k_e = efflux rate constant (day^{-1})

t = time in days

The same procedure was used to assess efflux in six species used for uptake experiments (*Ephemerella dorothea*, *Acroneuria carolinensis*, *Drunella cornutella*, *Maccaffertium pudicum*, *Pteronarcys sp*). Insects were individually placed into approximately 400 mL of uncontaminated ASW for depuration as described above, with water changes at 3 day intervals. Animals were fed periphyton from day 2-7. After ten days, the animals were frozen and stored at -20°C.

Ascorbate Rinse to Remove Mn Oxides

At the end of the exposure period, animals were counted and rinsed thoroughly with 0.1M ascorbate, which is known to reduce metal oxides (such as iron oxide) at much lower concentrations (*1*). After the ascorbate rinse, the animals were then rinsed with 0.05M EDTA to remove the reduced Mn, and were finally washed with deionized water. The use of Leucoberbelin Blue, which changes color upon contact with Mn oxides, confirmed that this rinsing process successfully removed Mn oxides from the cuticles (*2*).

Molting Mn loss from field samples

We were able to obtain Mn tissue concentrations from US Department of Energy (Oak Ridge) and Tennessee Valley Authority (TVA) biologists from field collected larvae and adult mayflies (*Hexegenia sp.*) from two field sites – the Clinch and Emory Rivers in Tennessee. During the field sampling process, Oak Ridge and TVA scientists archived shed exuvia (sub-imago to imago molt), which they subsequently sent to us for analysis by ICP-MS.

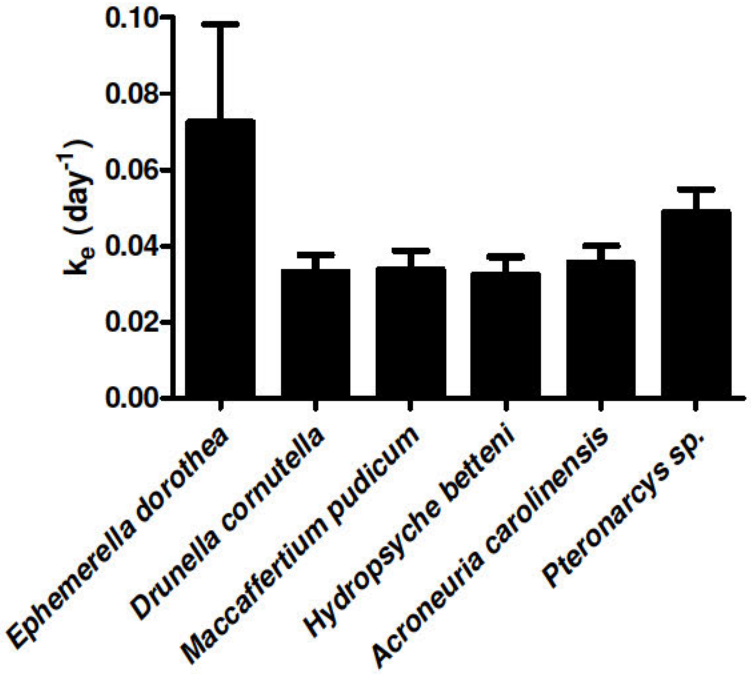

Figure 1. Mean (± standard deviation) efflux rate constants, k_e (day^{-1}) for six species of aquatic insects loaded with Mn and depurated in clean water for ten days.

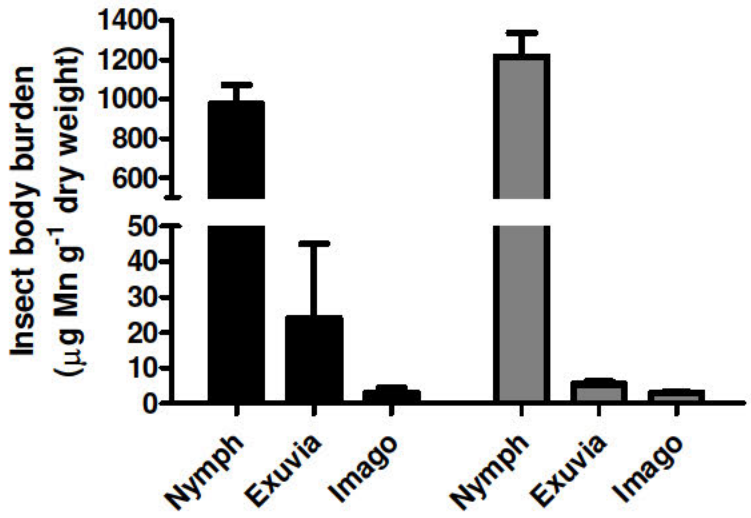

Figure 2. Mean (± standard deviation) manganese body burdens (µg Mn g^{-1} dry weight) of mayfly nymphs, imagos, and exuvia from the sub-imago to imago molt collected from two sites in Tennessee. Black bars indicate samples from Clinch River; grey bars represent Little Emory River.

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Susan Cormier/CI/USEPA/US
11/05/2010 06:44 PM

To Michael Slimak, Matthew Klasen
cc
bcc
Subject Preview of Glenn and my session on Toxicity of Salt session at SETAC on Thursday, chekc out slide 11 and 9

Courtesy copy, do not distribute.

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From: Justin Conley <jmconley@ncsu.edu>
To: Amy Bergdale/R3/USEPA/US@EPA, cingersoll@usgs.gov, Teresa Norberg-King/DUL/USEPA/US@EPA, ben.kefford@rmit.edu.au, d-soucek@inhs.uiuc.edu, david_buchwalter@ncsu.edu, Glenn Suter/CI/USEPA/US@EPA, Patty.Gillis@ec.gc.ca, Susan Cormier/CI/USEPA/US@EPA, Tina Laidlaw/MO/R8/USEPA/US@EPA
Date: 11/05/2010 01:45 PM
Subject: Conley Buchwalter TDS slides

Hello all,

Here is a copy of the presentation I'll be giving in the Salinization session on the work Dave and I have been doing. If I missed anyone in the email list, please forward the slides on to them. Looking forward to it.

Cheers,

Justin Conley_Buchwalter_Salty_presentation.pdf

Preliminary investigations of TDS toxicity and sulfate trafficking in mayflies

Justin Conley[1], Nick Cariello[2], David Buchwalter[1]

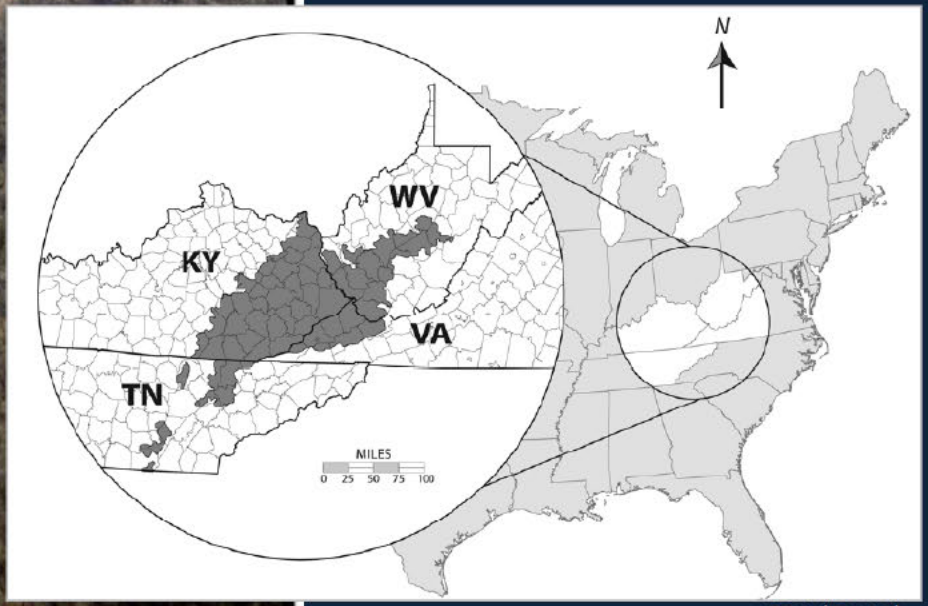
[1]North Carolina State University

[2]Stanford University

NC STATE UNIVERSITY

Mountaintop removal

Palmer et al., *Science* (2010)



EPA (2010)

Witches brew

Variable	Reference	Impacted
Se ($\mu g\ L^{-1}$)	< 1.5	11 (<1.5 – 36.8)
Mn ($\mu g\ L^{-1}$)	34 (<5 – 83)	141 (9 - 904)
Conductivity ($\mu S\ cm^{-1}$)	62 (34 – 1330)	1020 (159 – 2540)
Ca^{2+} ($mg\ L^{-1}$)	7.5 (2.7 – 120)	138 (38 – 269)
Mg^{2+} ($mg\ L^{-1}$)	4.3 (2.3 – 7)	122 (28 – 248)
K^{+} ($mg\ L^{-1}$)	1.6 (1.3 – 2)	10.6 (<1.5 – 36.8)
HCO_3^{-} ($mg\ L^{-1}$)	20.9 (6.1 – 35)	183 (10.7 – 501.8)
SO_4^{2-} ($mg\ L^{-1}$)	16 (11 – 21.6)	696 (155 – 1520)
Na^{+} ($mg\ L^{-1}$)	2.4 (0.7 – 5.5)	12.6 (2.6 – 39)
Cl^{-} ($mg\ L^{-1}$)	2.8 (<2.5 – 4)	4.6 (<2.5 – 11)

Pond et al. (2008)

Centroptilum triangulifer

- Native to eastern North American streams
- Parthenogenetic
- Marginal habitats – minimal flow requirement
- Full life-cycle exposures

- Genomic sequencing
- Antioxidant enzyme expression

Full life-cycle endpoints

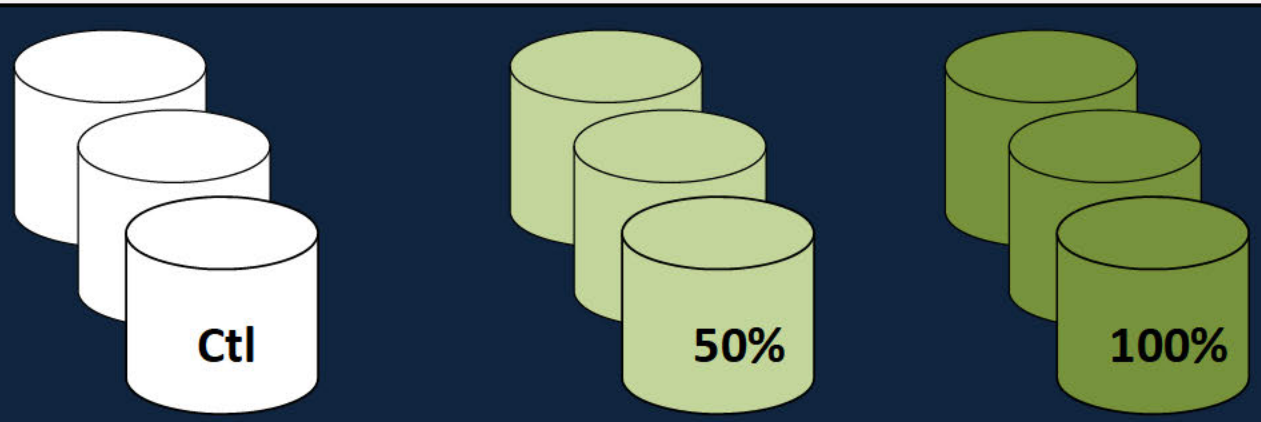
- Survivorship
- Fecundity
- Body mass
- Developmental period

Future endpoints

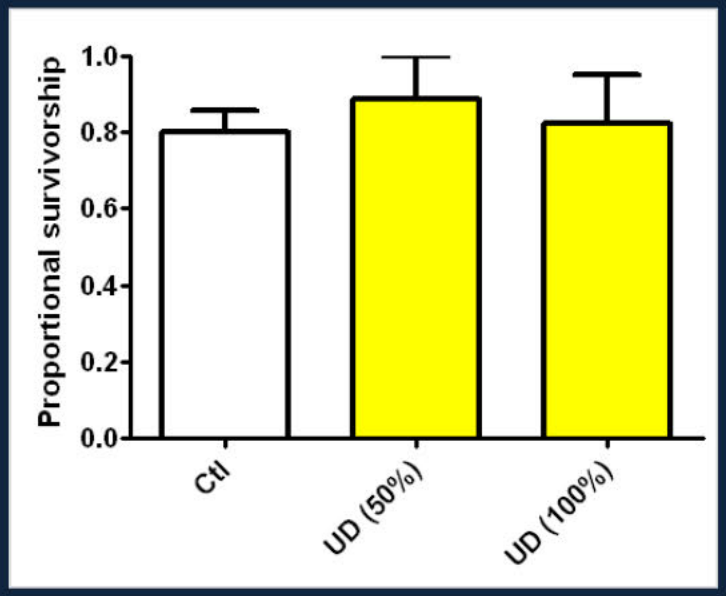
- Gene expression
- Transcriptomics

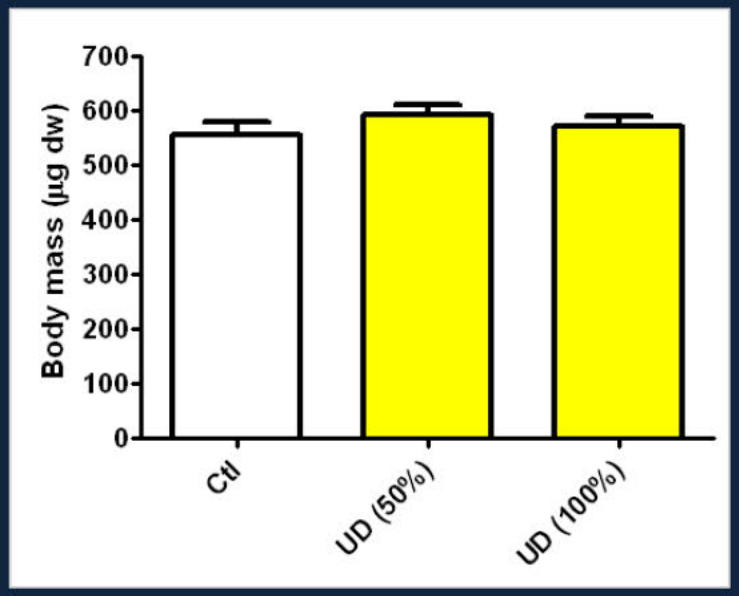
Reconstituted high TDS waters – Ingersoll Lab (USGS)

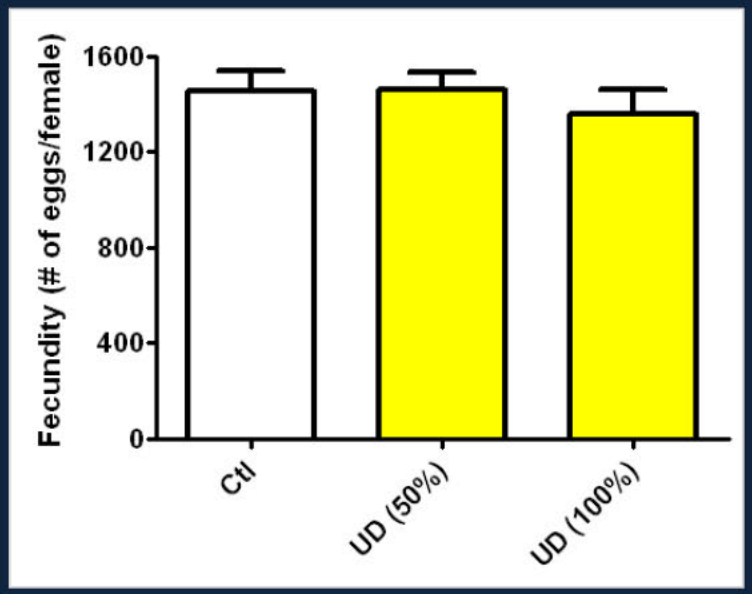
	Strength	Conductivity (µS cm^{-1})
Control (Ctl) **50/50: Well water/ASW**		185 ± 3
Upper Dempsey (UD)	50%	798 ± 3
	100%	1342 ± 19
Boardtree (BT)	50%	1300 ± 4
	100%	2184 ± 3
Winding Shoals (WS)	50%	1085 ± 14
	100%	1806 ± 1

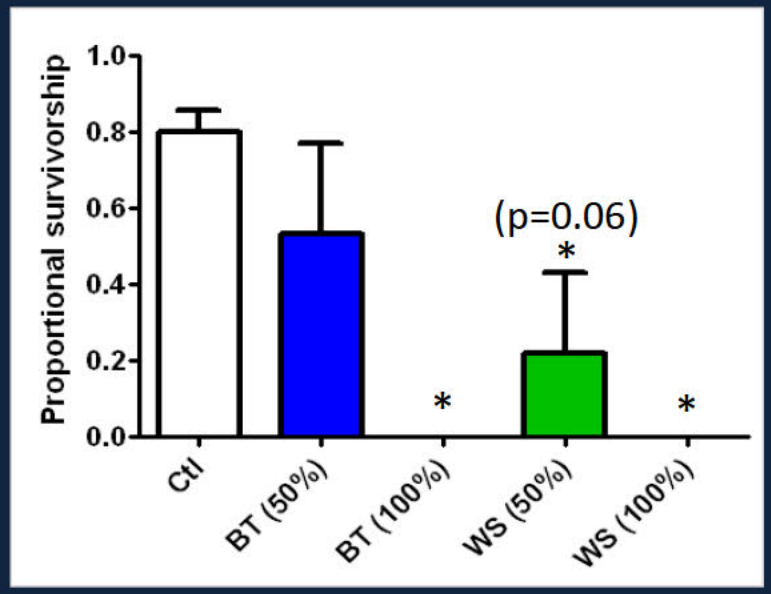


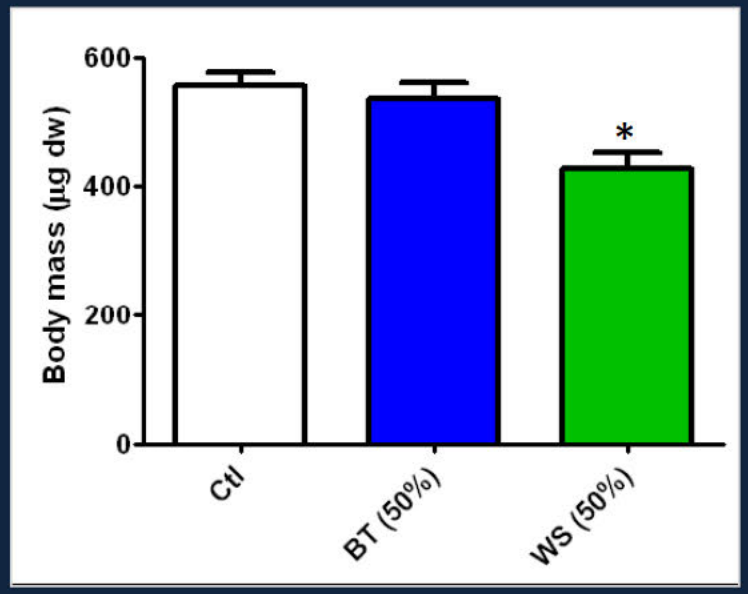
20 *C.triangulifer* larvae per bottle (3-5 d old)

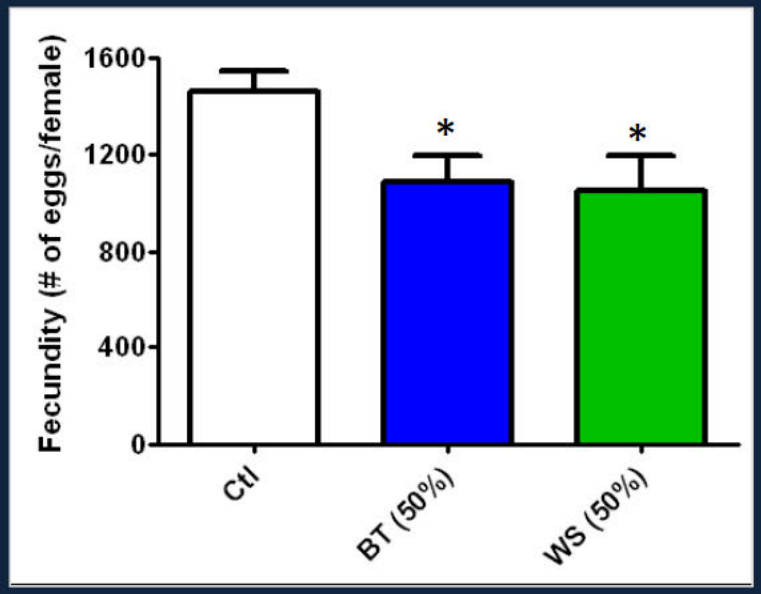

Proportional survivorship
1.0
0.8
0.6
0.4
0.2
0.0
Ctl
UD (50%)
UD (100%)

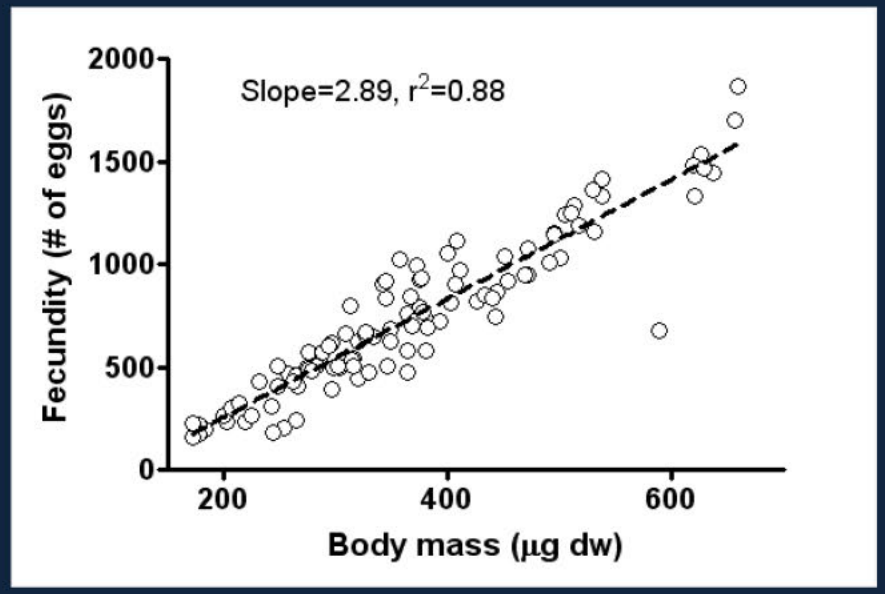

Body mass (µg dw)
700
600
500
400
300
200
100
0
Ctl
UD (50%)
UD (100%)

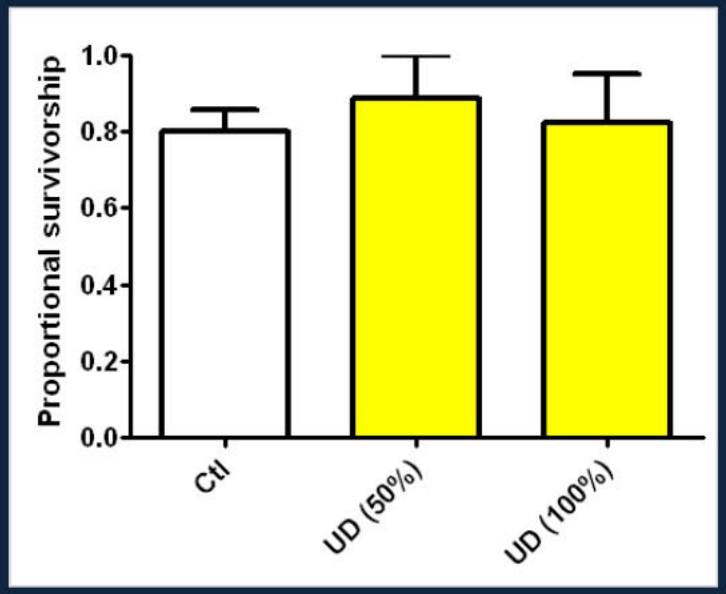

Fecundity (# of eggs/female)
1600
1200
800
400
0
Ctl
UD (50%)
UD (100%)

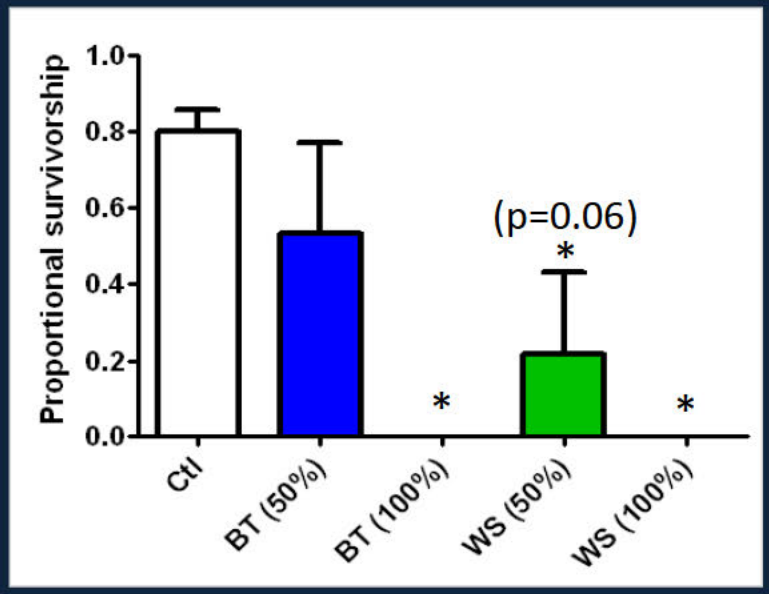

Proportional survivorship
1.0
0.8
0.6
0.4
0.2
0.0
(p=0.06)
*
*
*
Ctl
BT (50%)
BT (100%)
WS (50%)
WS (100%)


Body mass (µg dw)
600
400
200
0
*
Ctl
BT (50%)
WS (50%)


Fecundity (# of eggs/female)
1600
1200
800
400
0
*
*
Ctl
BT (50%)
WS (50%)


Slope=2.89, r2=0.88
Fecundity (# of eggs)
2000
1500
1000
500
0
200
400
600
Body mass (µg dw)





	HCO_3	Ca	Mg	K	Na	Cl	SO_4
Control **50/50:Well water/ASW**	46.7	15.2	0.8	0.5	10.6	5.0	28.6
Upper Dempsey (UD)	104.6	82.2	27.7	11.0	341.0	33.5	557.0
Boardtree (BT)	590.6	246.0	262.0	22.6	11.2	7.4	1490.0
Winding Shoals (WS)	463.6	118.0	242.0	24.6	28.1	7.9	1200.0

Take home points

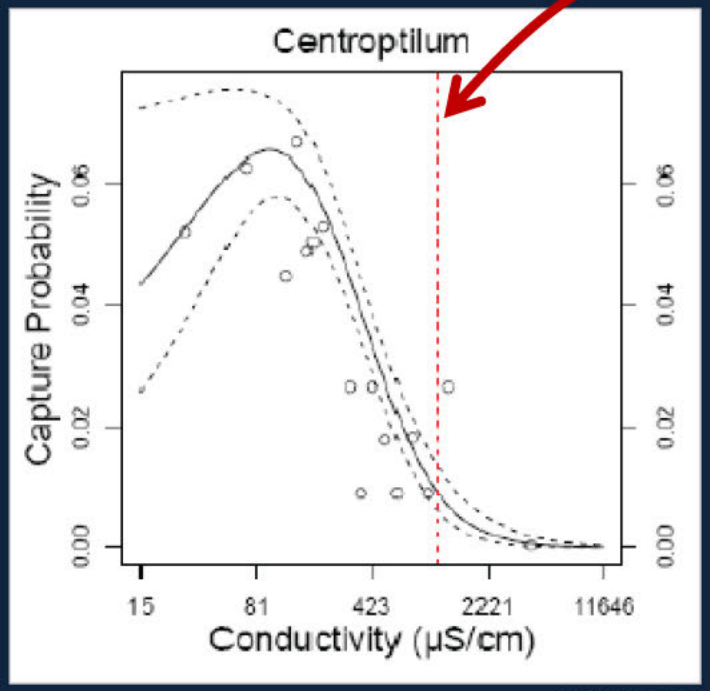
1. High TDS waters with MTM-VF signatures were overtly lethal to *C. triangulifer* in full life-cycle assays.

   a. Presence of dead late instar larvae suggests that <u>chronic exposures are necessary</u> for evaluating TDS toxicity.
   b. Water chemistry is important - Waters with the highest specific conductance were not necessarily the most toxic.
   c. Subtle differences in toxicity of MTM-VF simulated waters

2. Important to have relevant laboratory test organisms for evaluating water chemistry impacts on stream biota.

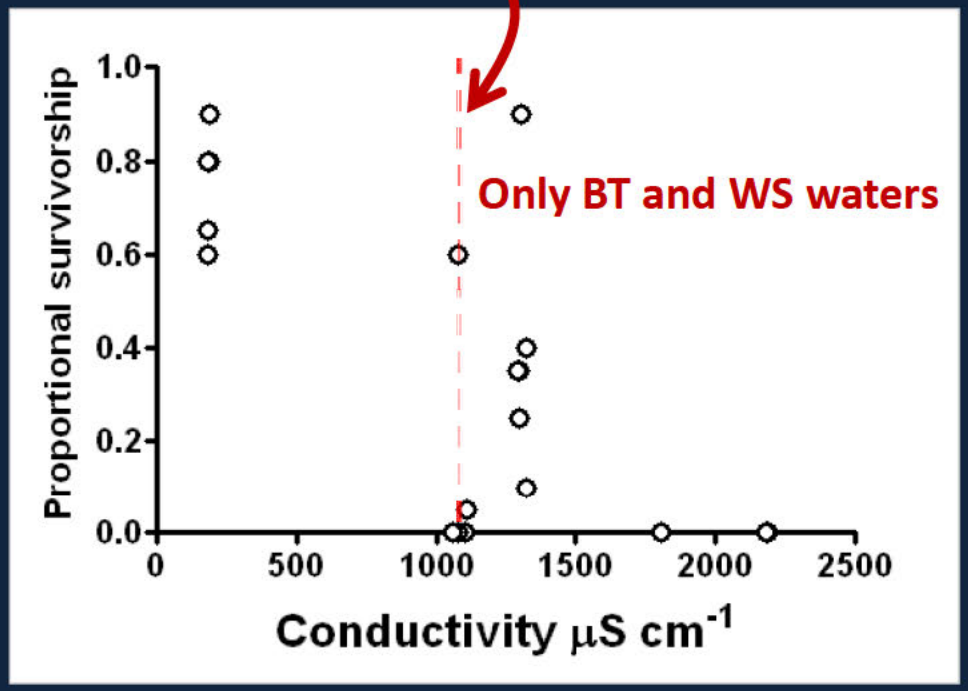
***Centroptilum* sp.**

EPA Extirpation Concentration (XC_{95}) = 1,075 µS cm^{-1}



EPA (2010)

Multiple species
Multiple stressors



Single species
Isolated stressors

Witches brew

Variable	Reference	Impacted
Se ($\mu g\ L^{-1}$)	< 1.5	11 (<1.5 – 36.8)
Mn ($\mu g\ L^{-1}$)	34 (<5 – 83)	141 (9 - 904)
Conductivity ($\mu S\ cm^{-1}$)	62 (34 – 1330)	1020 (159 – 2540)
Ca^{2+} ($mg\ L^{-1}$)	7.5 (2.7 – 120)	138 (38 – 269)
Mg^{2+} ($mg\ L^{-1}$)	4.3 (2.3 – 7)	122 (28 – 248)
K^{+} ($mg\ L^{-1}$)	1.6 (1.3 – 2)	10.6 (<1.5 – 36.8)
HCO_3^{-} ($mg\ L^{-1}$)	20.9 (6.1 – 35)	183 (10.7 – 501.8)
SO_4^{2-} ($mg\ L^{-1}$)	16 (11 – 21.6)	696 (155 – 1520)
Na^{+} ($mg\ L^{-1}$)	2.4 (0.7 – 5.5)	12.6 (2.6 – 39)
Cl^{-} ($mg\ L^{-1}$)	2.8 (<2.5 – 4)	4.6 (<2.5 – 11)

Pond et al. (2008)

Sulfate toxicity

- Thought to be large, bulky ion - difficult for insects to deal with
- Aborbance can be very rapid
- Remains in dissolved/ionic form in haemolymph
- Some species (*Aedes* sp.) are able to rapidly clear SO_4 from haemolymph via active transport, while other are not (*Calliphora* sp., *Rhodnius* sp.)

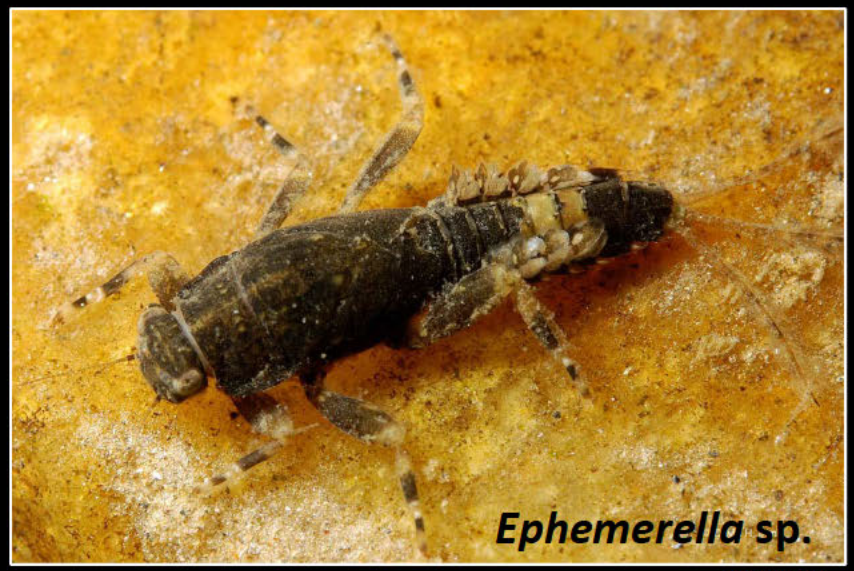
  (Maddrell and Phillips 1975)

- Na_2SO_4 considerably more toxic than NaCl to a mayfly (*Tricorythus* sp.)

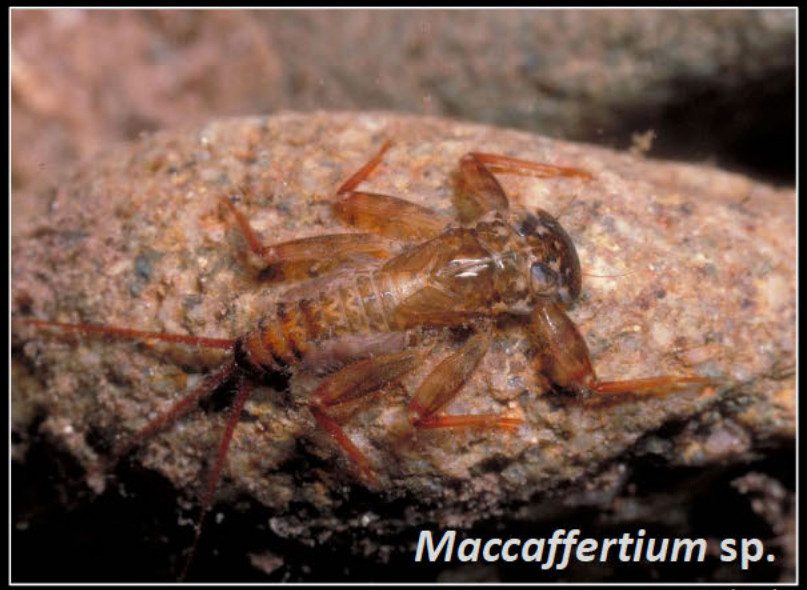
  (Goetsch and Palmer 1997)

Michaelis-Menten uptake and efflux kinetics in field collected mayflies

David Funk



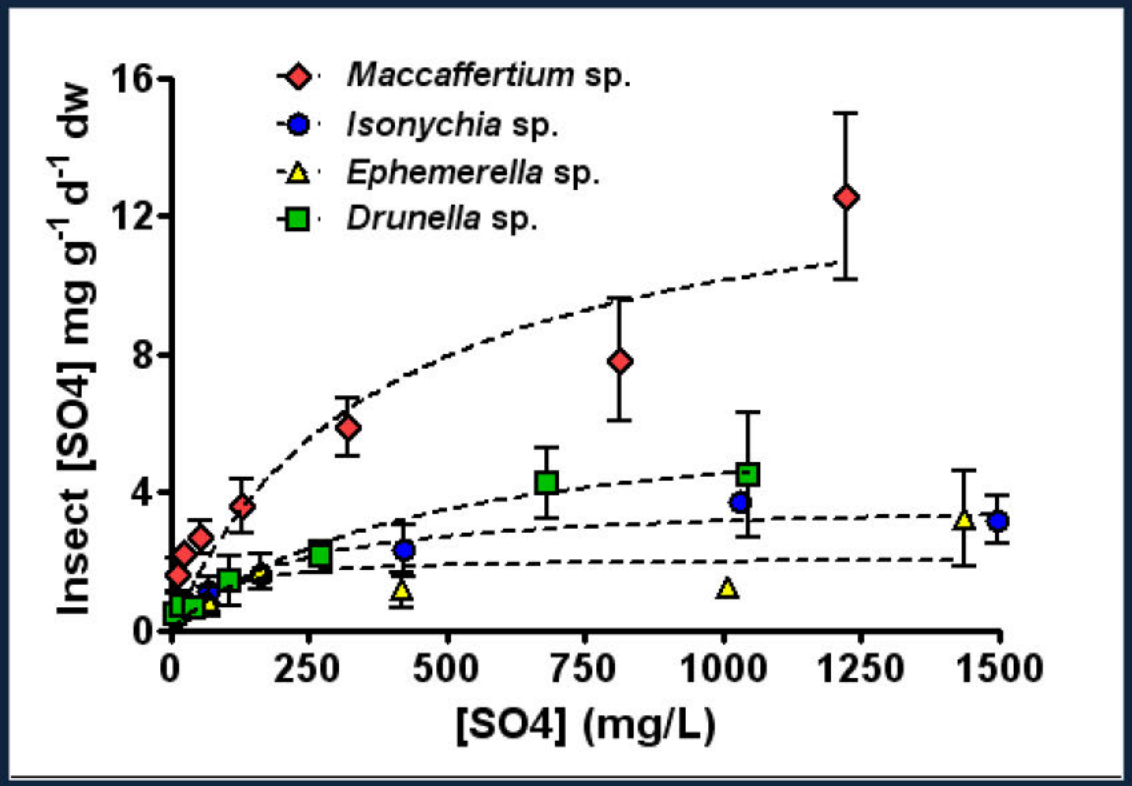
David Funk



David Funk

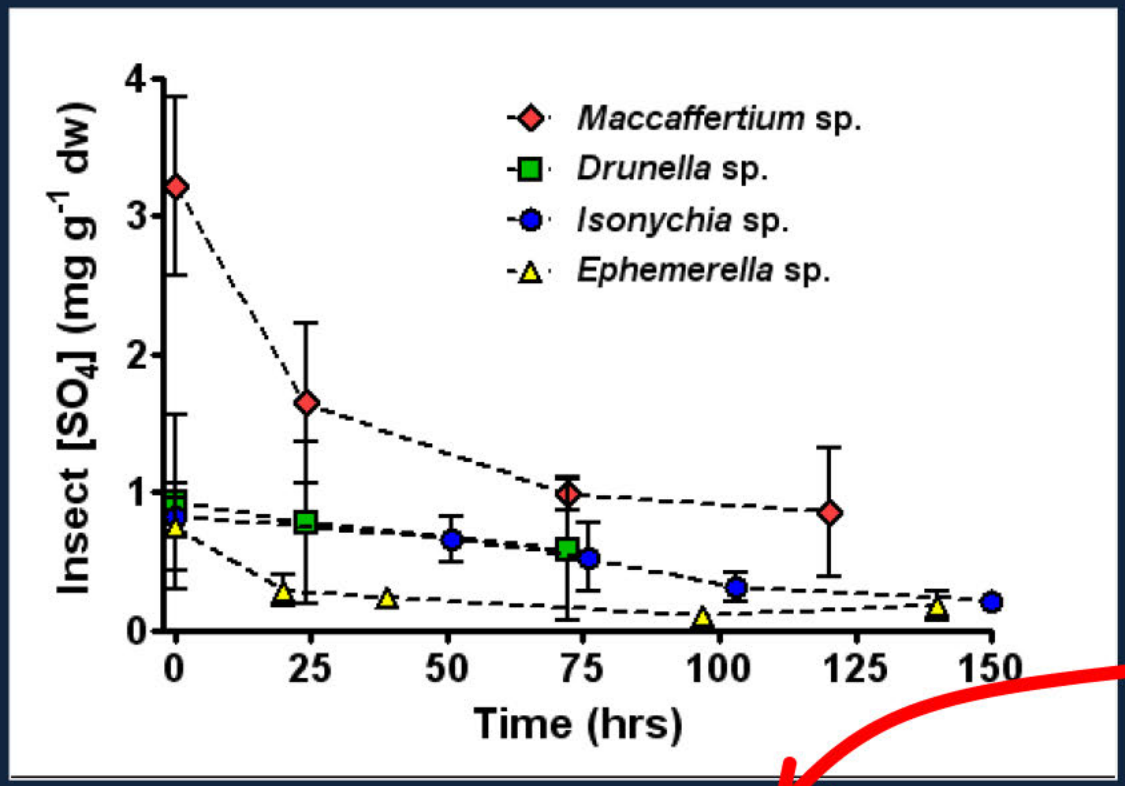
http://www.pbase.com/tmurray74/image/111032561

$^{35}SO_4$ uptake



	V_{max} (mg g^{-1} d^{-1})	K_m (mg L^{-1})	R^2
Maccaffertium sp.	13.97	378.6	0.80
Isonychia sp.	3.76	191.8	0.84
Ephemerella sp.	2.12	63.1	0.28
Drunella sp.	6.43	418.8	0.80

$^{35}SO_4$ efflux



Proportional daily loss = ~20%

	K_e (d^{-1})	r^2
Maccaffertium sp.	0.217	0.54
Isonychia sp.	0.253	0.71
Ephemerella sp.	0.153	0.45
Drunella sp.	0.151	0.20

Sulfate kinetics

1. Sulfate is absorbed from solution in a concentration dependent manner
2. Sulfate elimination is rapid, suggesting that mayflies "work" to remove excess sulfate from haemolymph
3. Sulfate does not appear to be hi hl bioaccumulative in mayflies
4. However, continual elimination of sulfate may create an energetic drain in insects
5. Alternatively, sulfate could interfere with normal trafficking of other anions (i.e., Cl^-)

Data gaps and recommendations

1. Resolved dose response curves
2. Egg hatching success
3. SO_4 vs. HCO_3 vs. K toxicity
4. Protective effect of Ca
5. Efflux of SO_4 in a high conductivity matrix
6. Interactions between SO_4 and Cl fluxes

Thanks!

- Chris Ingersoll (USGS)
- Dave Funk (Stroud Water Research Center)
- Lingtian Xie (NCSU)
- Glenn Suter (US EPA)

DEPARTMENT OF ENVIRONMENTAL AND MOLECULAR TOXICOLOGY
College of Agriculture & Life Sciences NC STATE UNIVERSITY

NC STATE UNIVERSITY
COLLEGE OF AGRICULTURE & LIFE SCIENCES
ACADEMICS ▲ RESEARCH ▲ EXTENSION

Dave Funk

Stefania Shamet/R3/USEPA/US
11/08/2010 09:53 AM

To Bonnie Lomax
cc Donna Heron, John Forren, Margaret Passmore, Michael Dunn
bcc
Subject Re: Fw: MTM Research Inquiry - Response

Thanks Bonnie!

Bonnie Lomax	My message (sent 11/4/2010) states that she ca...	11/08/2010 09:52:35 AM

From: Bonnie Lomax/R3/USEPA/US
To: Stefania Shamet/R3/USEPA/US@EPA, Donna Heron/R3/USEPA/US@EPA, Michael Dunn/R3/USEPA/US@EPA, John Forren/R3/USEPA/US@EPA
Cc: Margaret Passmore/R3/USEPA/US@EPA
Date: 11/08/2010 09:52 AM
Subject: Fw: MTM Research Inquiry - Response

My message (sent 11/4/2010) states that she can call me if she has any questions. See below

Bonnie Turner-Lomax
Communications Coordinator
Environmental Assessment and Innovation Division
U.S. Environmental Protection Agency - Region 3
1650 Arch Street
Philadelphia, PA 19103

215-814-5542 - (Telephone)
215-814-2783 - (FAX)
lomax.bonnie@epa.gov

"Go confidently in the direction of your dreams. Live the life you have imagined".....Henry David Thoreau

----- Forwarded by Bonnie Lomax/R3/USEPA/US on 11/08/2010 09:51 AM -----

Bonnie Lomax/R3/USEPA/US
11/04/2010 07:21 AM

To NEHA KARMESHU <karmeshu@sas.upenn.edu>
cc Margaret Passmore/R3/USEPA/US@EPA
Subject MTM Research Inquiry - Response

Good Morning Neha - - Thank you for your e-mail and for your interest and research in the effects of MTM on West Virginia streams. I have included a link to the EPA MTM webpage in this message.

This the Agency webpage on Clean Water Act Section 404 mining activities, providing additional links to various information on the topic including Recent Actions and Scientific Report.

I hope this information is useful to you and will assist in your research.

Please feel free to contact me is you have any questions regarding the website. Thank you

http://water.epa.gov/lawsregs/guidance/wetlands/mining.cfm

Bonnie Turner-Lomax
Communications Coordinator
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1650 Arch Street
Philadelphia, PA 19103

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215-814-2783 - (FAX)
lomax.bonnie@epa.gov

Hi Maggie,

Hope you are doing well.

As Stan mentioned, I'm doing research on MTM's affect on the streams of West Virginia. I referred to your paper ("Downstream effects of mountaintop coal mining: comparing biological conditions using family-and genus-level macroinvertebrate bioassessment tools") to get an initial understanding on the extent to which the streams get impaired as a result of this practice and I really appreciate how comprehensively the negative impact has been illustrated.

As I continue with my research, I have following questions in mind and it would be great if you could help me in understanding these issues

-Is it possible to get some recent data on the condition of streams to show a comparison overtime on how has EPA and other state agencies been able to minimise harmful effects of MTM on streams.

-What challenges are being faced by EPA in terms of enforcing sections 303(d) (impaired streams due to selenium concentration) and 404 (discharge of dredged material in the streams) of CWA

-Has any recent progress been made by EPA in this direction

-How much does it cost EPA (a rough estimate) to carry out this exercise of regulation

Also, please let me know if I can discuss these issues with you over phone sometime soon.

Thanks for the help!

Best,
Neha

"Go confidently in the direction of your dreams. Live the life you have imagined".....Henry David Thoreau

Susan Norton/DC/USEPA/US
11/08/2010 01:28 PM

To Jeffrey Lapp, Jessica Martinsen
cc
bcc
Subject Site visits to MTM-VF

Hi Jeff and Jessica,
On last week's mining call, someone mentioned bringing some of recent Region 3 hires out to view some mountaintop mining/valley fill sites. Is there any possibility for 2 or 3 of us in ORD to come along? If you are not the right folks to be asking, can you steer me to the right contacts?
Thanks,
Sue Norton

****
Susan B. Norton, Ph.D. | 703-347-8549 | norton.susan@epa.gov | http://www.epa.gov/caddis
Mailing Address: USEPA (8623-P), 1200 PA Ave. NW, Washington DC 20460
FedEx and Ground Deliveries: Two Potomac Yard (North Building), 2733 S. Crystal Drive, Arlington VA 22202

Brian Frazer/DC/USEPA/US
11/08/2010 01:29 PM

To Christopher Hunter
cc
bcc
Subject Fw: Revised Spruce Proposal

Lotus notes is killing me!

****

Brian M. Frazer, Chief
Wetlands & Aquatic Resources Regulatory Branch
Office of Wetlands, Oceans and Watersheds
U.S. EPA
1200 Pennsylvania Avenue, NW (MC 4502T)
Washington, DC 20460
202-566-1652

----- Forwarded by Brian Frazer/DC/USEPA/US on 11/08/2010 01:28 PM -----

From: Ann Campbell/DC/USEPA/US
To: David Evans/DC/USEPA/US
Cc: Brian Frazer/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA
Date: 11/08/2010 12:53 PM
Subject: Re: Fw: Revised Spruce Proposal

I think it's appropriate to share. It was discussed this morning with Pete and Nancy and i believe they would like Denise's (and ergo the program's) opinion on it.

Spruce Coal Mine Process Technical Review (Doc Only).pdf

Ann Campbell
Special Assistant
Office of the Administrator
U.S. Environmental Protection Agency
Mail Code: 1101

P: (202) 566-1370
C: (202) 657-3117
F: (202) 501-1428

David Evans | Ann, If you feel able to share the proposal, welco... | 11/08/2010 12:41:47 PM

From: David Evans/DC/USEPA/US
To: Ann Campbell/DC/USEPA/US@EPA
Cc: Brian Frazer/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA
Date: 11/08/2010 12:41 PM

Subject: Fw: Revised Spruce Proposal

Ann,

If you feel able to share the proposal, welcome it. If not, I'll check with Greg, but wasn't sure you wanted me to.

Dave

David Evans, Director
Wetlands Division
Office of Wetlands, Oceans and Watersheds
(202) 566-0535

----- Forwarded by David Evans/DC/USEPA/US on 11/08/2010 12:40 PM -----

From: Denise Keehner/DC/USEPA/US
To: Brian Frazer/DC/USEPA/US@EPA, David Evans/DC/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA
Date: 11/08/2010 12:32 PM
Subject: Fw: Revised Spruce Proposal

FYI----not sure how this exactly fits into what we expect to say at the meeting on the 16th--but suppose that we should discuss what this could mean at 1:30. Looks like it is on the agenda for 5:00.

----- Forwarded by Denise Keehner/DC/USEPA/US on 11/08/2010 12:29 PM -----

From: Ann Campbell/DC/USEPA/US
To: Peter Silva/DC/USEPA/US@EPA, Mike Shapiro/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA
Cc: Nancy Stoner/DC/USEPA/US@EPA
Date: 11/08/2010 12:25 PM
Subject: Fw: Revised Spruce Proposal

Folks - this is the proposal Greg discussed this morning and would likely be part of the discussion at today's 5pm meeting.

Ann Campbell
Special Assistant
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F: (202) 501-1428

----- Forwarded by Ann Campbell/DC/USEPA/US on 11/08/2010 12:22 PM -----

From: Gregory Peck/DC/USEPA/US
To: Nancy Stoner/DC/USEPA/US@EPA
Cc: Ann Campbell/DC/USEPA/US@EPA
Date: 11/08/2010 11:16 AM
Subject: Revised Spruce Proposal

Nancy:

These were the additional elements of the Spruce alternative I coordinated with John Morgan to

eliminate discharges from the toe of the remaining valley fill at Spruce (at Seng Camp Creek).

- Installation of a low permeability diversion berm on the coal seam pavement to divert any base flow that migrates down dip on the coal pavement from discharging into the valley fill footprint at the coal seams downdip outcrop.
- Development of a drainage blanket and water collection system at the downdip outcrop of any aquifers identified within the footprint of the fill, these aquifers will primarily be the coal seams. The collection drains should be routed to the groin ditches
- Compaction of a zone about 20ft below the top surface of the valley fill to decrease the infiltration of precipitation into the fill. The top 20 ft should be unconsolidated to promote tree growth
- Install a collection system at the toe of the fill to collect the basal (perennial) flow that discharges from the fill. This drainage will be pumped to the existing coal preparation plant at Seng Camp Creek to be used in the closed cycle washing process.
- Preserve in perptuity existing undisturbed streams flowing into Seng Camp Creek to maintain dilution.

Here's the original John Morgan proposal.

[attachment "Spruce Coal Mine Process Technical Review (Doc Only).pdf" deleted by Ann Campbell/DC/USEPA/US]

Spruce Coal Mine Process Technical Review

Prepared for:

EPA Region III

Submitted:

September 23, 2010

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1. Introduction

1.1 ASSIGNMENT

At the request of EPA Region 3, Morgan Worldwide (MW) conducted a review of the Mingo Logan Coal Company's - Spruce No. 1 Clean Water Act (CWA) § 404 permit application. The Spruce No. 1 Mine is located in the East District of Logan County, West Virginia, approximately two miles northeast of the town of Blair, in the Spruce Fork Watershed.

The specific Technical Directive for this review was defined in letters from EPA dated August 12, August 13, and August 30, 2010, and was outlined in MW's Statement of Work – Coal Mining Process Technical Review, as detailed in its contract with EPA (EP-10-3-000123).

In response to its agreed upon Statement of Work, MW conducted a review of the following parameters, each of which is analyzed in detail in this report:

- The capacity of Fills 1A and 1B in Seng Camp and whether these fills could be expanded
- The range of mining that could be conducted using Fills 2A, 2B, and 3 in Pigeonroost or Fill 4 in Oldhouse Branch
- Cost differences between the Applicant's plan and a plan where the total amount of excess spoil is disposed of in Seng Camp
- Evaluation of the differences between an alternate plan and the plan proposed by the Applicant
- A discussion of fill construction techniques

This report includes information analyzed through September 20, 2010, and could be augmented based on the receipt of additional information or directive from EPA.

1.2 DOCUMENTS REVIEWED

In preparing its analysis, MW reviewed and utilized all available documents and data, including documents and data supplied by EPA, as well as other accessible documents. On August 6, 2010, MW received data from EPA, including Mingo Logan's §404 permit application and the final Department of the Army §404 permit issued for the Spruce No. 1 Mine on January 22, 2007 (DA Permit No. 199800436-3), as well as WVDEP SMCRA and EPA NPDES permit documents for the Spruce No.1 mine. MW also received and reviewed at this time the complete Record of Decision for the §404 permit and the Draft and Final EISs for the Spruce No. 1 §404 permit. In addition to the documents MW received from the EPA on August 6, 2010, MW utilized digital data received directly from Arch Coal in 2004, which was associated with the analysis of the permit's compliance with AOC. This data did not contain any restrictions on its future use.

1.3 CURRENT STATUS

The analysis contained in this report is based on a review of the IBR#2 surface mining permit, which was issued by the WVDEP on April 26, 2005. Compared to the original permit, IBR #2 contained several revisions. This permit revised the dragline operation to a truck and shovel

operation, revised the seams to be mined and the type of mining method to be feasible and economical with that type of equipment. The AOC determination, the spoil balance, valley fill and drainage control designs, and haulage and access road designs were also updated to reflect the change in equipment. Finally, IBR #2 contained a change in the post mining land use compared to the original permit.

IBR #2 was used by MW in this analysis because it was the surface mining permit in effect at the time of the Applicant's §404 permit application and it was also the only electronic permit information available to MW. While subsequent revisions to IBR #2 have been approved, no alterations to the mine area and final pit have occurred that would preclude the use of IBR #2 in this analysis

MW requested from the WVDEP all permit activity for the Spruce No. 1 Mine in September 2010. From this information, the various revisions that have occurred since IBR #2 are listed below:

S-5013-98 (IBR #3)

Issued on September 29, 2006:

- Haulroad 2 was slightly relocated and the Truck Dump Facility and Pond 1-3A were revised due to the haulroad relocation.
- Haulroad 3 was added to connect Access Road 1A and Haulroad 2. Also, a conveyor right-of-way was added to the permit and located north of the truck dump to connect to U-5013-97.
- The bond increment map was updated to demonstrate additions and deletions by increment. Thirty acres were added and deleted to remain at 2,278 acres.
- The NPDES modification was included in order to relocate Outlet 14 from Pond 1-3A.

S-5013-97 (IBR #4)

Issued on June 30, 2008:

- Addressed proposed changes in drainage control from Valley Fill Nos. 2A, 2B, and 3 in Pigeonroost Branch and Valley Fill No. 4 in Oldhouse Branch.
- Added and deleted 7.53 acres, keeping the total acreage at 2,278.0 acres.
- Removed the office area from Pigeonroost Branch and redesigned and relocated ponds 2, 2A, 2B and 2C.
- Added sediment control Ponds 2D and 2G and Sediment Ditch PR01.
- Added temporary stream channel diversion in Pigeonroost Branch. Although the stream is not in the same location as shown in the §404 permit, it has the same capacity.
- NPDES outlet 001 was moved 230 feet.
- Pond 3 was deleted and Diversion Ditch VF3 was added to divert runoff from Valley Fill 3 into reconfigured Pond 2.
- NPDES outlet 002 was relocated to Sediment Ditch 2-2 and the flow path of Sediment Ditches 2-5 and 2-6 was bonded from the mine bench down to Pond 2G to allow NPDES outlet 017 to be relocated to Sediment Ditch 2-3.

- Access Road No. 2 will not be constructed. It was replaced with infrequently used Access Road 2, which provides access to Pond 2, 2A-2G. It will extend from CR 17/13 up Pigeonroost Branch and intersect Haulroad No 1.
- Pond 4 was redesigned and Pond 4A was added below the toe of Valley Fill 4. Temporary Pond 4B was added within the toe area of the fill, but will be removed prior to final reclamation of the fill.
- An NPDES modification was submitted to relocated outlets 001, 002, and 017. The SWROA was updated to reflect changes.
- Incremental bond increments were changed to reflect a net change of 0 acres.

S-5013-97 (Revision #5)

Issued on July 10, 20008:

- Raised the final deck height of Valley Fill 1A in Seng Camp by about 80 feet.
- Adjusted Haulroads 1 and 2 to account for additional fill.
- Raised Sediment Ditches P.D.1-4A1 and P.D. 1-4A2 consistent with the fill.

S-5013-97 (Revision #6)

Issued on July 14, 2008:

- Details on the proposed phase revision are provided in Additional SMA Sections, Section N.
- Topographic lines were included, and fills and coal seams were identified on phase maps.
- Haul roads were labeled.
- Ancillary areas exceeded 10% in some phases.
- All phase maps were updated, topographic lines were shown on each phase, haulroads, truck dump, conveyor, and valley fills were labeled, and ancillary and exempt areas were identified and addressed in the acreage tables.
- The acreage summary table listings for disturbed, undisturbed, ancillary, exempt, and regraded acres by phase were attached.
- The mining sequence was changed to allow mining in upland areas in Pigeonroost watershed from the haulage road in the Right Fork of Seng Camp Creek.
- Haulage to existing handling facilities on Mountain Laurel Complex can now be maintained through the Right Fork of Seng Camp Creek and along the ridge above Seng Camp Creek throughout the life of the operation.

S-5013-97 (Revision #7)

Issued on September 10, 2008:

- Designated a site for coal stockpiling within the existing permit area.

2. Geologic Model

As the Applicant's original geologic model was not provided, MW used the data received to prepare a reproduction of the Applicant's original geologic model in order to conduct an analysis of the excess spoil volumes, the volumes of backfill, and the amount of spoil material associated with each mining area are described in the mine plan. The data and method MW used to recreate the geologic model is described below.

First, the 3D polylines representing the outcrops of the coal seams within the deposit were obtained from the AutoCAD® drawing "Spruce Outcrops.dwg," which was provided to MW in the original data received from Arch Coal. The polylines are listed below, in lithological order:

Outcrop Polyline Layer Name	Inferred Coal Seam Name
M5B1_EL	Middle Five Block No. 1
M5B2_EL	Middle Five Block No. 2
L5BL_EL	Lower Five Block
LT5B_EL	Little Five Block
LT5C_EL	Little Five Block "C" or Center Split
LT5L_EL	Little Five Block Lower Split
US1R_EL	Upper Stockton No. 1 Rider
UST1_EL	Upper Stockton No. 1
US1L_EL	Upper Stockton No. 1 Lower Split
UST2_EL	Upper Stockton No. 2
UST3_EL	Upper Stockton No. 3
MS1U_EL	Middle Stockton No. 1 Upper Split
MS1L_EL	Middle Stockton No. 1 Lower Split
MS2U_EL	Middle Stockton No. 2 Upper Split
MS2L_EL	Middle Stockton No. 2 Lower Split
LST1_EL	Lower Stockton No. 1
LST3_EL	Lower Stockton No. 3
UC1L_EL	Upper Coalburg No. 1 Lower Split
UC2U_EL	Upper Coalburg No. 2 Upper Split
UC2L_EL	Upper Coalburg No. 2 Lower Split
MC1L_EL	Middle Coalburg No. 1 Lower Split
BCA-1 CROP	Buffalo Coal "A" First Split
BCA2_EL	Buffalo Coal "A" Second Split
BCA3_EL	Buffalo Coal "A" Third Split
Buf-crop-b-minex	Buffalo Coal "B"

In addition, images of Geologic Cross Sections A-A, B-B, and C-C were provided in Adobe Acrobat® format. These images contained corehole data with acid-base accounting results and specific coal seams identified. The data was entered into an electronic format and imported into Carlson Software®, where it was used to re-generate a geologic model. Because at least one of the map images incorrectly identified coordinates and elevations of the corehole collars, MW used an AutoCAD® drawing, titled "Spruce 1 Proposal IBR no.2 Map.dwg," to identify the proper locations and elevations of coreholes for its geologic model. Other typographic errors were discovered in the logs and these were corrected or adjusted by MW staff, experienced in the interpretation of drill log data, while accounting for the context in which the error occurred.

MW also used contours from two grid files supplied by EPA in developing its geologic model. The file "spruce base w-top remove.grd" appeared to be a grid of the ultimate pit floor for the proposed mine plan (IBR #2) and was contoured at a five-foot interval. Because these contours appeared to be on a common coal seam, the Middle Coalburg, and because the Applicant's

Environmental Information Document (EID) indicated that the Middle Coalburg was a target coal seam for the ultimate pit floor, MW used this data in developing its geologic model.

In order to identify various splits observed in the outcrop layer, MW grouped splits into bed names and simplified the geologic model. Although detailed drill logs and E-Logs were not supplied to MW, it appears likely that E-Logs were used to develop the Applicant's geologic model, as evidenced by subtle variations between the Middle Coalburg seam elevation on the geologic cross sections and the elevation of the grid file at the coreholes. Because thin coal strata are grouped together with this method, a false high recovery may result due to the model representing recoverable coal thickness as greater than it actually is.

The following major groupings of coal strata, in lithologic order, were used to determine splits in the outcrop layer. Bench numbers were assigned based on their vertical distribution:

Bed Name	Description	Bench Number
6BLK	Six Block	1
5BLK	Five Block	2
5LTL	Little Five Block	3
UST1	Upper Stockton No. 1	3
UST2	Upper Stockton No. 2	4
MST1	Middle Stockton No. 1	4
MST2	Middle Stockton No. 2	4
LSTK	Lower Stockton	4
UCB	Upper Coalburg	5
MCB	Middle Coalburg	5
LCB	Lower Coalburg	6
BUFA	Buffalo "A"	7
BUFB	Buffalo "B"	8

With the data above entered into Carlson Software®, grid files representing the surface of each coal and rock interface were created. First, elevation grids for the base of each coal bed name were created utilizing 3D Polylines. Then, each respective strata was tagged using the outcrop and drillhole data. Grids were created using triangulation, since the outcrop elevations are known, fixed, and provide a great density of data from which to model.

Second, thickness grids were generated for each coal bed using an Inverse Distance Squared algorithm while modeling strata pinch-out. Grid file utilities were used to add the thickness grids

to each respective coal bed elevation grid to generate the base elevation of the rock layer. No additional coal seam compositing was performed on the model.

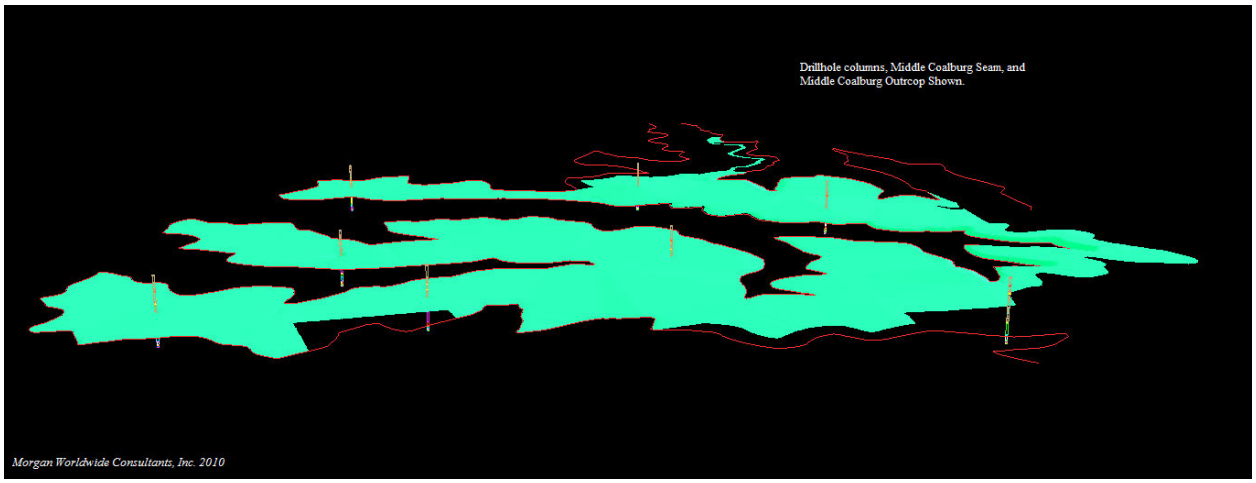


Figure 1 - Image of Middle Coalburg bottom elevation, drillholes, and outcrop line (3D perspective).

With the completed geologic model, the permit area was subdivided into Areas 1, 2, 2A, 2B, 3, and 4 (Final EIS Exhibit 2-14). These areas served as the pits for storing data from the calculations of surface mine reserves. The following key parameters were used in the reserve calculations:

- Minimum recoverable coal seam thickness: 1 foot
- Minimum depth of overburden required: 15 feet
- Recovery percentage: 100%

The minimum recoverable seam thickness is a function of the machinery's ability to extract thin seams and the quality of the coal seam being extracted. Operators today often use one-half foot as a minimum recoverable thickness. The minimum depth of overburden is a function of how the coal weathers (loss of volatile matter) near the outcrop. No information related to seam specific recovery was provided to MW. Therefore, a recovery factor of 100% was initially adopted for the entire reserve. Later, the recovery factor was reduced to 75% to determine "saleable coal tons." Based on past experience, MW believes that recovery rates of 75%-80% are typical for surface mining reserve estimates.

A two-grid surface calculation was performed on the original topography and pit floor to verify the total volume calculated in the model. The new model is within 3% of the original model's volume, a difference that may be due to using the Applicant's supplied pit floor surface grid instead of actual model grids of the Middle Coalburg and Upper Stockton No. 1 strata to represent the pit floor.

Applicant Data (from EID and EIS)			
	Non-Coal and Discard	**Coal Volume**	**Coal Tons**
All areas, all seams	408,880,000 bcy	unknown	54,547,000
	Swell: 25%		Recovery: 75%
TOTALS	**511,100,000 lcy**		**40,910,000 tons**
Note Appoximately 1.3-million tons (3%) is indicated as coming from auger/highwall operations. Due to the lack of a complete geologic model, relatively low volume, and the limited time allotted for this study, all tons are considered as surface tons.			
Geologic Model Results			
	Non-Coal and Discard	**Coal Volume**	**Coal Tons**
All areas, all seams	405,410,982 bcy	51,671,887 bcy	55,805,638 tons
	Swell: 25%		Recovery: 75%
TOTALS	**506,763,727 lcy**		**41,854,229 tons**
An additional 5-10% of the coal volume left in the pit would match the Applicant's stated volumes and tons, leaving 20% of the coal volume lost in processing.			

3. Proposed Action

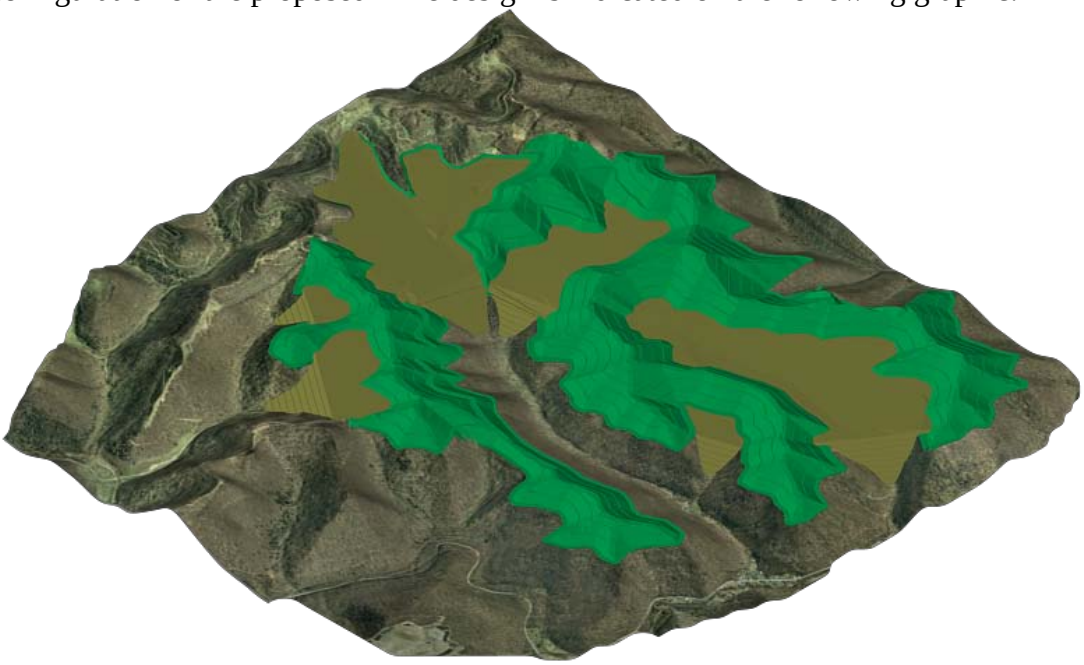
As detailed in the mine permit application and the Environmental Impact Statement related to the project, Mingo Logan is proposing to mine approximately 41 million tons of coal. The project proposes the construction of six valley fills: two fills in Seng Camp Creek; three fills in Pigeonroost Branch; and one fill in Oldhouse Branch. These fills are designed to accommodate the capacities listed below, as detailed in Section O-2 of the IBR #2 permit application. Note that the capacities below are downslope of the vertical demarcation line described in the West Virginia Final AOC Guidance.

Fill capacities - IBR 2

	Volume (lcy)
Fill #1A	11,823,491
Fill #1B	1,531,100
Fill #2A	39,303,135
Fill #2B	13,848,721
Fill #3	3,434,460
Fill #4	40,068,262
Total	**110,009,169**

In addition to the impacts associated with the fills, the Applicant proposes in-stream sediment control structures in Seng Camp, Pigeonroost and Oldhouse. Furthermore, the permit application includes a mine management area and access roads in Pigeonroost Branch.

The configuration of the proposed mine design is indicated on the following graphic:



4. Alternatives Analysis

4.1 INTRODUCTION

Three alternatives were evaluated by MW for the Spruce No. 1 Surface Mine. The basis for these evaluations was the Applicant's IBR #2 permit application, submitted to the West Virginia Department of Environmental Protection in 2004. The mine area outlined in IBR #2 was maintained without modification. However, the permit area was expanded in Seng Camp to accommodate a larger valley fill and an access road. It is likely that the need for additional sediment storage may slightly increase the permit area again near the toe of the valley fill.

A new IBKF (Initial Backfill) design was created by MW, removing the drainage ditch proposed in IBR #2. This new IBKF confirmed that an additional 33 million cubic yards can be stored in the mine backfill, thereby reducing the excess spoil by an equal amount. The configuration of this IBKF is indicated on **Drawing #1**. The MW IBKF was applied to Alternative No. 1, but MW used the original IBKF when evaluating Alternatives 2 and 3. Although the proposed valley fills in Alternatives 2 and 3 should be considered non-optimized, these valley fills are representative of the impacts that would be incurred if either alternative was implemented.

All three alternatives listed below include a larger valley fill in Seng Camp than was originally presented in IBR # 2 and overlay the footprint of the proposed Fills 1A and 1B.

4.2 ALTERNATIVE #1

Under this alternative, <u>all</u> excess spoil from the proposed operation will be stored in Seng Camp hollow. The toe of the valley fill will be at the 1050 foot elevation. The two existing ponds, Sediment Ponds 1 and 2 will be modified and/or a contour cut will be established on the east side of Seng Camp to handle the increased sediment load.

An 80-foot wide haul road will be built from the existing road near the confluence of Seng Camp and an unnamed tributary to the 1,400 foot elevation. This road will serve as the main access road for the mine operation throughout its life.

Mining will begin on the North Mine Reserves (Mining Areas 2 and 2A, located north of Pigeonroost) to establish the toe and raise the working surface of the fill. Between elevations of 1050 to 1400 feet, as the fill is raised, temporary road(s) will be built on contour to the main access road for transport of coal and supplies. After the fill reaches the 1,400 foot elevation, a permanent 100-foot wide road will be established up its face at approximately a 10 percent grade to the 1,650 foot elevation. There, the fill road will intersect the coal chute road, originally proposed in IBR #2, and continue to the 1,800 foot elevation and beyond, as is deemed necessary.

The primary issue with this alternative is that most of the spoil will be generated in mining areas located south of Pigeonroost Branch. In order to minimize the haul distance from the south reserves to Seng Camp, a temporary stream crossing was designed across Pigeonroost. This crossing has a 100 foot wide road at its crest, allowing haul trucks to efficiently transfer about 117 million cubic yards of excess spoil over the stream to Seng Camp or the North IBKF. A box or arched culvert will be installed beneath the road fill to effectively route Pigeonroost. In addition, the road fill can function as a Surface Water Runoff Analysis (SWROA) structure to

help alleviate the effects of increased runoff. The road fill will be entirely removed during the reclamation process and stored on the mine bench.

After crossing Pigeonroost, a road-cut was designed, opening the North Mine Block to Seng Camp Hollow. The road surface will be 150-feet wide with a 10 percent grade. The road will begin on the Middle Coalburg seam (on the North Mine Block) and terminate at the Upper Stockton seam at approximately the 1650 elevation. Since this road-cut crosses through the mine area, the company may choose to increase its width so that the location and number of safety benches may be reduced.

Landforming on the crest of the Alternative No. 1 Seng Camp Valley Fill will create a gently rolling terrain, which will help control drainage and provide aesthetic benefits. The crest of the Seng Camp valley fill for Alternative No. 1 peaks at the 1,920 foot elevation with the structure containing about 157 million cubic yards of excess spoil.

See **Drawing #2** for a detailed depiction of Alternative #1.

4.3 ALTERNATIVE #2

Alternative #2 is based on the original Spruce IBKF and therefore, excess spoil amounts will differ from Alternative #1. This alternative stores a portion of the excess spoil south of Pigeonroost in addition to Seng Camp hollow. About 86 million cubic yards of spoil will be placed in the right tributary of Pigeon Roost and the remainder, 100 million cubic yards, will be transported to Seng Camp.

An 80-foot wide haul road will be built from the existing road near the confluence of Seng Camp and an unnamed tributary to the 1400 foot elevation. This road will serve as the main access road for the mine operation throughout its life.

Mining will begin on the North Mine Reserves to establish the toe of the Seng Camp Valley Fill and raise the working surface. The access road plan will be identical to Alternative #1, with the road up the face of the fill to the 1,600 foot elevation. All grades and road widths will be the same as described in Alternative #1.

A second mine section can begin mining in the right tributary of Pigeonroost and proceed according to the approved mine plan.

A road fill will be constructed about 2200 feet upstream of the Alternative #1 road fill. This road fill will contain about 1.3 million cubic yards of material with a 100-foot road width on top and will transfer 60 million cubic yards of spoil material from the south to Seng Camp Valley Fill or the North IBKF. A road-cut through the North Mine Block will facilitate the transfer of spoil material. This road-cut design mirrors the Alternative #1 design, although less excavation will be required.

The road fill will be entirely removed during reclamation.

4.4 ALTERNATIVE #3

As with Alternative #2, Alternative #3 is based on the original Spruce IBKF, and therefore, excess spoil amounts will differ from Alternative #1. This option stores 103 million cubic yards of the excess spoil south of the North Mine Block in upper Pigeonroost Branch.

An 80-foot wide haul road will be built from the existing road near the confluence of Seng Camp and an unnamed tributary to the 1400 foot elevation. This road will serve as the main access road for the mine operation throughout its life.

Mining will begin on the North Mine Reserves to establish the toe of the Seng Camp Valley Fill and raise the working surface. The access road plan will be identical to Alternative #1, with the road extending up the face of the fill to the 1600 foot elevation. All grades and road widths will be the same as described in Alternative #1.

No road fill across Pigeonroost Branch will be required since the valley fill itself will provide access from south to north. A small road fill will be constructed in the right tributary of Pigeonroost to facilitate transfer of spoil from the west to the IBKF or Pigeonroost Valley Fill. A total of 43 million cubic yards of spoil material from the south will be stored in the Pigeonroost Valley Fill or the north IBKF. For this option, no spoil from the south will be transferred to Seng Camp Valley Fill.

As with the previous alternatives, the road fill in the right fork of Pigeonroost will be entirely removed during reclamation.

5. Comparison of Alternatives

5.1 INTRODUCTION

MW used the following criteria to analyze the three alternative design options in relation to each other and the Applicant's proposed action:

- Stream Impacts
- Drainage through fills
- Tons per acre
- Excess spoil per ton
- Excess spoil per foot of stream impact
- Tons per foot of stream impact
- Slope

These criteria are used to examine a full range of characteristics related to the alternative mine design options and to evaluate their efficiency and potential impacts.

The "**Stream Impacts**" metric is used to evaluate alternative mine configurations where the mining area (coal recovered and total spoil material) remains constant. The use of the stream impacts metric is not applicable when comparing different mining operations.

Objective: The objective is to minimize the impacts to designated stream segments.

The "**Drainage Area Through Valley Fills**" metric is a means to evaluate water quality issues. Studies have indicated that the flows from the toe of conventional valley fills has higher conductivity levels (dissolved solids) that create significant impairment to downstream habitat. Reducing the portion of the mine area that drains through valley fills is a means to address this issue.

Objective: The objective is to minimize the areas draining through valley fills in order to increase the probability of maintaining compliance with applicable water quality standards.

The "**Tons Per Acre**" metric is indicative of the efficiency of the mining project. This metric measures the number of tons of coal recovered per acre of land disturbed, with a higher ratio indicating a more efficient use of the land.

Objective: The objective of the operation is to maximize the tonnage of coal recovered per acre of disturbance.

The "**Excess Spoil Per Ton**" metric measures the effectiveness of the mining operation to maximize the quantity of spoil material returned to the mine bench. Lowering this indicator will lessen the various impacts associated with excess spoil disposal.

Objective: The objective is to maximize the amount of material placed back on to the mine area.

The "**Excess Spoil Per Foot of Stream**" measures the efficiency of spoil placement and the optimization of the valley fill design. The higher this number, the less streams are impacted and the configuration of the fill design is more efficient.

Objective: The objective is to place excess spoil in the most efficient location available that maximizes the spoil storage per foot of stream impact.

The "**Tons Per Foot of Stream Impact**" is a composite metric that compares the mine resource with the spoil per foot of stream impact. This metric is useful for a comparison of multiple projects. The higher this number, the greater the efficiency and value of the operation.

Objective: The objective is to minimize the overall stream impact per ton of coal mined.

5.2 STREAM IMPACTS

For purposes of this report, stream impacts are defined as any jurisdictional stream segment that is impacted either temporarily or permanently through activities associated with the extraction of coal and subsequent placement of spoil material. Temporary impacts to jurisdictional streams most often occur during construction of in-stream sediment structures or stream crossings. The stream bed is normally covered with material during construction of the facility and the material is removed from the stream during reclamation. Permanent impacts to jurisdictional streams normally occur during construction of hollow fills or when coal extraction progresses through the stream and the stream bed is excavated. Generally, extracted streams are classified as ephemeral. By definition, permanent stream impacts cannot be reclaimed and this length of stream is lost.

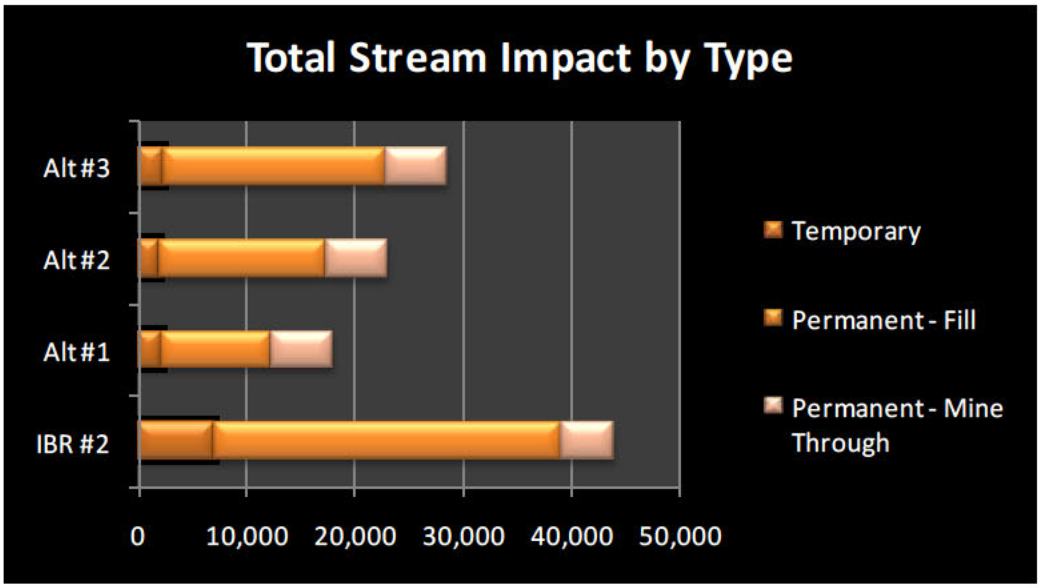
The temporary and permanent stream impacts for the IBR #2 plan and the three Alternatives, as described below, include the permanent impacts associated with mining through streams. MW has based its stream delineation and subsequent impact lengths off of a 3/16/2006 map titled "Spruce No. 1 Mitigation Plan, Stream Delineation Map" which references IBR2. No Perennial streams were shown on this map. This same stream delineation also appears on February 2004 maps titled "During Mining Drainage Map" and "Proposal Map," which were prepared by Decota Consulting Company, Inc., a firm experienced in preparing stream delineations for the USACE for jurisdictional determination. MW did not receive the official USACE Jurisdictional Determination and has therefore assumed the supplied Stream Delineation Map is in accordance with an approved JD.

MW identified a discrepancy between the impacts for IBR #2 as defined in the §404 permit (39,518 ft) and the CMP (43,946 ft).

The stream delineation used in the analysis is indicated on **Drawing #4.**

The classification of the stream impacts by type are:

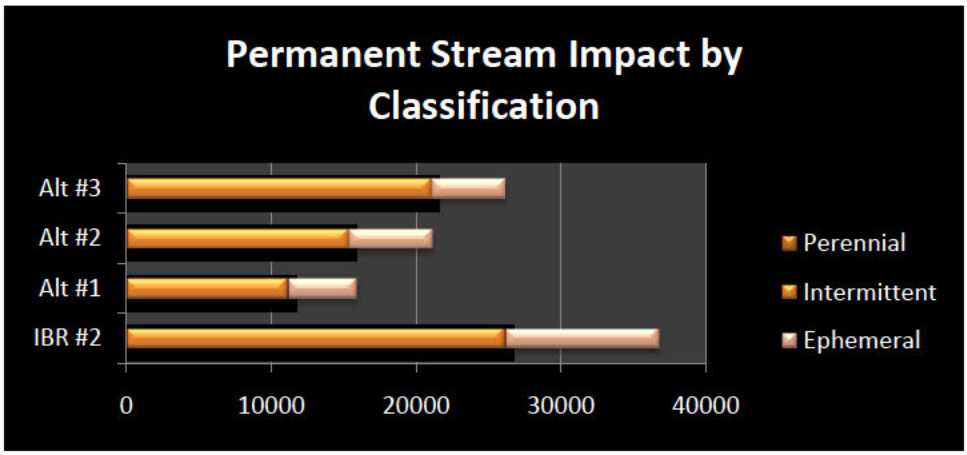
	STREAM IMPACTS			
Alternative	Temporary	Permanent - Fill	Permanent - Mine Through	Total
IBR #2	7,132	31,979	4,835	43,946
Alt #1	2,131	10,250	5,687	18,068
Alt #2	1,951	15,468	5,687	23,106
Alt #3	2,300	20,501	5,687	28,488



The permanent stream impacts are classified by perennial, intermittent, ephemeral and mined-through categories. The stream classification is similarly detailed in the §404 permit application. However, MW identified a difference in the mine through stream lengths between the data in the §404 permit application (4,835 ft) and the stream lengths calculated from the drawing (5,687 ft). These impacts should be identical since the mined area is common to all of the alternatives.

The permanent stream impacts for the IBR #2 and each alternative evaluated are:

	Permanent Impact - Stream Type			
Alternative	Perennial	Intermittent	Ephemeral	Total
IBR #2		26,184	10,630	36,814
Alt #1	0	11,162	4,775	15,937
Alt #2	0	15,354	5,801	21,155
Alt #3	0	21,063	5,125	26,188



Because no perennial streams were delineated on the stream delineation map for IBR #2 (**Drawing 4**), and lacking a U.S. Army Corps of Engineers jurisdictional determination letter, MW assumed such streams to be intermittent. The "Mine Through" stream impact values were determined using the Stream Delineation drawing (all mine-through impacts are considered permanent). Based solely on the potential total stream impacts, the alternative with the least permanent stream impacts is Alternative #1. Although Alternative #2 has approximately 6,000 more feet of stream impacts than Alternative #1, it has over 15,000 feet less than IBR #2. Alternative #3, while having more stream impacts than Alternative #1 and Alternative #2, still reduces stream impacts compared to IBR#2 by over 10,000 feet.

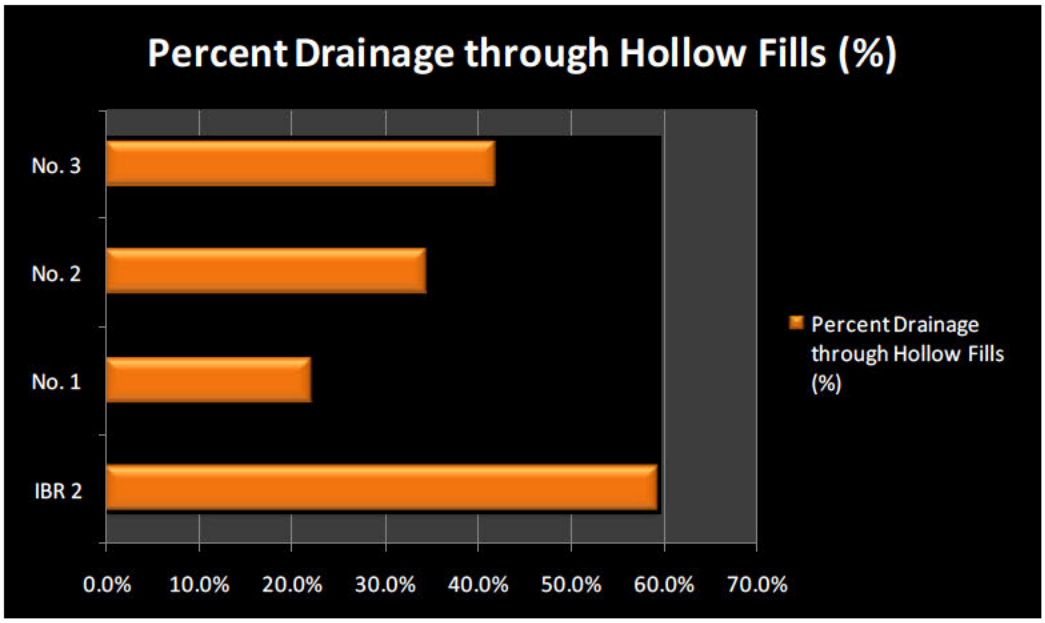
5.3 DRAINAGE THROUGH FILLS

MW conducted an analysis to determine the percentage of the total drainage area that drained through the hollow fills. Drainage areas were defined using the original topography along with the proposed regrade of the permit area. These watersheds were to include the permit area along with any area that would drain into the disturbed area, which includes hollow fills, sediment or SWROA ponds, and road fills. The watersheds that would drain through the hollow fills were initiated at the toe of the fill and followed the drainage line up the hill and along the ridge until it returned back to the toe of the fill, creating a closed area. A similar approach was used when determining the drainage area that would flow into the ponds. In one instance, the ridge line continued outside of the permit area, necessitating the inclusion of this area in the total drainage area.

Drainage areas were determined for the IBR #2 and the three (3) Alternatives presented below.

Drainage Through Fills

Alternative	Drainage Area through Hollow Fills (ac)	Total Drainage Area (ac)	Percent Drainage through Hollow Fills (%)
IBR No. 2	1,658	2,791	59.4%
No. 1	486	2,198	22.1%
No. 2	779	2,261	34.5%
No. 3	975	2,326	41.9%



These areas are represented in **Drawings #7, 8, 9, and 10**.

Based on the information provided above, the alternative with the lowest acreage of drainage area flowing through hollow fills, and the lowest percentage of the total area flowing through hollow fills, is Alternative #1. Alternatives #2 and #3, while having slightly higher total drainage areas than Alternative #1 and more drainage area and percent drainage through hollow fills, both have far lower drainage through hollow fills in terms of actual acreage and percent of drainage than IBR #2.

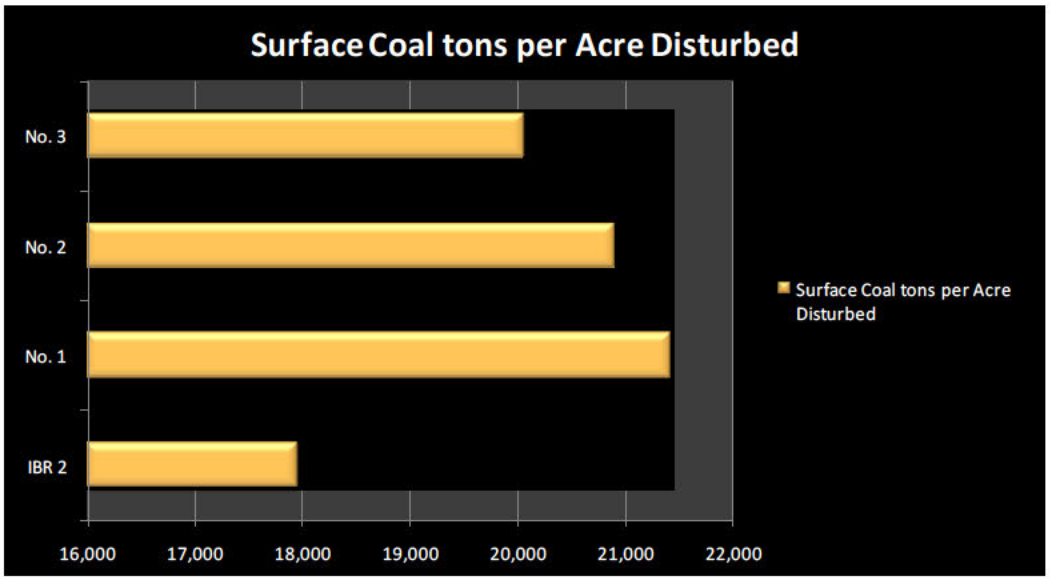
5.4 Tons per Acre

MW performed an analysis to determine the surface coal tons to be mined per acre of area disturbed during the mining process. The coal ton values were determined using surface mine reserves, as calculated using the MW geologic model. For IBR #2, the coal tonnage defined in the EID was used. Acres to be disturbed include any area that is to be affected during the mining process. Included in this area are the permit area, fills, sediment and SWROA ponds, and road fills.

The tons per acre analysis for the IBR #2 and the three (3) alternatives is reflected below.

Tons per Acre

Alternative	Coal Tons	Proposed Surface Acres to Disturb	Surface Coal tons per Acre Disturbed
IBR #2	40,910,000	2,278	17,959
Alt #1	41,854,229	1,954	21,415
Alt #2	41,854,229	2,002	20,906
Alt #3	41,854,229	2,087	20,055



Based on the figures above, Alternative #1 produces the most surface coal tons per acre disturbed. Therefore, this option recovers the highest amount of surface coal while limiting the acres of land affected during mining. Alternative #2 and Alternative #3 both recover only slightly less coal tons per acre disturbed than Alternative #1, with IBR #2 recovering less coal tons per acre disturbed than any of the alternatives considered.

5.5 EXCESS SPOIL PER TON

This analysis compared the amount of excess spoil placed outside of the mineral removal area to the recoverable coal tons. The coal tonnages for the three MW alternatives were obtained from the geologic model. The coal tonnage for the IBR#2 alternative was obtained from the Applicant's section 404 permit application. As shown by the figures below, Alternative #2 would produce the least amount of spoil per ton of coal mined. Alternative #3, Alternative #1, and IBR #2 would each produce more amounts of excess spoil per ton of coal recovered than Alternative #2.

	Coal Tonnage	Excess Spoil	Spoil per Ton
	tons	LCY	LCY/ton
IBR #2	40,910,000	110,631,108	2.7
Alt #1	41,854,229	115,713,838	2.8
Alt #2	41,854,229	91,462,071	2.2
Alt #3	41,854,229	108,824,699	2.6

5.6 SPOIL PER FOOT OF STREAM IMPACT

This analysis reviewed the amount of excess spoil per foot of stream impact. The stream impact is defined as the permanent impact associated with fill and excludes the mine through stream lengths, as these are defined as being within the mined area, and not the excess spoil disposal area.

	Permanent Streram Impact	Excess Spoil	Spoil per Foot
IBR #2	31,979	110,631,108	3,459
Alt #1	10,250	115,713,838	11,289
Alt #2	15,468	91,462,071	5,913
Alt #3	20,501	108,824,699	5,308

This analysis indicates that the Seng Camp fill selected for Alternative #1 provides a much higher efficiency in terms of excess spoil per foot of permanent stream impact than any other alternative. Alternative #2 and Alternative #3 each provide for about half the excess spoil per foot of stream impact compared to Alternative #1. IBR #2 represents the alternative with the least amount of spoil per foot of stream impact, making it the most inefficient alternative under this metric.

5.7 TONS PER FOOT OF STREAM IMPACT

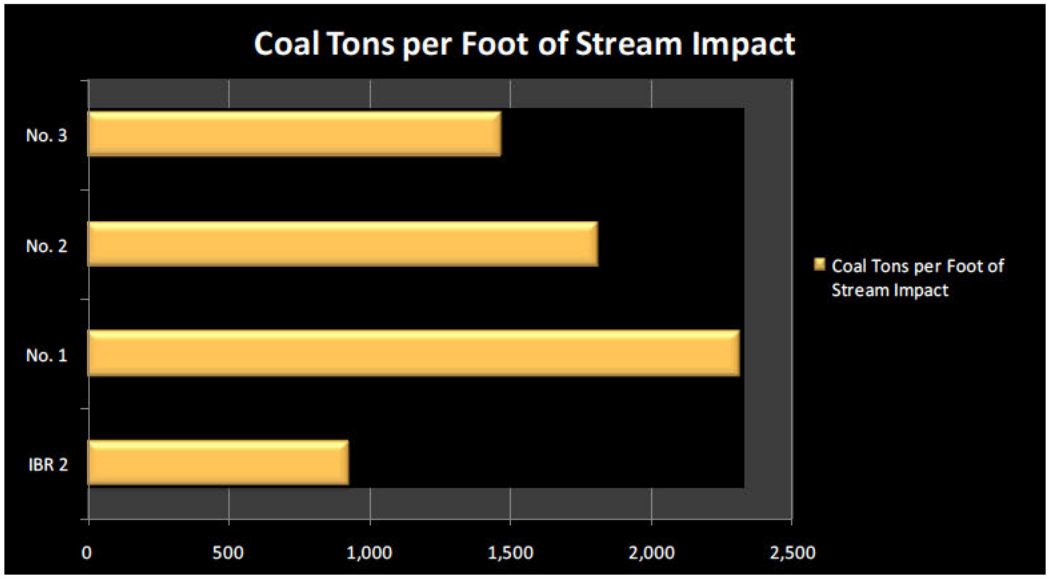
MW conducted an analysis to determine the ratio of coal tons per linear feet of total impacted streams. The calculated coal tons for Alternatives #1 through #3 were found using surface mine reserves, as referenced in the MW geologic model. Total stream impacts were categorized as permanent or temporary impacts. These were further categorized as intermittent, ephemeral and mined-through, which are shown in the Stream Impacts analysis. The coal tons and total stream

impact values for the IBR #2 Alternative were found in the Applicant's section 404 permit application.

The calculated tons of recoverable coal per foot of total stream impact are:

Coal Tons per Foot of Stream Impact

Alternative	Coal Tons	Total Stream Impacts (linear feet)	Coal Tons per Foot of Stream Impact
IBR #2	40,910,000	43,946	931
Alt #1	41,854,229	18,068	2,316
Alt #2	41,854,229	23,106	1,811
Alt #3	41,854,229	28,488	1,469



Based on the determined coal tons per foot of impacted stream, the alternative with the highest ratio is Alternative #1. Alternative #2 has the next highest ratio, followed by Alternative #3. IBR#2 is the alternative with the least amount of coal tons recovered per foot of stream impacts, with a ratio of less than half of Alternative #1.

5.8 SLOPE

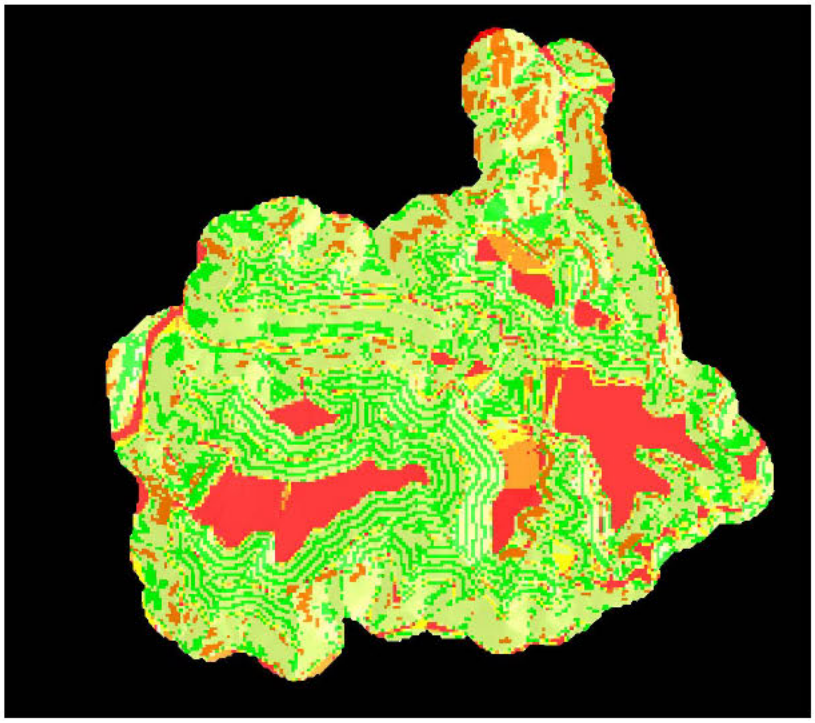
The average slope of a given watershed reflects anthropogenic alterations to the natural slope of the headwater watershed. Under natural conditions in West Virginia, headwater stream systems form within moderately steep to extremely steep mountain coves where average slope exceeds 45%. Steep slopes facilitate movement of water downslope to the stream channel and removal of detrital material downstream to perennial streams. Changes in the watershed slope can alter movement of water and nutrients downstream at a reduced rate.

The scoring of average percent slope places 30-45% or unaltered areas in an ideal condition category and excessively high (>65%) and very low (<10%) slopes in an adverse condition category.

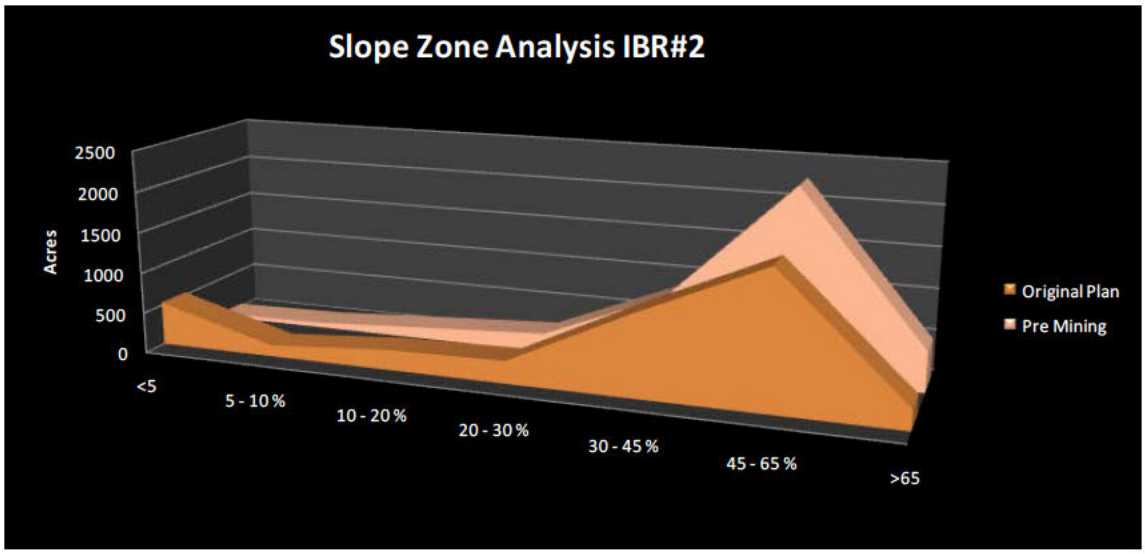
Traditional fills with flat decks will reduce the rate of flow of water and nutrients downstream. In addition, interflow through the fills may leach undesirable nutrients out of the rock and into streams. The analysis of the three alternatives and the IBR #2 configuration are depicted on the graphs below.

Slope Analysis IBR #2

The change in slope between the pre-mining and post mining (IBR #2) configuration are:

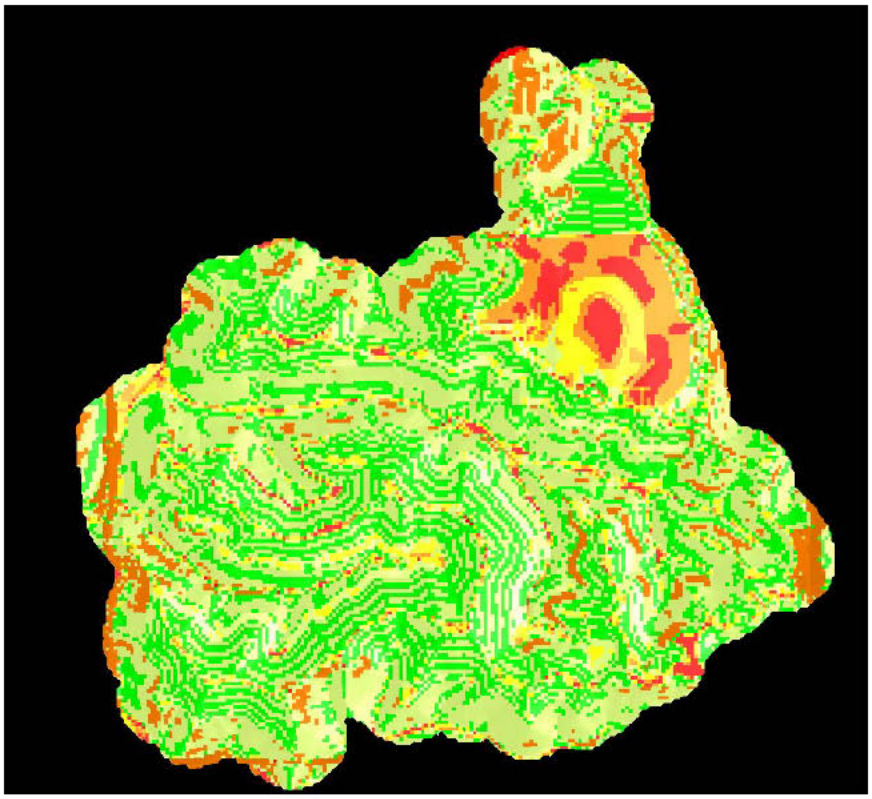


	<5	5 - 10 %	10 - 20 %	20 - 30 %	30 - 45 %	45 - 65 %	>65
IBR #2	532.1	137.8	245.4	274.7	998.8	1665.1	247.6
Pre-Mining	37.4	61.7	147.4	229.5	845.7	2287.6	492.2

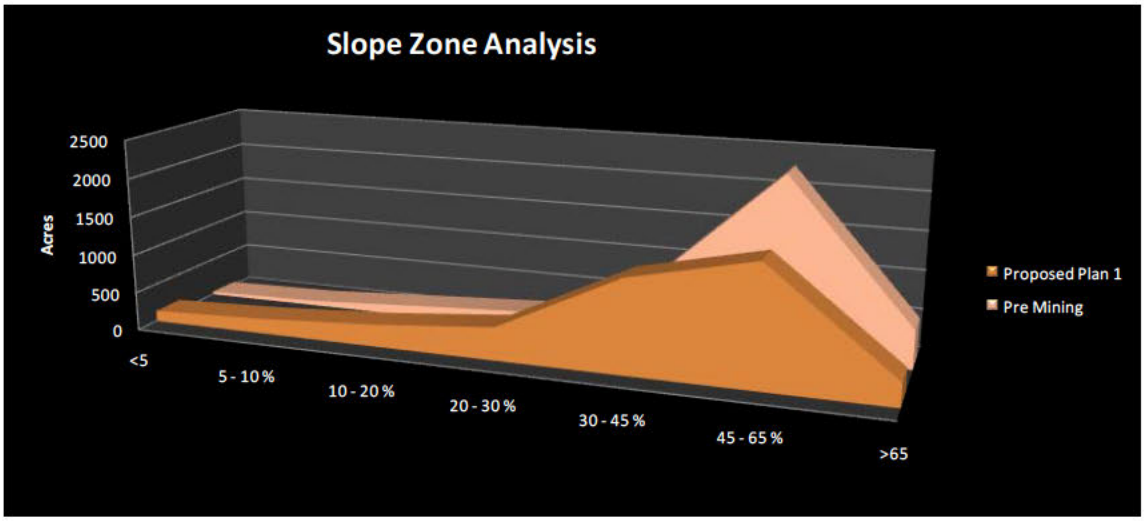


Slope Analysis Alternative #1

The change in slope between the pre-mining and post mining (Alt #1) configuration are:

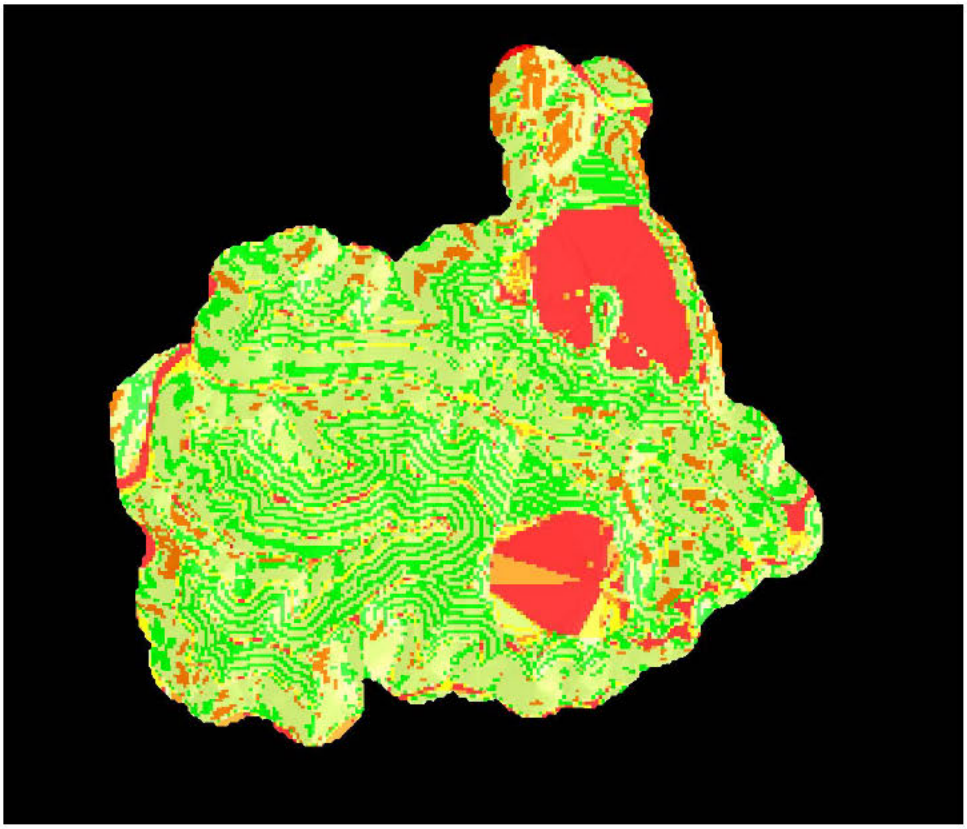


	<5	5 - 10 %	10 - 20 %	20 - 30 %	30 - 45 %	45 - 65 %	>65
Alternative #1	141.1	196.2	287.9	426.8	1199.8	1547.0	302.7
Pre-Mining	37.4	61.7	147.4	229.5	845.7	2287.6	492.2

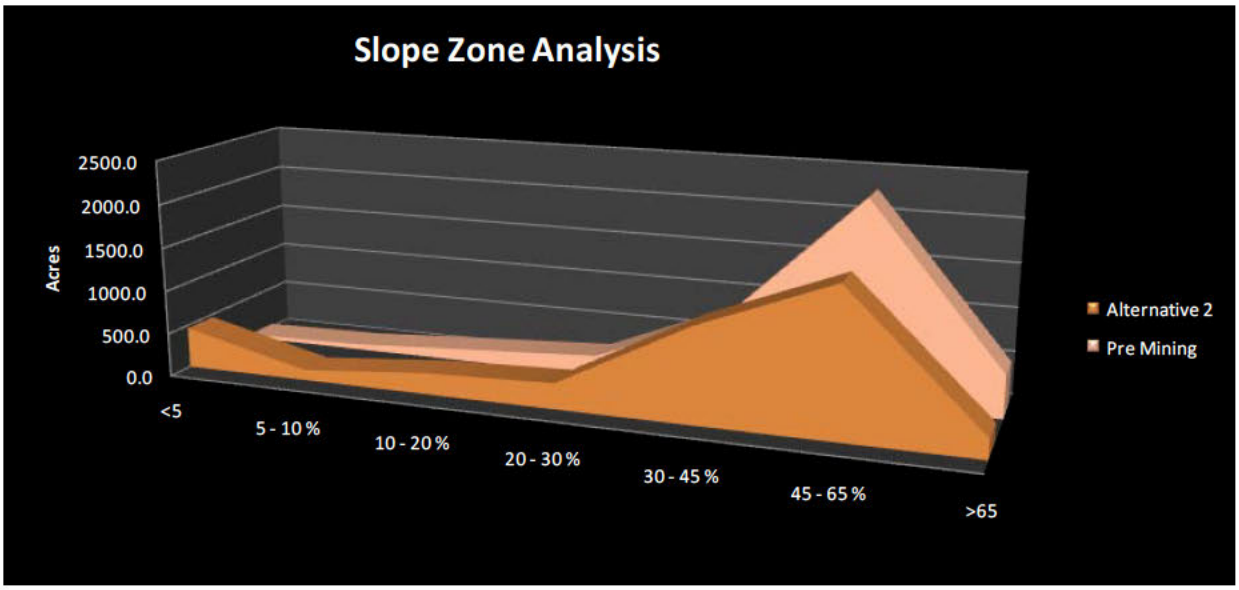


Slope Analysis Alternative #2

The change in slope between the pre-mining and post mining (Alt #2) configuration are:

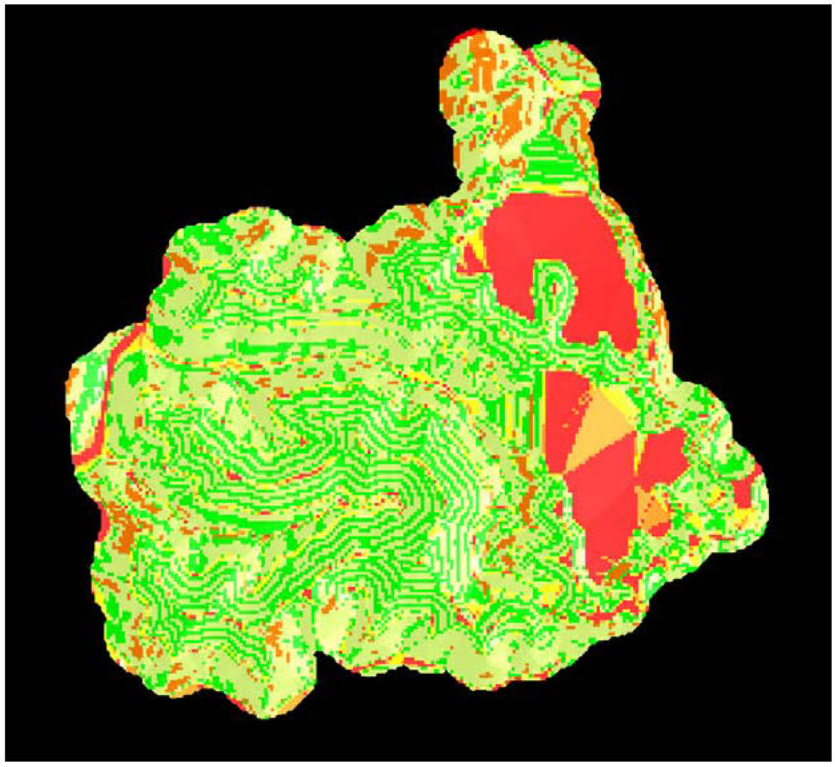


	<5	5 - 10 %	10 - 20 %	20 - 30 %	30 - 45 %	45 - 65 %	>65
Alternative 2	465.4	119.2	243.9	295.3	1081.2	1669.9	226.6
Pre Mining	37.4	61.7	147.4	229.5	845.7	2287.6	492.2

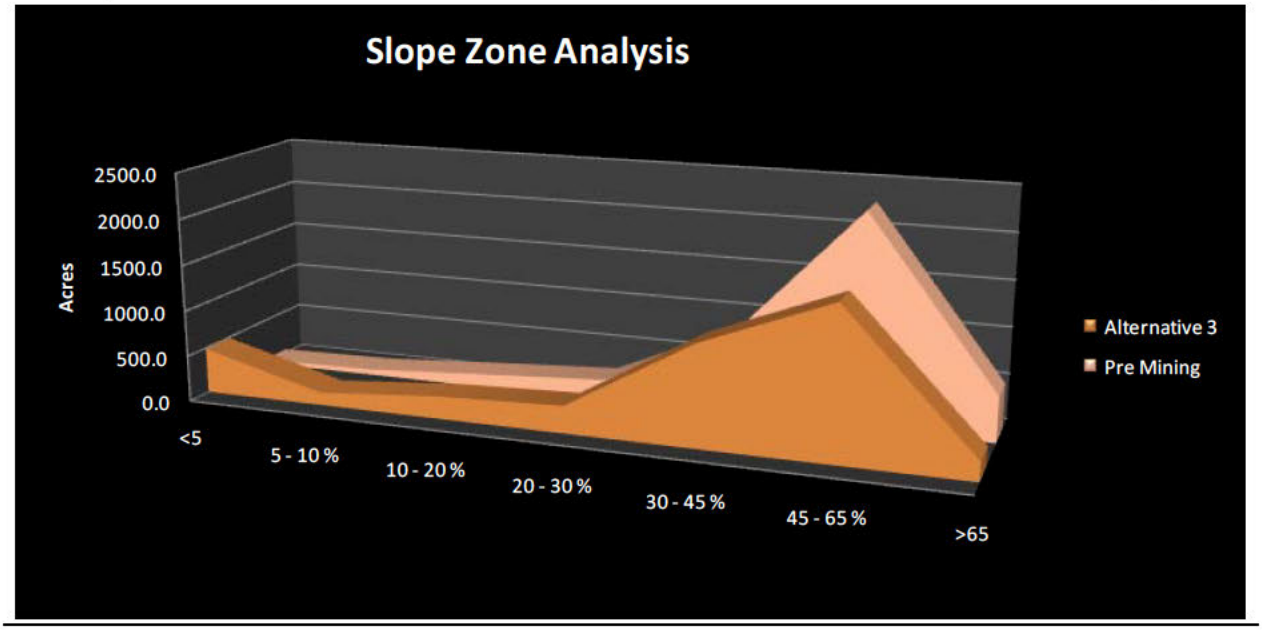


Slope Analysis Alternative #3

The change in slope between the pre-mining and post mining (Alt #3) configuration are:



	<5	5 - 10 %	10 - 20 %	20 - 30 %	30 - 45 %	45 - 65 %	>65
Alternative 3	489.9	138.7	246.0	295.0	1093.8	1631.7	206.3
Pre Mining	37.4	61.7	147.4	229.5	845.7	2287.6	492.2



As depicted on the graphics and charts above, Alternative #1, Alternative #2 and Alternative #3 minimize less favorable slopes (0% to 30%). Such slopes are associated with increased infiltration of surface water through fill and backfill areas, thereby increasing the potential for release of toxic pollutants. Alternative #1 is shown to have the least increase in acreage of less than 5% slope; those areas that would have the greatest potential for infiltration of surface water through the fills.

6. Alternative #1

6.1 SELECTION CRITERIA

In selecting Alternative #1 for additional review, MW ensured that each alternative was evaluated using the same basic parameters and limitations in order to ensure an accurate comparison. Shown below are the basic parameters each alternative shares:

- The boundary for coal extraction is similar for each Alternative
- The volume of overburden overlying the coal is similar for each Alternative
- A swell factor of 25% is used in each Alternative
- Procedures for calculating the IBKF surface were similar for each Alternative
- All Alternatives would be required to adhere to the basic surface mining regulations of West Virginia
- The stream delineation criterion is common to all Alternatives

Presented below is a compilation of the mining metrics discussed in the previous section and the respective rank of each Alternative:

Summary of Metrics

Alternative	Total stream impacts	Drainage through fills	Tons per acre	Excess spoil per ton	Spoil per foot of stream impact	Tons per stream impact	Slope analysis
IBR #2	43,946	59.4%	17,959	2.7	3,459	931	998.8
Alternative No. 1	18,068	22.1%	21,415	2.8	11,289	2,316	1199.8
Alternative No. 2	23,106	34.5%	20,906	2.2	5,913	1,811	1081.2
Alternative No. 3	28,488	41.9%	20,055	2.6	5,308	1,469	1093.8

Ranking

								Total
IBR #2	4	4	4	3	4	4	4	27
Alternative No. 1	**1**	**1**	**1**	**4**	**1**	**1**	**1**	**10**
Alternative No. 2	2	2	2	1	2	2	2	13
Alternative No. 3	3	3	3	2	3	3	3	20

As shown in the Table above, Alternative #1 has the lowest score based on the total score from the evaluated metrics.

In addition to the ranking of the mining metrics analysis, there are several existing conditions that lend additional credence to the selection of Alternative #1 for additional review.

- Alternative #1 provides for all excess spoil storage in Seng Camp Hollow. Seng Camp has been extensively disturbed due to previous mining and disturbances from the initial mining operations for IBR #2. By placing all excess spoil in Seng Camp, the other streams (Pigeonroost and Oldhouse) are spared any impacts from the mining operations, other than stream mine-through impacts.
- The IBKF volume in Alternative #1 utilizes all the efficiencies of the West Virginia AOC process and is able to place 10% more spoil on the bench than the IBR #2 proposed action.

- The magnitude of the difference of overall stream impacts from Alternative #1 to the other alternatives is substantial. Because of the utilization of a single fill in Alternative #1, five fewer miles of stream are impacted when compared to IBR #2.
- The overall footprint of the proposed permit area is significantly reduced in comparison to IBR #2.
- Although Alternative #1 would produce the highest amount of excess spoil per ton of coal mined, it would only produce slightly more spoil than the IBR #2 alternative. In addition, the amount of spoil per ton of coal mined produced by Alternative #1 above that of Alternative #2 is not overly significant considering the other factors outlined in this analysis.

6.2 REVISED REGRADE

In order to obtain accurate volumetrics for Alternative #1, a revised regrade configuration with a revised IBKF (Initial Backfill) model was constructed utilizing the West Virginia AOC model. Parameters for the revised IBKF included:

- Bench widths conforming to West Virginia AOC policy
- 2:1 outslopes with a 20 foot safety bench every 100 feet in elevation
- At the peak of each individual regraded ridgeline, a minimum dimension width of 100 feet was used to insure constructability

The revised IBKF surface demonstrated the ability to store approximately 350 MM cubic yards of swelled overburden, which in turn predicated the volume of the Seng Camp Hollow Fill to be approximately 157 MM cubic yards of spoil material.

The original IBKF surface, as shown in documents included in the IBR #2 permit, was calculated (using a 2 surface grid volume) to have a volume of approximately 317 MM cubic yards of swelled overburden. As a result, the revised IBKF was able to store an additional 33 MM cubic yards of swelled overburden, which in turn led to reduced stream impacts, reduced spoil distribution outside of the mineral extraction area, and reduced drainage through fills.

6.3 DRAINAGE

The basic mining premise for Alternative #1, is that the excess spoil from the mining operations will be placed in a single valley fill located in Seng Camp Creek. The configuration of the drainage control for the mined areas will then fall into two categories: In-Stream Sediment Structures and On-Bench Sediment Structures.

In-Stream Sediment Structures

As shown on **Drawing #2**, there are two existing in-stream sediment structures north of the toe of the proposed Seng Camp Hollow Fill. Using the Final Regrade configuration for Alternative #1, the sediment storage required for the Seng Camp Hollow is approximately 52 acre feet. In order to accommodate this sediment storage, the two existing sediment structures could be reconstructed into one in-stream sediment structure to increase the sediment storage. In addition to this reconstruction, there is potential for excavating an incised pond (on-bench pond) east of the two existing in-stream ponds for additional sediment storage.

On-Bench Sediment Structures

The balance of the drainage control (other than Seng Camp Hollow) would be handled by on-bench sediment structures namely sediment ditches. As shown on **Drawing #3**, Alternative #1 proposes fifty-nine sediment ditches to contain the run-off drainage from the mining operations. All sediment ditches will discharge into existing natural drainageways.

NPDES Sampling points are proposed at the outlets of all In-Stream and On-bench Sediment Structures as shown on **Drawing #3.**

The Alternative #1 thus eliminates all but two of the in-stream sediment structures that are contained within IBR #2 and the potential liabilities associated with drainage through hollow fills. In addition to the elimination of the sediment structures, all of the auxiliary disturbances such as access roads to the sediment structures are eliminated.

6.4 MINE ACCESS

The proposed operation will require access to the Mountain Laurel facilities located at the mouth of Seng Camp. This access will be achieved by a combination of hillside excavation and road construction up the face of the Seng Camp Valley Fill. The road will begin near the confluence of an unnamed tributary and Seng Camp to the 1,400 foot elevation. From this point, the road will be constructed up the face of the valley fill to the 1,650 foot elevation. From there, it will rise along the western abutment of the valley fill to the 1,800 foot elevation.

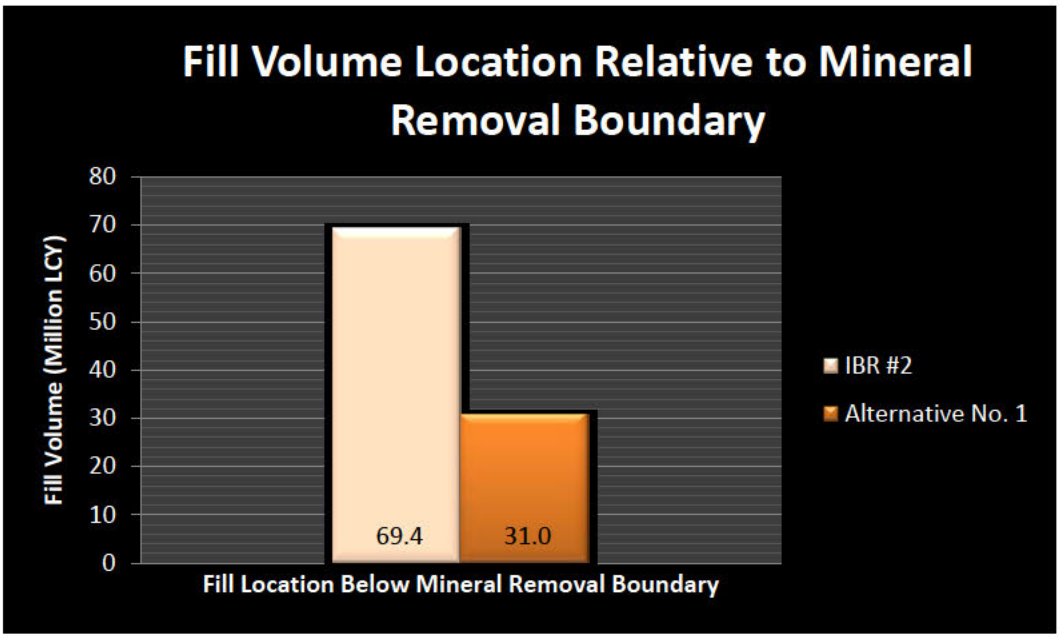
From the start of the road to the 1400 foot elevation, the road will be 80 feet wide and on an 11 percent grade. Subsequently, the road will widen to 100 feet wide and will be on about a 10 percent grade until it terminates at the 1800 foot elevation.

Internal roads will be constructed from this point to various locations throughout the permit area to facilitate the transport of personnel, supplies, coal and spoil.

6.5 FILL VOLUME BELOW COAL REMOVAL BOUNDARY

The following metric compares the volume of fill placed below the pavement of the Middle Coalburg Seam, which is the lowest seam mined. Groundwater will flow along this pavement boundary down dip. Any fill placed below this level will become a conduit for groundwater seepage from the Middle Coalburg pavement and thus susceptible for the interaction of the groundwater and fill material. The increased volume of groundwater that has the opportunity to interact with the fill material increases the potential for the production of dissolved solids. It is important, therefore, to minimize the fill material that could become exposed to groundwater flow.

As shown in the figure below, Alternative #1 places 20% of the total fill below the mineral removal boundary. The IBR #2 proposed the placement of 44% of total fill below the mineral removal boundary. This is more than twice that outlined in Alternative #1.



6.6 Basal Seam Drainage

This metric measures the drainage area of the pit floor, whose drainage will report ot the perimeter of a hollow fill. The flow on the pit floor is controlled by the dip of the coal seam.

This drainage will infiltrate the fill material and increase the potential for degradation of water quality as it exits the toe of the hollow fill, as discussed above. The prior metric evaluated the quantity of material that could be influence by the groundwater flow, while this metric focuses on the volume of that groundwater.

Alternative	Fills	Regrade Drainage Through Fill (acres)
IBR #2	6 Fills	735.7
Alternative #1	1 Fill (Seng Camp)	100.7

As shown in the above table, Alternative #1, with only one (1) hollow fill, has only 100.7 acres draining through the Seng Camp valley fill, representing 5.8% of the total mine pavement that drains toward a fill. For comparison, the IBR #2 has 42.3% draining toward a fill. A graphical representation of these areas can be found on Drawing Nos. 12 and 13.

6.7 DRAINAGE TO FILL METRIC

In order to allow comparison between mining project with different coal tonnages and different configurations some method of normalizing the data outlined in the previous two sections is required.

The drainage area flowing into the fill represents the flow that will discharge at the down dip outcrop of the coal pavement, within the confines of the fill. The area is a suitable measure as any rainfall onto that portion of the mined area, that does not either evaporate, get lost to evapotransporation or run off as surface water, will migrate down to the coal pavement.

As discussed in the previous section, the volume of fill below the lowest seam being mined is that portion of the fill that will be influenced by flow from the adjacent coal seam outcrop. The portion of the fill above this elevation will only be affected by infiltration of precipitation onto the fill surface above.

The coal tonnage is the best measure of the overall size and efficiency of the operation and is therefore applicable as a common denominator.

The metric is based on the mine area that would discharge within the confines of the valley fill multiplied by the volume of film material through which it could flow. The denominator is the coal tonnage. Using this data, the comparison of the IBR#2 data with the proposed Alternative #1 is:

Project Name	Coal Tonnage	Fill Below Lowest Seam	Acres into Fill	Fill x Acres per Coal Ton
	Tons	*LCY*	*Acre*	*lcy*acre/ton*
IBR #2	40,910,000	69,400,000	735.7	1,248
Alternative #1	41,854,229	31,000,000	100.7	75

6.8 ECONOMICS

Introduction

A preliminary study of the project economics was conducted on the basis of volume and distance to move spoil to disposal and backfill areas. The Applicant's preferred alternative (IBR #2) included six disposal areas located near the point of origin of spoil material. Material placement for Alternative #1, a single fill in Seng Camp, is compared against the IBR #2.

Equipment selected for IBR #2 would also apply to Alternative #1. From the EID, the Applicant has indicated the following equipment would be employed on the project:

Table 1 - Equipment List from Table 2-16 of the EID.

Equipment Item	Number/Qty.	Average Annual Operating Hours/Unit
54-cubic yard Electric Shovel	1	4140
28-cubic yard Overburden Front-end Loader	1	4580
15-cubic yard Overburden Front-end Loader	1	4580
150-ton Overburden Haul Trucks	6	4140
300-ton Overburden Haul Trucks	12*	4580
Coal Front-End Loader	10	4140
D11 Production Dozers	6	4140
Utility Dozers	12	4580
Production Drills	5	4580
Coal Haul Trucks	15	4580
Motor Grader	3	4580
Water Trucks	3	4580
Miscellaneous Service Vehicles	20	4580
Other Mobile Equipment	4	4140

Annual Operating hours is effective production hours. All scheduled maintenance, holidays, availability, and operator efficiency has been included in the above estimates.

** The table in the supplied EID indicated 12 trucks at 4580 hours. It's recognized that this may be a typographic error because the hours do not match the shovel, and the likely fleet should be 6 trucks. The analysis will utilize the unaltered table data though.*

Ownership of equipment and operating cost is a subject that generally relies upon numerous assumptions based on the mine operator's own experience and familiarity with the maintenance culture, operations management, and accounting practices within his/her company.

Sequencing

The placement of material, with respect to the mining sequence, is detailed in the EID for IBR #2. In broad summary, the mining sequence is (Refer to EIS Exhibit 2-14):

1. Mine the Contour Cut (Area 2B) at the head of Pigeonroost Branch and place material in Valley Fill 2A.
2. Continue mining south (Area 3) and complete construction of Valley Fill 2A.
3. Enter Oldhouse Branch and construct Valley Fill 4, then construct Valley Fill 3 with material from Area 4.
4. After Area 4 is complete, mine north (Area 2A and Area 2) and utilize Valley Fill 1A and 1B in Seng Camp.
5. Complete the mining in Area 1.
6. Backfill, regrade, and complete reclamation for the project.

Utilizing the same area nomenclature, Alternative #1 proposes a different sequence. The details of the sequencing are indicated on **Drawing #11**. In broad summary:

1. Contour mine Area 2A and begin the Seng Camp fill.
2. Mine Area 2 and continue filling Seng Camp.
3. Mine the north portion of Area 2B contour and continue filling Seng Camp.
4. Mine Area 1, utilizing both Seng Camp and Area 2 backfill for spoil placement. Mining of Area 2B contour should continue, utilizing the previously contoured strip for backfill.
5. Construct a road across Pigeonroost Branch and begin mining Area 4, hauling all initial spoil to Area 2 backfill, Area 1 backfill, and complete Seng Camp, including reclamation of mine areas north of Pigeonroost Branch.
6. Mine both Area 4 and Area 3, utilizing remaining backfill storage areas south of Pigeonroost Branch.

Haulage Study

Haulage was studied for both IBR #2 and Alternative #1. The analysis for each case calculated the ton-miles required to haul material from the centroid of a given mine area to the centroid of each fill or backfill area. Distances were considered in the x-y plane only. Elevations and grades have been ignored due to the limited evaluation period, but would be considered as an additional evaluation factor in a more detailed analysis. Material handled by production dozers has been ignored, assuming all material will be hauled by truck. The basic equation for haulage is:

$$Haulage\ (ton - miles) = Spoil\ (tons) \times Distance_{\ Centroid-Centroid}\ (miles)$$

Where:

- Spoil (tons) calculated on a density of 2.23 tons/bcy, 1.78 tons/lcy (25% swell);
- Distance is a straight line between centroids; and
- Centroids for fills are based on mass, not plan-view areas.

For instances where material haulage was confined to the active mining area, an assumed distance of 2,000 ft. was employed.

Table 2 - Haulage Study for IBR #2

Mine Area	Spoil Generated (LCY)	Disposal Location	Disposal Amount (LCY)	Haul Distance (ft)	Haulage (ton-miles)
AREA 1	34,381,285	Regrade Area 2	28,837,726	5,813	56,581,147
AREA 1		Regrade Area 1	5,543,559	2,000	3,741,902
AREA 2	58,190,441	Regrade Area 2B	29,380,010	1,996	19,794,521
AREA 2		Regrade Area 3	4,928,560	5,951	9,898,292
AREA 2		Regrade Area 2A	7,223,083	1,157	2,820,092
AREA 2		Regrade Area 2	16,658,788	2,000	11,244,682
AREA 2A	11,856,797	ValleyFill 1B	383,643	1,234	159,778
AREA 2A		ValleyFill 1A	6,916,010	1,157	2,701,111
AREA 2A		Regrade Area 2A	4,557,144	2,000	3,076,072
AREA 2B	37,038,375	ValleyFill 2A	37,038,375	714	8,925,249
AREA 3	28,646,073	ValleyFill 2A	4,280,501	2,989	4,317,872
AREA 3		Regrade Area 2B	24,365,572	2,381	19,576,650
AREA 4	336,650,756	ValleyFill 4	44,214,017	1,582	23,612,044
AREA 4		ValleyFill 3	4,173,369	2,596	3,657,031
AREA 4		Regrade Area 4	249,595,071	2,000	168,476,673
AREA 4		Regrade Area 3	24,566,208	5,636	46,730,993
AREA 4		ValleyFill 2B	14,102,090	4,331	20,613,597
TOTALS	**506,763,727**		**Weighted Avg.**	**2,373**	**405,927,706**

Table 3 - Haulage Study for Alternative #1

Mine Area	Spoil Generated (LCY)	Disposal Location	Disposal Amount (LCY)	Haul Distance (ft)	Haulage (ton-miles)
AREA 1	34,381,285	Seng Camp Stg.3a	34,381,285	7,079	82,145,228
AREA 2	58,190,441	Seng Camp Stg.1	19,439,097	2,883	18,914,638
AREA 2		IBKF Area 2A	9,795,061	1,157	3,824,263
AREA 2		Seng Camp Stg.2	28,956,283	2,084	20,369,601
AREA 2A	11,856,797	Seng Camp Stg.1	11,856,797	1,924	7,698,062
AREA 2B1	15,928,628	Seng Camp Stg.2	15,928,628	3,969	21,336,384
AREA 2B2	21,109,748	IBKF Area 2B1	9,275,597	5,059	15,836,351
AREA 2B2		Seng Camp Stg.2	2,916,438	6,625	6,520,979
AREA 2B2		Seng Camp Stg.3a	8,917,713	6,204	18,672,446
AREA 3	28,646,073	IBKF Area 2B2	13,341,969	1,198	5,393,526
AREA 3		IBKF Area 3	15,304,104	2,000	10,330,270
AREA 4a	32,769,681	Seng Camp Stg.3a	32,769,681	5,496	60,783,880
AREA 4b	72,663,083	IBKF Area 1	20,752,473	4,342	30,413,467
AREA 4b		IBKF Area 2 I	7,306,827	6,755	16,659,188
AREA 4b		Seng Camp Stg.3a	4,421,124	7,742	11,551,730
AREA 4b		IBKF Area 2 II	30,014,777	5,633	57,058,666
AREA 4b		Seng Camp Stg.3b	10,167,882	6,296	21,607,112
AREA 4c	19,530,573	IBKF Area 2 II	9,787,713	5,727	18,918,289
AREA 4c		IBKF Area 4	9,742,860	2,000	6,576,431
AREA 4d	43,481,289	IBKF Area 4	43,481,289	2,000	29,349,870
AREA 4e	168,209,896	IBKF Area 3	3,397,450	5,837	6,693,412
AREA 4e	0	IBKF Area 4	164,812,446	2,000	111,248,401
TOTALS	**506,763,727**		**Weighted Avg.**	**3,402**	**581,902,196**

1. Seng Camp valley fill and Area 2 backfill have been segmented into several components to better represent haul distances from each area.
2. Areas 2B and Area 4 have been subdivided in order to calculate more representative haul distances.

This method of haulage analysis shows that the difference in the weighted average haul distance is 1,029 feet (43%) for the entire mine property. In today's economy, it is generally understood and accepted that mine haul distances should be maintained at less than 1-mile (5,280 ft.). As shown in the chart below, the average haul distance for both IBR #2 and Alternative #1 meet this objective.

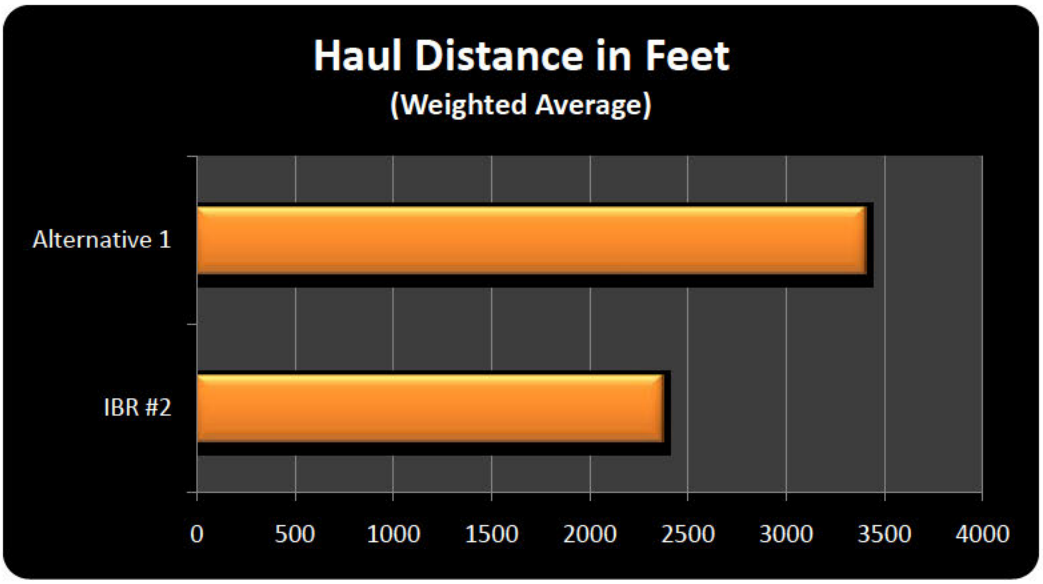
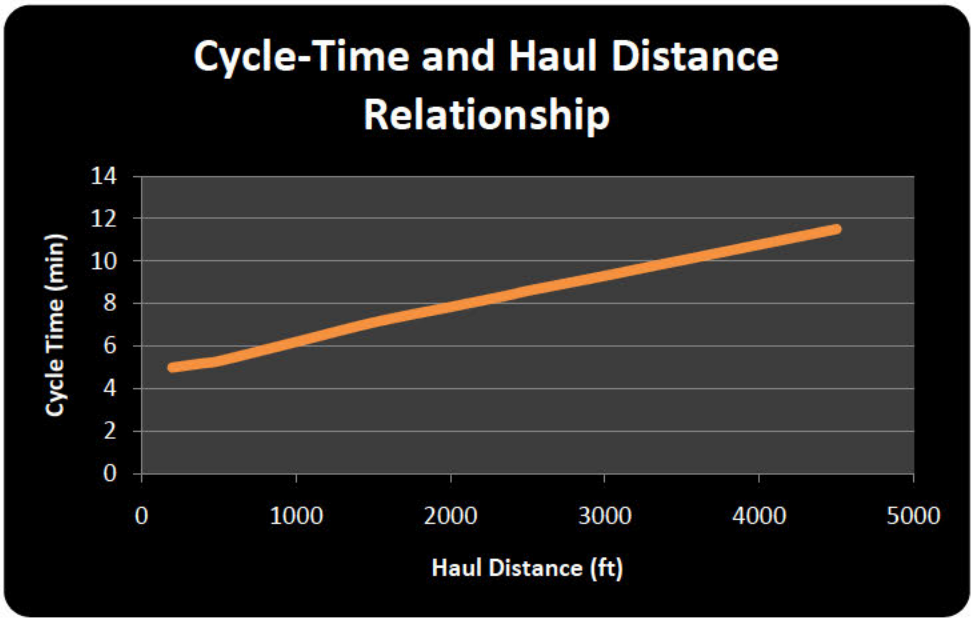


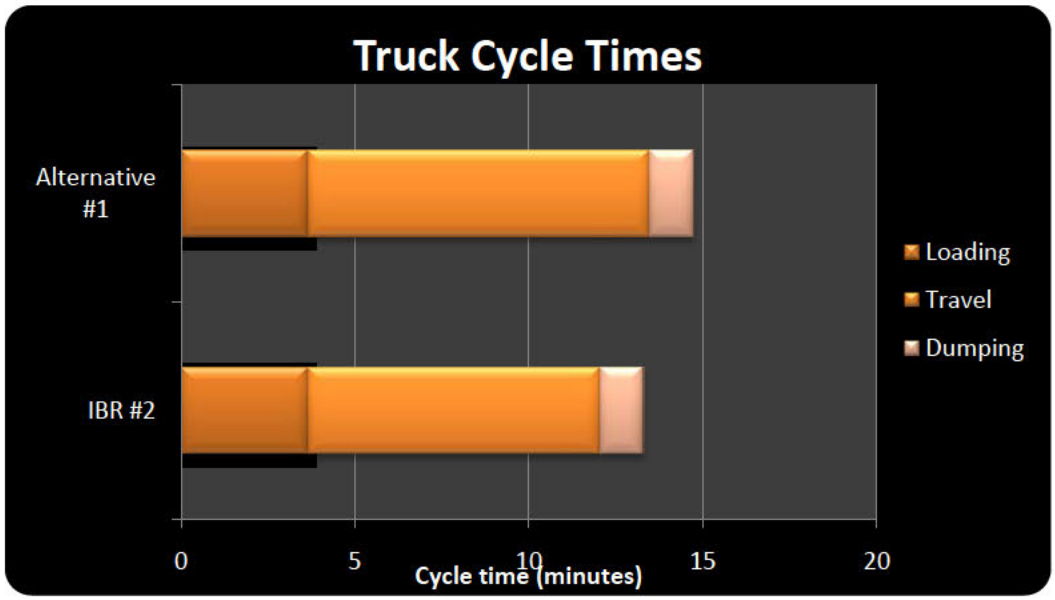
Figure 2- Comparison of Haul Distance Between IBR #2 and Alternative #1

The relationship between cycle time and haul distance is only somewhat linear after a sufficient distance is traveled when acceleration becomes zero and the effective grade is constant. Stated another way, longer travel distances will generally have slightly higher average travel speeds during the haulage cycle than shorter travel distances, assuming that all grades are equal. For large mining trucks, the distance required to achieve top speed (acceleration = zero) is typically a few hundred feet, under ideal conditions.



Fleet Requirements

To load 300-ton payload trucks with an electric shovel requires approximately 4-passes per truck. At an average shovel cycle time of 40-seconds, the first cycle requiring slightly longer while the truck maneuvers under the dipper, MW estimated a shovel can load 20 trucks per hour. At an assumed rock density of 2.2 bcy/ton, annual shovel production would be about 13.4-million bcy per year. Note that bcy is a commonly used unit of production. This is approximately half of the Applicant's stated annual overburden removal.



With the 43% difference in weighted average haul distance, the cycle time difference is estimated to be 1.43 minutes, or 17%. Further, to keep the shovel operating efficiently at a pace of 20-truckloads per hour, IBR #2 is estimated to require 3 trucks at all times, while Alternative #1 only requires one additional truck. Fleet requirements would likely be 5 and 6 units respectively, and would increase as distances and grades increased. For example, an estimated 6 trucks would be required in the truck-shovel production unit where haul distances approached 7,000 feet. This would likely equate to a truck fleet size of 9 units. The Applicant has indicated a fleet size of 12 units would be required; therefore the proposed fleet could accommodate the haul distances for either IBR #2 or Alternative #1. No additional equipment would be required beyond what has been proposed.

It should be noted also that equipment has changed since this permit was submitted. The 54-yd electric shovels (i.e. Bucyrus® 495) commonly employed at the time of the IBR #2 permit application have been largely replaced by 72-yd machines (i.e. Bucyrus® 495-HR). The newer machines can load trucks in 3 passes, and have demonstrated production rates around 17-million bcy per year due to the increased size and improved reliability of electric control systems. Additionally, trucks have increased in size to a nominal payload of 360-tons, though the 320-ton payload truck has remained very popular.

Cost Analysis

Haulage Cost Components that will remain unchanged, no matter what fill design is utilized. These cost components include:

- Unit ownership cost;
- Loading cost (shovel and wheel loaders), including ownership, operation, and maintenance (the same number of buckets and man-hours will be required to move material into trucks); and
- Loading time and dump time for each truck.

Haulage Cost Components that will vary with number of ton-miles include:

- Quantity of haul units (trucks) required to meet production goals;
- Number of employees required to operate and maintain a larger fleet;
- Annual fuel cost; and
- Average cycle time (travel time component) will increase as distance increases.

Significant assumptions in calculating an incremental haulage cost due to changes in distance have been made herein. Major assumptions include:

- The incremental difference will be due to travel distance and is a function of the rate of travel for that component of cycle time.
- Most large capacity trucks are capable of travel speeds exceeding 25 mph loaded and 35 mph empty. Conservative average travel speeds of 12 mph loaded and 22 mph empty have been utilized for comparative analysis.

With the addition of a haul unit, the results of the incremental cost analysis showed only a marginal cost increase while maintaining shovel operating efficiency and meeting annual production targets. This figure is simply a crude estimate by the methodology outlined above, but illustrates that the additional haulage distance to the Seng Camp fill is only a small added cost to the overall operation.

Table 4 - Variable Costs of Material Handling

Cost Component	Cost Estimate	Units	Converted to $/ton-mile
Fuel (300-ton trucks) 53 gal/hr	$3.00	/gallon	$0.0811
Tires (300-ton trucks) 3,000 hrs/tire	$25,000	/tire	$0.0256
Labor (including burden) One extra truck operator (/hr)	$37.50	/hour	$0.0192
Annual Total (27.64 MM bcy/year at additional haul of 1,029 ft.)			**$1,512,342 per year**

1. *Annual bcy/year converted to tons per year to keep units consistent.*
2. *1,029 ft additional haul distance converted to miles.*
3. *Difference in ton-miles per hour utilizes a cycle time difference of 1.43 minutes, assumes 320-tons per cycle, and shovel productive capacity of 20 trucks per hour.*

6.9 COST SAVINGS

It is projected that some cost savings exist with the proposed change to the mine design, most relating to the reduction in stream impacts and the disturbed area.

To compensate for impacts to streams, the applicant has developed a Compensatory Mitigation Plan. This permit review has not evaluated the costs of the proposed mitigation, but industry experience indicates that a rate of approximately $400 per linear foot is applicable. Based on the reduced stream impacts of 25,878 ft (as detailed in Section 5.2 of this report), the mitigation savings will amount to approximately $10.4M.

The reclamation costs for a mine are directly related to the disturbed acreage. An average cost per acre for reclamation is approximately $2,000 to cover final grading and vegetation. Based on the reduced areal extent of the project to 324 acres (as detailed in Section 5.4 of this report), the reclamation saving is approximately $0.6M.

In addition, the number of sediment control ponds will be reduced from nine to the three ponds that have already been constructed in Seng Camp. This reduction will result in savings to the applicant of approximately $0.3M, assuming a cost per pond of $50,000.

6.10 STABILITY ANALYSIS

In Alternative #1, all excess swelled overburden is placed in the Seng Camp Hollow Fill. The design of the fill incorporates the following parameters:

- The face of the fill exhibits 2:1 slopes with safety benches every 50 feet in height.
- Drainage (groin) ditches are constructed at the intersection of the fill with the original groundline. These ditches transport surface drainage from areas adjacent to the fill and from the face of the fill.
- A portion of the mine access road is incorporated into the face of the fill
- The top of the fill has been landformed to approximate a rolling terrain with defined watersheds.

Stability analyses were conducted on the Seng Camp Hollow Fill utilizing Rocscience SLIDE®, a computerized version of the Modified Bishop Method of Slices. The strength parameters used for the analysis are as follows:

- Unit Weight 120 lb per cubic feet;
- Cohesion 0; and
- Internal angle of friction is 38 degrees.

The strength parameters were taken from the Stability Analyses conducted in IBR #2. The stability analysis results show the minimum static factor of safety for hollow fills of 1.5 was met. See **Drawings #5 and #6** for stability analysis results.

7. Best Management Practices

7.1 AOC Requirements

The WVDEP Final AOC Guidance Document Policy (02/19/2004) has traditionally been the tool employed for fill optimization and minimization of stream impacts. Review of the Applicant's permit indicates that this guidance has been employed to determine the configuration of each of the six proposed fills.

As demonstrated by each of the proposed Alternatives to the Applicant's IBR #2, further minimization of stream impacts can be achieved by designing beyond the requirements outlined in the AOC Guidance Document. The key element is to maintain the drainage areas so they are not altered as a result of the final regrade configuration.

Per the AOC guidance and WV 38CSR2, backfill areas will be graded at 2:1 slopes with benches every 100' in elevation. Slopes will be stabilized and revegetated in accordance with the planting plan approved by WVDEP.

7.2 Fill Construction

Fill construction for Alternative #1 is confined exclusively in Seng Camp, located down dip within the coal reserve. As outlined by WV 38CSR2 §14.14.g.1.A and §14.14.g.1.B, Durable Rock fills will be constructed with 80% or greater durable rock and shall not consist of acid forming or toxic forming material, will not slake and water, and will not degrade to soil material.

The schedule of toxic forming material has grown to not only include Aluminum, Manganese, and Iron, but also Selenium and other sulfates and carbonates that can leach out or dissolve in water. As part of an approved permit, the applicant will have completed chemical analysis of the overburden to identify toxic material in the strata and developed a toxic material handling / disposal plan approved by WVDEP. Best management practices have shown that placing toxic material high in the backfill and capping it with low permeability material offers the lowest probability of leaching harmful elements. Toxic materials will be excluded from the fills insomuch as is possible. Therefore, a mine design with a high percentage of excess spoil disposal above the elevation of the lowest seam being mined decreases the potential for leachate development.

An underdrain, constructed of sufficiently large material, shall be placed within the fill to serve as a continuous drainage medium.

7.3 Compacted Fill

In order to minimize the potential increase in dissolved solids due to water migrating through a fill, it is recommended that the fill be constructed in lifts beginning from the toe, using haulage equipment to compact each lift as it is placed. This process is similar to the approach used in placing material in the mined area backfill.

7.4 Seepage Collection

Groundwater flow along the pavement of the lowest seam being mined will discharge on the down dip side of the ridge line. If this outcrop is exposed, the groundwater flow will co-mingle with any surface water in the perimeter sediment control ditch. However, if this discharge is

within the confines of a valley fill, it will provide constant flow into (and through) the fill material.

To reduce the interaction of groundwater with the excess spoil, Best Management Practices dictate intercepting the groundwater flow along the down-dip outcrop of the mine floor with a French drain and routing the flow to the groin ditches. This will be necessary for the Seng Camp fill as the coal dips to the northwest and some base flows from the lowest seam can be expected.

7.5 LOW PERMEABILITY ZONES

In order to reduce the infiltration of water into the fill, a potential Best Management Practice is to construct horizontal low permeability zones within the outslope of the fill so that any surface water infiltrating the fill is stopped from seeping through the fill where it could potentially dissolve adverse elements or increase dissolved solids.

7.6 LANDFORMING

The use of the mining metrics identified the reduction in the percentage of the drainage flowing through fills as a positive indicator The slope analysis also identified the objective that the post-mining slope distribution closely match the pre-mining slope distribution.

Traditionally valley fills have flat decks and terraced outlsopes. However, this configuration does not match the pre-mining configuration and the presence of large deck areas increases the potential for surface water to infiltrate into the fill. Flow into the fill influences the dicharge at the toe of the fill and also increases the potential for interaction with the spoil particulates.

The use of landforming on the top surface of the fill adds natural slopes to the zone and also increases the slope angle so that it closely resembles the pre-mining slope and drainage patterns. Replicating pre–mining slope also encourages pre-mining vegetation, which in turn reduces water infiltration.

8. Summary

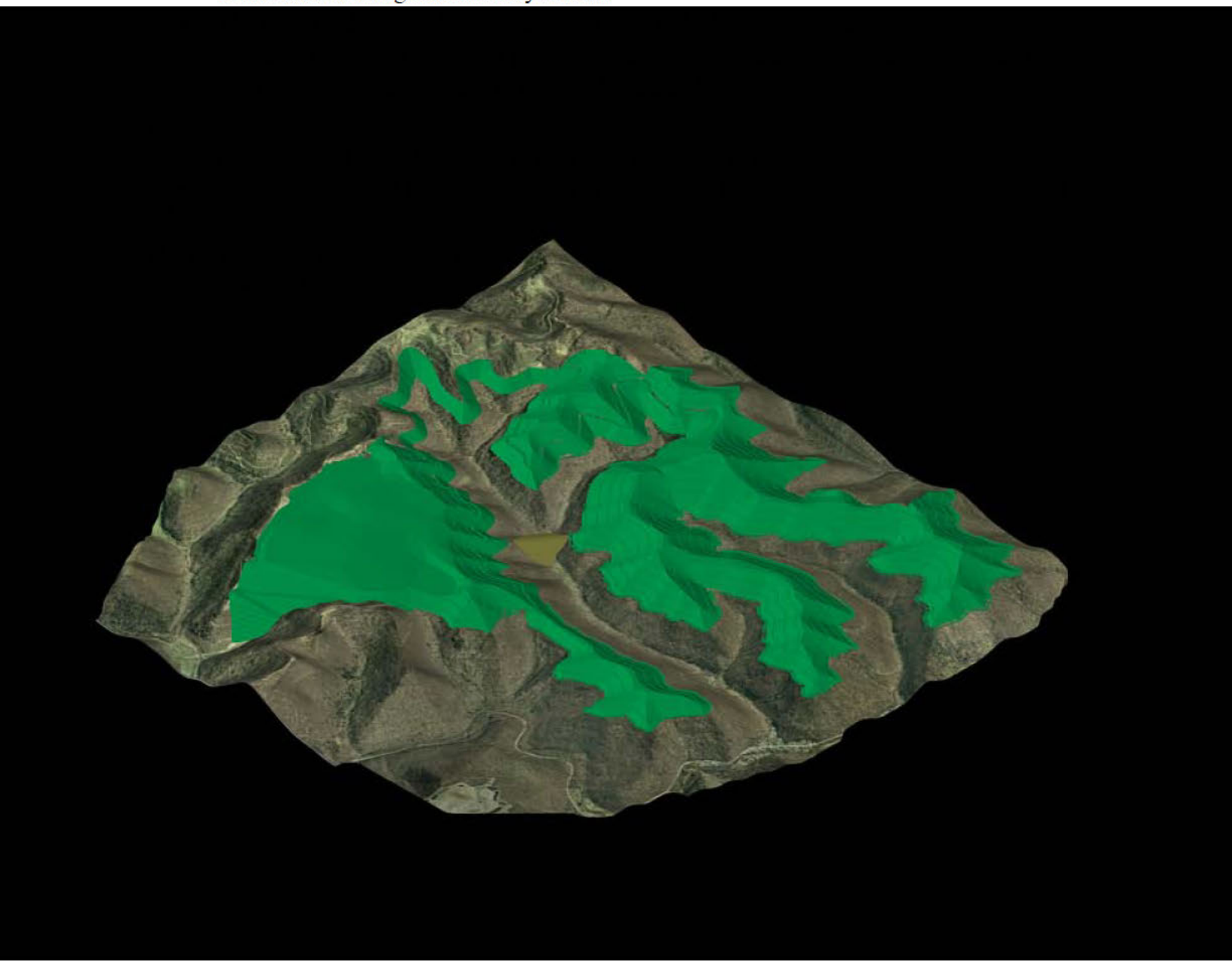
This analysis of the Spruce No. 1 Mine permit demonstrates that an alternative mine design (Alternative #1) can meet the project objective and is practicable, in so much that it is capable of being done using existing mining technology.

In fact, each of the three alternatives analyzed in this report indicate significant environmental benefits when compared to the proposed Mingo Logan IBR #2 configuration.

The objective of the analysis was to mine the same resource as proposed by Mingo Logan and this objective has been met.

The key differences between Alternative #1 and IBR #2 are:

- The stream impacts (temporary and permanent) have been reduced from 43,946 feet (IBR #2) to 18,068 feet (Alternative #1), 41% of the originally proposed impacts.
- The Alternative #1 design reduces the surface water flow through valley fills from 59.4% of the mine drainage area to only 22.1%.



9. Review of Comments

9.1 MINGO LOGAN COAL COMPANY

MW has reviewed portions of the comments from Mingo Logan regarding the pending CWA §404 (c) action and our responses to Section E of that document are detailed below.

E. Mingo Logan has Demonstrated that the Permitted Action is the Least Environmental Damaging Practicable Alternative

The analysis conducted as part of this "Spruce Permit Review" identified three alternatives that all had fewer impacts than the proposed action. In particular, Alternative #1, which contains only one fill in comparison to the six proposed in IBR #2, does not require sequential fills. In addition, this alternative has stream impacts that are only 41% of those proposed by Mingo Logan in IBR #2 and Alternatives #2 and #3 also contain far less stream impacts than IBR #2 (48% and 64% of the stream impacts of IBR #2, respectively). Each alternative considered in this analysis scored higher than IBR #2 in almost all of the seven metrics analyzed, with Alternatives #2 and #3 scoring higher than IBR #2 on all of the metrics.

Discussion of the specific subsections of the Mingo Logan comments are:

> <u>E-1 The Corps conducted a robust and complete alternatives analysis of the Spruce #1 Mine</u>
>
> The EIS reviewed a no action alternative, an off-site alternative, and seven on-site surface mining alternatives, including the Mingo Logan's preferred alternative (IBR #2), for which the EIS also analyzed fill placement and off-site spoil disposal alternatives. The off-site disposal alternatives considered either placement of 100% of the overburden back on the mine bench or hauling 100% of the 110 million cubic yards of excess spoil off-site via Pigeonroost, both of which were determined to be impractical. The EIS section entitled "Fill Placement Alternative" described West Virginia's AOC/Fill Optimization Process Guidance Document (Guidance Document), but did not suggest or analyze any alternatives related to fill placement. In addressing valley fill location alternatives, the EIS described the process used to identify potential valley fill locations, which included slope sufficiency and stability and the "ESDA Bank" Analysis procedure described in the Guidance Document, but did not actually propose or analyze any on-site spoil disposal alternatives. Following these statements, the EIS identified that Alternative 7 (IBR #2) was the least environmentally damaging practicable alternative.
>
> Although the EIS evaluated seven different alternatives, none of the alternatives evaluated the fill placement options and valley fill locations identified in this report as Alternative #1, #2, and #3, all of which maintain the overall recoverable coal while significantly reducing the environmental impacts compared to Alternative 7. Thus the EIS did not review at least three alternatives that were practicable, but less environmentally damaging than Alternative 7.

E-2 EPA's reconsideration of the Corp's Analysis violates EPA's own rules and unjustly ignores Mingo Logan's changes to the Project in response to EPA's previously expressed concerns.

Each alternative analyzed by MW in this report maintains the previous revisions to the permit that eliminated any filling of White Oak Branch, while maintaining the overall recoverable coal and reducing environmental impacts in relation to IBR #2. In addition, as shown by the analysis contained in this report, each alternative proposed by MW is less environmentally damaging than the Applicant's IBR #2 project. None of these alternatives were presented by the Applicant or analyzed by the Corps.

E-3 EPA's Fill "Approval" alternative is not practicable

The Alternative #1 option developed by MW is not a sequential fill approach, as the mine design proposes a single efficient fill with the capacity to hold all of the required excess spoil. As demonstrated above in this report, this approach would not incur significant cost and it is practicable. Most significantly, the analysis confirms that it is less environmentally damaging than the proposed action of Mingo Logan.

Furthermore, Alternatives #2 and #3, as shown above, would also minimize environmental impacts in comparison to IBR #2 while recovering the same amount of coal, making these alternatives practicable, as well.

E-3 (a) A sequential fill "Approval" alternative would not met the project purpose

Alternative #1 avoids all of the concerns expressed by Mingo Logan with regard to sequential fills. This "Spruce Permit Review" concurs with Mingo Logan that the project is one of the largest and lowest ratio (overburden to coal tonnage) surface minable reserves in Central Appalachia. Alternative #1 does not place any constraints on the operation of a large scale mining operation with the type of equipment specified in the EID.

In addition, Alternatives #2 and #3 would recover the same amount of coal as proposed in IBR #2, thus meeting the Applicant's project purpose, as well.

E-3 (b) Costs makes sequential approval impracticable

Alternative #1 would not require sequential approval since it is a single fill. Therefore, the whole reserve could be mined and the proposed large scale equipment is still practicable, as is the proposed coal handling facility.

E-3 (c) Logistics make sequential approval impracticable

None of the concerns expressed by Mingo Logan are applicable if the single fill included in the Alternative #1 is selected.

E-4 A sequential fill "Approval" alternative is not less environmentally damaging

Alternative #1 would not require sequential fill approval and has significantly less environmental impact than the approach proposed by Mingo Logan. These reduced impacts include less permanent stream impacts, only one valley fill, and a lower percentage of the drainage flowing through a valley fill. All of these reduced

environmental impacts are achieved while mining the same quantity of coal. All of the coal identified in Mingo Logan's proposed action would still be mined under Alternative #1.

In addition, this analysis has shown that Alternative #2 and Alternative #3, while both employing sequential fills, also have less environmental impacts than Mingo Logan's proposal. Alternatives #2 and #3 were shown to reduce stream impacts and the drainage area flowing through valley fills and to result in more efficient mining than IBR #2. Thus, at least two alternatives exist that employ sequential fills and are less environmentally damaging than Mingo Logan's approach.

E-5 The fill "Approval" alternative is not lawful

The Alternative #1 has only one valley fill and this is located in Seng Camp where there are two fills already permitted and one existing NPDES point. Mining is currently being conducted in this watershed. With only one fill there is no sequential approval or condition on future mining, so even if the fill "Approval" alternative was lawful, Alternative #1 is not contained within that category.

9.2 UNITED COMPANY

Morgan Worldwide has reviewed the letter from Mr. James W McGlothlin to Mr. Shawn Garvin, dated May 13, 2010, which details the concerns of The United Company. The United Company (through its wholly owned subsidiary United Affiliates Corporation) is the lessor of the majority of the coal covered by the proposed Spruce Mine. United appears concerned about the revenue loss if the permit is not allowed to proceed.

Based on the recoverable coal tonnage reported in the EID in the submittal to the Corps, the revenue to United is indicated on the following chart:

Coal Resource	40,910,000 tons
Average selling price	$50 per ton
Total Revenue	$2,045,500,000
Royalty Rate	8%
Royalty Revenue	$163,640,000
Mine Life	15 years
Annual Royalty	$10,909,333

The royalty rate is imputed from comments in the McGlothlin letter and is not substantiated by any review of the lease. In addition, it is not known if United is receiving any minimum royalties (recoupable or not) from Mingo Logan.

If the project is postponed, United is impacted by the loss of revenue over the period of delay. The best approach to evaluating that impact is to compare the net present value of the project

with two different start dates. For the purpose of the analysis, the base case assumes a commencement of coal production in 2012, the delay case moves the start date to 2015. Using a discount factor of 15% the delay in project commencement has a financial impact to United of about $8.3M over the life of the mine. However, it would have an immediate effect of eliminating the receipt of $33M of royalty payment over the three year delay period.

Since the alternatives evaluated by MW all mine all of the coal within the existing proposed mining area, there is no reduction in the overall royalty payment to United. Furthermore, the elimination of sequential fills in Alternative #1 removes any segmentation of mining and the potential for reducing the mining area due to non-approval of future fills.

David Evans/DC/USEPA/US
11/08/2010 01:30 PM

To Christopher Hunter, Timothy Landers, Marcel Tchaou, Brian Topping, Ross Geredien
cc
bcc
Subject Fw: Revised Spruce Proposal

David Evans, Director
Wetlands Division
Office of Wetlands, Oceans and Watersheds
(202) 566-0535

----- Forwarded by David Evans/DC/USEPA/US on 11/08/2010 01:29 PM -----

From: Ann Campbell/DC/USEPA/US
To: David Evans/DC/USEPA/US
Cc: Brian Frazer/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA
Date: 11/08/2010 12:53 PM
Subject: Re: Fw: Revised Spruce Proposal

I think it's appropriate to share. It was discussed this morning with Pete and Nancy and i believe they would like Denise's (and ergo the program's) opinion on it.

Spruce Coal Mine Process Technical Review (Doc Only).pdf

Ann Campbell
Special Assistant
Office of the Administrator
U.S. Environmental Protection Agency
Mail Code: 1101

P: (202) 566-1370
C: (202) 657-3117
F: (202) 501-1428

David Evans	Ann, If you feel able to share the proposal, welco...	11/08/2010 12:41:47 PM

From: David Evans/DC/USEPA/US
To: Ann Campbell/DC/USEPA/US@EPA
Cc: Brian Frazer/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA
Date: 11/08/2010 12:41 PM
Subject: Fw: Revised Spruce Proposal

Ann,

If you feel able to share the proposal, welcome it. If not, I'll check with Greg, but wasn't sure you wanted me to.

Dave

David Evans, Director
Wetlands Division
Office of Wetlands, Oceans and Watersheds
(202) 566-0535
----- Forwarded by David Evans/DC/USEPA/US on 11/08/2010 12:40 PM -----

From: Denise Keehner/DC/USEPA/US
To: Brian Frazer/DC/USEPA/US@EPA, David Evans/DC/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA
Date: 11/08/2010 12:32 PM
Subject: Fw: Revised Spruce Proposal

FYI----not sure how this exactly fits into what we expect to say at the meeting on the 16th--but suppose that we should discuss what this could mean at 1:30. Looks like it is on the agenda for 5:00.
----- Forwarded by Denise Keehner/DC/USEPA/US on 11/08/2010 12:29 PM -----

From: Ann Campbell/DC/USEPA/US
To: Peter Silva/DC/USEPA/US@EPA, Mike Shapiro/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA
Cc: Nancy Stoner/DC/USEPA/US@EPA
Date: 11/08/2010 12:25 PM
Subject: Fw: Revised Spruce Proposal

Folks - this is the proposal Greg discussed this morning and would likely be part of the discussion at today's 5pm meeting.

Ann Campbell
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----- Forwarded by Ann Campbell/DC/USEPA/US on 11/08/2010 12:22 PM -----

From: Gregory Peck/DC/USEPA/US
To: Nancy Stoner/DC/USEPA/US@EPA
Cc: Ann Campbell/DC/USEPA/US@EPA
Date: 11/08/2010 11:16 AM
Subject: Revised Spruce Proposal

Nancy:

These were the additional elements of the Spruce alternative I coordinated with John Morgan to eliminate discharges from the toe of the remaining valley fill at Spruce (at Seng Camp Creek).

- Installation of a low permeability diversion berm on the coal seam pavement to divert any base flow that migrates down dip on the coal pavement from discharging into the valley fill footprint at the coal seams downdip outcrop.
- Development of a drainage blanket and water collection system at the downdip outcrop of any aquifers identified within the footprint of the fill, these aquifers will primarily be the coal seams.

The collection drains should be routed to the groin ditches

- Compaction of a zone about 20ft below the top surface of the valley fill to decrease the infiltration of precipitation into the fill. The top 20 ft should be unconsolidated to promote tree growth
- Install a collection system at the toe of the fill to collect the basal (perennial) flow that discharges from the fill. This drainage will be pumped to the existing coal preparation plant at Seng Camp Creek to be used in the closed cycle washing process.
- Preserve in perptuity existing undisturbed streams flowing into Seng Camp Creek to maintain dilution.

Here's the original John Morgan proposal.

[attachment "Spruce Coal Mine Process Technical Review (Doc Only).pdf" deleted by Ann Campbell/DC/USEPA/US]

Spruce Coal Mine Process Technical Review

Prepared for:

EPA Region III

Submitted:

September 23, 2010

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1. Introduction

1.1 ASSIGNMENT

At the request of EPA Region 3, Morgan Worldwide (MW) conducted a review of the Mingo Logan Coal Company's - Spruce No. 1 Clean Water Act (CWA) § 404 permit application. The Spruce No. 1 Mine is located in the East District of Logan County, West Virginia, approximately two miles northeast of the town of Blair, in the Spruce Fork Watershed.

The specific Technical Directive for this review was defined in letters from EPA dated August 12, August 13, and August 30, 2010, and was outlined in MW's Statement of Work – Coal Mining Process Technical Review, as detailed in its contract with EPA (EP-10-3-000123).

In response to its agreed upon Statement of Work, MW conducted a review of the following parameters, each of which is analyzed in detail in this report:

- The capacity of Fills 1A and 1B in Seng Camp and whether these fills could be expanded
- The range of mining that could be conducted using Fills 2A, 2B, and 3 in Pigeonroost or Fill 4 in Oldhouse Branch
- Cost differences between the Applicant's plan and a plan where the total amount of excess spoil is disposed of in Seng Camp
- Evaluation of the differences between an alternate plan and the plan proposed by the Applicant
- A discussion of fill construction techniques

This report includes information analyzed through September 20, 2010, and could be augmented based on the receipt of additional information or directive from EPA.

1.2 DOCUMENTS REVIEWED

In preparing its analysis, MW reviewed and utilized all available documents and data, including documents and data supplied by EPA, as well as other accessible documents. On August 6, 2010, MW received data from EPA, including Mingo Logan's §404 permit application and the final Department of the Army §404 permit issued for the Spruce No. 1 Mine on January 22, 2007 (DA Permit No. 199800436-3), as well as WVDEP SMCRA and EPA NPDES permit documents for the Spruce No.1 mine. MW also received and reviewed at this time the complete Record of Decision for the §404 permit and the Draft and Final EISs for the Spruce No. 1 §404 permit. In addition to the documents MW received from the EPA on August 6, 2010, MW utilized digital data received directly from Arch Coal in 2004, which was associated with the analysis of the permit's compliance with AOC. This data did not contain any restrictions on its future use.

1.3 CURRENT STATUS

The analysis contained in this report is based on a review of the IBR#2 surface mining permit, which was issued by the WVDEP on April 26, 2005. Compared to the original permit, IBR #2 contained several revisions. This permit revised the dragline operation to a truck and shovel

operation, revised the seams to be mined and the type of mining method to be feasible and economical with that type of equipment. The AOC determination, the spoil balance, valley fill and drainage control designs, and haulage and access road designs were also updated to reflect the change in equipment. Finally, IBR #2 contained a change in the post mining land use compared to the original permit.

IBR #2 was used by MW in this analysis because it was the surface mining permit in effect at the time of the Applicant's §404 permit application and it was also the only electronic permit information available to MW. While subsequent revisions to IBR #2 have been approved, no alterations to the mine area and final pit have occurred that would preclude the use of IBR #2 in this analysis

MW requested from the WVDEP all permit activity for the Spruce No. 1 Mine in September 2010. From this information, the various revisions that have occurred since IBR #2 are listed below:

S-5013-98 (IBR #3)

Issued on September 29, 2006:

- Haulroad 2 was slightly relocated and the Truck Dump Facility and Pond 1-3A were revised due to the haulroad relocation.
- Haulroad 3 was added to connect Access Road 1A and Haulroad 2. Also, a conveyor right-of-way was added to the permit and located north of the truck dump to connect to U-5013-97.
- The bond increment map was updated to demonstrate additions and deletions by increment. Thirty acres were added and deleted to remain at 2,278 acres.
- The NPDES modification was included in order to relocate Outlet 14 from Pond 1-3A.

S-5013-97 (IBR #4)

Issued on June 30, 2008:

- Addressed proposed changes in drainage control from Valley Fill Nos. 2A, 2B, and 3 in Pigeonroost Branch and Valley Fill No. 4 in Oldhouse Branch.
- Added and deleted 7.53 acres, keeping the total acreage at 2,278.0 acres.
- Removed the office area from Pigeonroost Branch and redesigned and relocated ponds 2, 2A, 2B and 2C.
- Added sediment control Ponds 2D and 2G and Sediment Ditch PR01.
- Added temporary stream channel diversion in Pigeonroost Branch. Although the stream is not in the same location as shown in the §404 permit, it has the same capacity.
- NPDES outlet 001 was moved 230 feet.
- Pond 3 was deleted and Diversion Ditch VF3 was added to divert runoff from Valley Fill 3 into reconfigured Pond 2.
- NPDES outlet 002 was relocated to Sediment Ditch 2-2 and the flow path of Sediment Ditches 2-5 and 2-6 was bonded from the mine bench down to Pond 2G to allow NPDES outlet 017 to be relocated to Sediment Ditch 2-3.

- Access Road No. 2 will not be constructed. It was replaced with infrequently used Access Road 2, which provides access to Pond 2, 2A-2G. It will extend from CR 17/13 up Pigeonroost Branch and intersect Haulroad No 1.
- Pond 4 was redesigned and Pond 4A was added below the toe of Valley Fill 4. Temporary Pond 4B was added within the toe area of the fill, but will be removed prior to final reclamation of the fill.
- An NPDES modification was submitted to relocated outlets 001, 002, and 017. The SWROA was updated to reflect changes.
- Incremental bond increments were changed to reflect a net change of 0 acres.

S-5013-97 (Revision #5)

Issued on July 10, 20008:

- Raised the final deck height of Valley Fill 1A in Seng Camp by about 80 feet.
- Adjusted Haulroads 1 and 2 to account for additional fill.
- Raised Sediment Ditches P.D.1-4A1 and P.D. 1-4A2 consistent with the fill.

S-5013-97 (Revision #6)

Issued on July 14, 2008:

- Details on the proposed phase revision are provided in Additional SMA Sections, Section N.
- Topographic lines were included, and fills and coal seams were identified on phase maps.
- Haul roads were labeled.
- Ancillary areas exceeded 10% in some phases.
- All phase maps were updated, topographic lines were shown on each phase, haulroads, truck dump, conveyor, and valley fills were labeled, and ancillary and exempt areas were identified and addressed in the acreage tables.
- The acreage summary table listings for disturbed, undisturbed, ancillary, exempt, and regraded acres by phase were attached.
- The mining sequence was changed to allow mining in upland areas in Pigeonroost watershed from the haulage road in the Right Fork of Seng Camp Creek.
- Haulage to existing handling facilities on Mountain Laurel Complex can now be maintained through the Right Fork of Seng Camp Creek and along the ridge above Seng Camp Creek throughout the life of the operation.

S-5013-97 (Revision #7)

Issued on September 10, 2008:

- Designated a site for coal stockpiling within the existing permit area.

2. Geologic Model

As the Applicant's original geologic model was not provided, MW used the data received to prepare a reproduction of the Applicant's original geologic model in order to conduct an analysis of the excess spoil volumes, the volumes of backfill, and the amount of spoil material associated with each mining area are described in the mine plan. The data and method MW used to recreate the geologic model is described below.

First, the 3D polylines representing the outcrops of the coal seams within the deposit were obtained from the AutoCAD® drawing "Spruce Outcrops.dwg," which was provided to MW in the original data received from Arch Coal. The polylines are listed below, in lithological order:

Outcrop Polyline Layer Name	Inferred Coal Seam Name
M5B1_EL	Middle Five Block No. 1
M5B2_EL	Middle Five Block No. 2
L5BL_EL	Lower Five Block
LT5B_EL	Little Five Block
LT5C_EL	Little Five Block "C" or Center Split
LT5L_EL	Little Five Block Lower Split
US1R_EL	Upper Stockton No. 1 Rider
UST1_EL	Upper Stockton No. 1
US1L_EL	Upper Stockton No. 1 Lower Split
UST2_EL	Upper Stockton No. 2
UST3_EL	Upper Stockton No. 3
MS1U_EL	Middle Stockton No. 1 Upper Split
MS1L_EL	Middle Stockton No. 1 Lower Split
MS2U_EL	Middle Stockton No. 2 Upper Split
MS2L_EL	Middle Stockton No. 2 Lower Split
LST1_EL	Lower Stockton No. 1
LST3_EL	Lower Stockton No. 3
UC1L_EL	Upper Coalburg No. 1 Lower Split
UC2U_EL	Upper Coalburg No. 2 Upper Split
UC2L_EL	Upper Coalburg No. 2 Lower Split
MC1L_EL	Middle Coalburg No. 1 Lower Split
BCA-1 CROP	Buffalo Coal "A" First Split
BCA2_EL	Buffalo Coal "A" Second Split
BCA3_EL	Buffalo Coal "A" Third Split
Buf-crop-b-minex	Buffalo Coal "B"

In addition, images of Geologic Cross Sections A-A, B-B, and C-C were provided in Adobe Acrobat® format. These images contained corehole data with acid-base accounting results and specific coal seams identified. The data was entered into an electronic format and imported into Carlson Software®, where it was used to re-generate a geologic model. Because at least one of the map images incorrectly identified coordinates and elevations of the corehole collars, MW used an AutoCAD® drawing, titled "Spruce 1 Proposal IBR no.2 Map.dwg," to identify the proper locations and elevations of coreholes for its geologic model. Other typographic errors were discovered in the logs and these were corrected or adjusted by MW staff, experienced in the interpretation of drill log data, while accounting for the context in which the error occurred.

MW also used contours from two grid files supplied by EPA in developing its geologic model. The file "spruce base w-top remove.grd" appeared to be a grid of the ultimate pit floor for the proposed mine plan (IBR #2) and was contoured at a five-foot interval. Because these contours appeared to be on a common coal seam, the Middle Coalburg, and because the Applicant's

Environmental Information Document (EID) indicated that the Middle Coalburg was a target coal seam for the ultimate pit floor, MW used this data in developing its geologic model.

In order to identify various splits observed in the outcrop layer, MW grouped splits into bed names and simplified the geologic model. Although detailed drill logs and E-Logs were not supplied to MW, it appears likely that E-Logs were used to develop the Applicant's geologic model, as evidenced by subtle variations between the Middle Coalburg seam elevation on the geologic cross sections and the elevation of the grid file at the coreholes. Because thin coal strata are grouped together with this method, a false high recovery may result due to the model representing recoverable coal thickness as greater than it actually is.

The following major groupings of coal strata, in lithologic order, were used to determine splits in the outcrop layer. Bench numbers were assigned based on their vertical distribution:

Bed Name	Description	Bench Number
6BLK	Six Block	1
5BLK	Five Block	2
5LTL	Little Five Block	3
UST1	Upper Stockton No. 1	3
UST2	Upper Stockton No. 2	4
MST1	Middle Stockton No. 1	4
MST2	Middle Stockton No. 2	4
LSTK	Lower Stockton	4
UCB	Upper Coalburg	5
MCB	Middle Coalburg	5
LCB	Lower Coalburg	6
BUFA	Buffalo "A"	7
BUFB	Buffalo "B"	8

With the data above entered into Carlson Software®, grid files representing the surface of each coal and rock interface were created. First, elevation grids for the base of each coal bed name were created utilizing 3D Polylines. Then, each respective strata was tagged using the outcrop and drillhole data. Grids were created using triangulation, since the outcrop elevations are known, fixed, and provide a great density of data from which to model.

Second, thickness grids were generated for each coal bed using an Inverse Distance Squared algorithm while modeling strata pinch-out. Grid file utilities were used to add the thickness grids

to each respective coal bed elevation grid to generate the base elevation of the rock layer. No additional coal seam compositing was performed on the model.

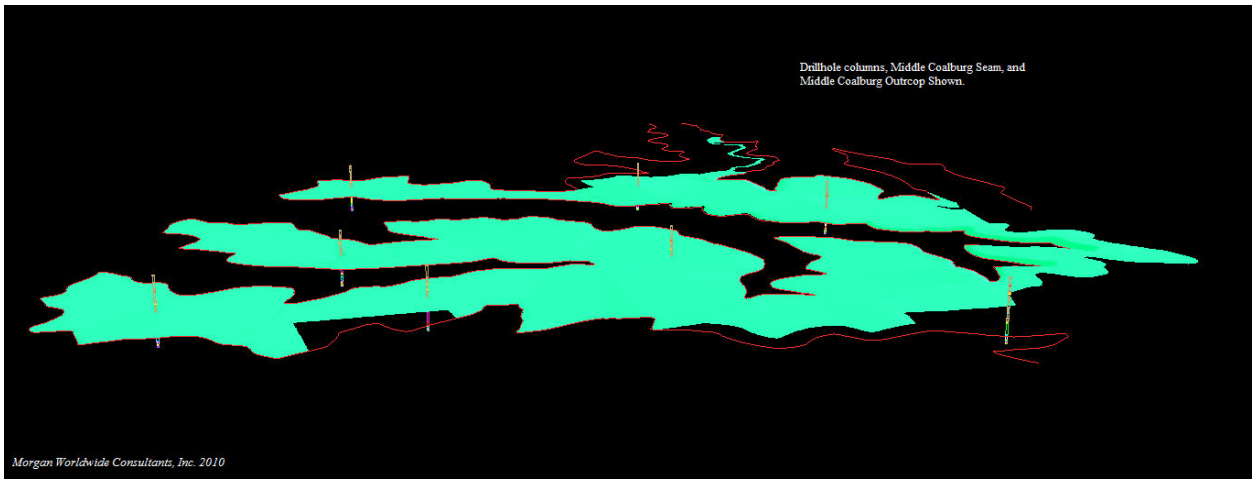


Figure 1 - Image of Middle Coalburg bottom elevation, drillholes, and outcrop line (3D perspective).

With the completed geologic model, the permit area was subdivided into Areas 1, 2, 2A, 2B, 3, and 4 (Final EIS Exhibit 2-14). These areas served as the pits for storing data from the calculations of surface mine reserves. The following key parameters were used in the reserve calculations:

- Minimum recoverable coal seam thickness: 1 foot
- Minimum depth of overburden required: 15 feet
- Recovery percentage: 100%

The minimum recoverable seam thickness is a function of the machinery's ability to extract thin seams and the quality of the coal seam being extracted. Operators today often use one-half foot as a minimum recoverable thickness. The minimum depth of overburden is a function of how the coal weathers (loss of volatile matter) near the outcrop. No information related to seam specific recovery was provided to MW. Therefore, a recovery factor of 100% was initially adopted for the entire reserve. Later, the recovery factor was reduced to 75% to determine "saleable coal tons." Based on past experience, MW believes that recovery rates of 75%-80% are typical for surface mining reserve estimates.

A two-grid surface calculation was performed on the original topography and pit floor to verify the total volume calculated in the model. The new model is within 3% of the original model's volume, a difference that may be due to using the Applicant's supplied pit floor surface grid instead of actual model grids of the Middle Coalburg and Upper Stockton No. 1 strata to represent the pit floor.

Applicant Data (from EID and EIS)			
	Non-Coal and Discard	**Coal Volume**	**Coal Tons**
All areas, all seams	408,880,000 bcy	unknown	54,547,000
	Swell: 25%		Recovery: 75%
TOTALS	**511,100,000 lcy**		**40,910,000 tons**
Note Appoximately 1.3-million tons (3%) is indicated as coming from auger/highwall operations. Due to the lack of a complete geologic model, relatively low volume, and the limited time allotted for this study, all tons are considered as surface tons.			
Geologic Model Results			
	Non-Coal and Discard	**Coal Volume**	**Coal Tons**
All areas, all seams	405,410,982 bcy	51,671,887 bcy	55,805,638 tons
	Swell: 25%		Recovery: 75%
TOTALS	**506,763,727 lcy**		**41,854,229 tons**
An additional 5-10% of the coal volume left in the pit would match the Applicant's stated volumes and tons, leaving 20% of the coal volume lost in processing.			

3. Proposed Action

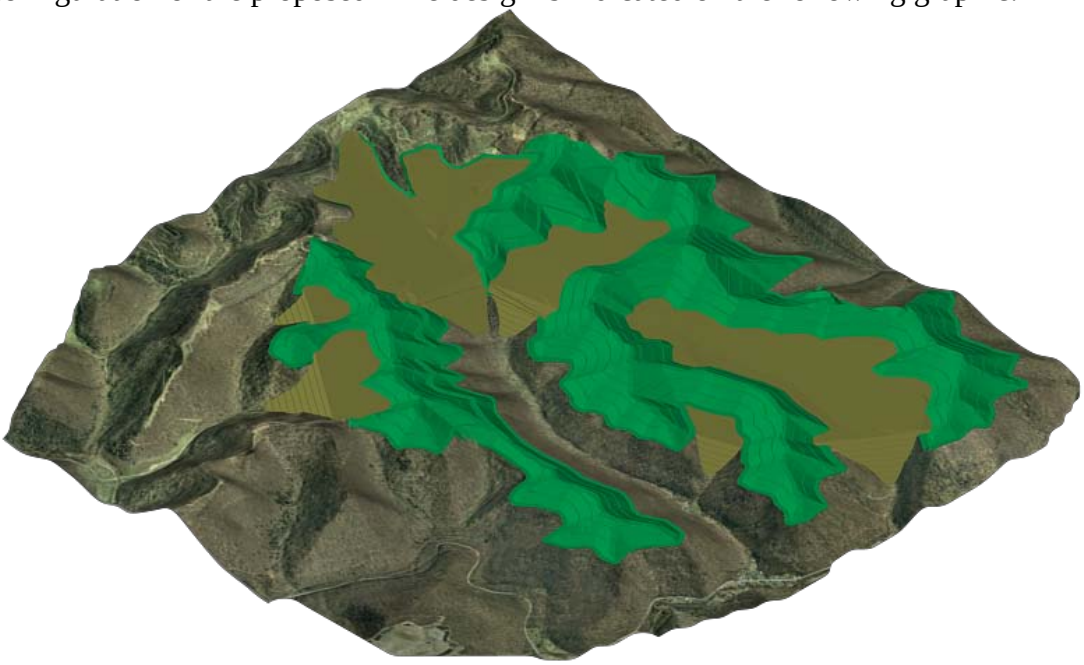
As detailed in the mine permit application and the Environmental Impact Statement related to the project, Mingo Logan is proposing to mine approximately 41 million tons of coal. The project proposes the construction of six valley fills: two fills in Seng Camp Creek; three fills in Pigeonroost Branch; and one fill in Oldhouse Branch. These fills are designed to accommodate the capacities listed below, as detailed in Section O-2 of the IBR #2 permit application. Note that the capacities below are downslope of the vertical demarcation line described in the West Virginia Final AOC Guidance.

Fill capacities - IBR 2

	Volume (lcy)
Fill #1A	11,823,491
Fill #1B	1,531,100
Fill #2A	39,303,135
Fill #2B	13,848,721
Fill #3	3,434,460
Fill #4	40,068,262
Total	**110,009,169**

In addition to the impacts associated with the fills, the Applicant proposes in-stream sediment control structures in Seng Camp, Pigeonroost and Oldhouse. Furthermore, the permit application includes a mine management area and access roads in Pigeonroost Branch.

The configuration of the proposed mine design is indicated on the following graphic:



4. Alternatives Analysis

4.1 INTRODUCTION

Three alternatives were evaluated by MW for the Spruce No. 1 Surface Mine. The basis for these evaluations was the Applicant's IBR #2 permit application, submitted to the West Virginia Department of Environmental Protection in 2004. The mine area outlined in IBR #2 was maintained without modification. However, the permit area was expanded in Seng Camp to accommodate a larger valley fill and an access road. It is likely that the need for additional sediment storage may slightly increase the permit area again near the toe of the valley fill.

A new IBKF (Initial Backfill) design was created by MW, removing the drainage ditch proposed in IBR #2. This new IBKF confirmed that an additional 33 million cubic yards can be stored in the mine backfill, thereby reducing the excess spoil by an equal amount. The configuration of this IBKF is indicated on **Drawing #1**. The MW IBKF was applied to Alternative No. 1, but MW used the original IBKF when evaluating Alternatives 2 and 3. Although the proposed valley fills in Alternatives 2 and 3 should be considered non-optimized, these valley fills are representative of the impacts that would be incurred if either alternative was implemented.

All three alternatives listed below include a larger valley fill in Seng Camp than was originally presented in IBR # 2 and overlay the footprint of the proposed Fills 1A and 1B.

4.2 ALTERNATIVE #1

Under this alternative, <u>all</u> excess spoil from the proposed operation will be stored in Seng Camp hollow. The toe of the valley fill will be at the 1050 foot elevation. The two existing ponds, Sediment Ponds 1 and 2 will be modified and/or a contour cut will be established on the east side of Seng Camp to handle the increased sediment load.

An 80-foot wide haul road will be built from the existing road near the confluence of Seng Camp and an unnamed tributary to the 1,400 foot elevation. This road will serve as the main access road for the mine operation throughout its life.

Mining will begin on the North Mine Reserves (Mining Areas 2 and 2A, located north of Pigeonroost) to establish the toe and raise the working surface of the fill. Between elevations of 1050 to 1400 feet, as the fill is raised, temporary road(s) will be built on contour to the main access road for transport of coal and supplies. After the fill reaches the 1,400 foot elevation, a permanent 100-foot wide road will be established up its face at approximately a 10 percent grade to the 1,650 foot elevation. There, the fill road will intersect the coal chute road, originally proposed in IBR #2, and continue to the 1,800 foot elevation and beyond, as is deemed necessary.

The primary issue with this alternative is that most of the spoil will be generated in mining areas located south of Pigeonroost Branch. In order to minimize the haul distance from the south reserves to Seng Camp, a temporary stream crossing was designed across Pigeonroost. This crossing has a 100 foot wide road at its crest, allowing haul trucks to efficiently transfer about 117 million cubic yards of excess spoil over the stream to Seng Camp or the North IBKF. A box or arched culvert will be installed beneath the road fill to effectively route Pigeonroost. In addition, the road fill can function as a Surface Water Runoff Analysis (SWROA) structure to

help alleviate the effects of increased runoff. The road fill will be entirely removed during the reclamation process and stored on the mine bench.

After crossing Pigeonroost, a road-cut was designed, opening the North Mine Block to Seng Camp Hollow. The road surface will be 150-feet wide with a 10 percent grade. The road will begin on the Middle Coalburg seam (on the North Mine Block) and terminate at the Upper Stockton seam at approximately the 1650 elevation. Since this road-cut crosses through the mine area, the company may choose to increase its width so that the location and number of safety benches may be reduced.

Landforming on the crest of the Alternative No. 1 Seng Camp Valley Fill will create a gently rolling terrain, which will help control drainage and provide aesthetic benefits. The crest of the Seng Camp valley fill for Alternative No. 1 peaks at the 1,920 foot elevation with the structure containing about 157 million cubic yards of excess spoil.

See **Drawing #2** for a detailed depiction of Alternative #1.

4.3 ALTERNATIVE #2

Alternative #2 is based on the original Spruce IBKF and therefore, excess spoil amounts will differ from Alternative #1. This alternative stores a portion of the excess spoil south of Pigeonroost in addition to Seng Camp hollow. About 86 million cubic yards of spoil will be placed in the right tributary of Pigeon Roost and the remainder, 100 million cubic yards, will be transported to Seng Camp.

An 80-foot wide haul road will be built from the existing road near the confluence of Seng Camp and an unnamed tributary to the 1400 foot elevation. This road will serve as the main access road for the mine operation throughout its life.

Mining will begin on the North Mine Reserves to establish the toe of the Seng Camp Valley Fill and raise the working surface. The access road plan will be identical to Alternative #1, with the road up the face of the fill to the 1,600 foot elevation. All grades and road widths will be the same as described in Alternative #1.

A second mine section can begin mining in the right tributary of Pigeonroost and proceed according to the approved mine plan.

A road fill will be constructed about 2200 feet upstream of the Alternative #1 road fill. This road fill will contain about 1.3 million cubic yards of material with a 100-foot road width on top and will transfer 60 million cubic yards of spoil material from the south to Seng Camp Valley Fill or the North IBKF. A road-cut through the North Mine Block will facilitate the transfer of spoil material. This road-cut design mirrors the Alternative #1 design, although less excavation will be required.

The road fill will be entirely removed during reclamation.

4.4 ALTERNATIVE #3

As with Alternative #2, Alternative #3 is based on the original Spruce IBKF, and therefore, excess spoil amounts will differ from Alternative #1. This option stores 103 million cubic yards of the excess spoil south of the North Mine Block in upper Pigeonroost Branch.

An 80-foot wide haul road will be built from the existing road near the confluence of Seng Camp and an unnamed tributary to the 1400 foot elevation. This road will serve as the main access road for the mine operation throughout its life.

Mining will begin on the North Mine Reserves to establish the toe of the Seng Camp Valley Fill and raise the working surface. The access road plan will be identical to Alternative #1, with the road extending up the face of the fill to the 1600 foot elevation. All grades and road widths will be the same as described in Alternative #1.

No road fill across Pigeonroost Branch will be required since the valley fill itself will provide access from south to north. A small road fill will be constructed in the right tributary of Pigeonroost to facilitate transfer of spoil from the west to the IBKF or Pigeonroost Valley Fill. A total of 43 million cubic yards of spoil material from the south will be stored in the Pigeonroost Valley Fill or the north IBKF. For this option, no spoil from the south will be transferred to Seng Camp Valley Fill.

As with the previous alternatives, the road fill in the right fork of Pigeonroost will be entirely removed during reclamation.

5. Comparison of Alternatives

5.1 INTRODUCTION

MW used the following criteria to analyze the three alternative design options in relation to each other and the Applicant's proposed action:

- Stream Impacts
- Drainage through fills
- Tons per acre
- Excess spoil per ton
- Excess spoil per foot of stream impact
- Tons per foot of stream impact
- Slope

These criteria are used to examine a full range of characteristics related to the alternative mine design options and to evaluate their efficiency and potential impacts.

The "**Stream Impacts**" metric is used to evaluate alternative mine configurations where the mining area (coal recovered and total spoil material) remains constant. The use of the stream impacts metric is not applicable when comparing different mining operations.

Objective: The objective is to minimize the impacts to designated stream segments.

The "**Drainage Area Through Valley Fills**" metric is a means to evaluate water quality issues. Studies have indicated that the flows from the toe of conventional valley fills has higher conductivity levels (dissolved solids) that create significant impairment to downstream habitat. Reducing the portion of the mine area that drains through valley fills is a means to address this issue.

Objective: The objective is to minimize the areas draining through valley fills in order to increase the probability of maintaining compliance with applicable water quality standards.

The "**Tons Per Acre**" metric is indicative of the efficiency of the mining project. This metric measures the number of tons of coal recovered per acre of land disturbed, with a higher ratio indicating a more efficient use of the land.

Objective: The objective of the operation is to maximize the tonnage of coal recovered per acre of disturbance.

The "**Excess Spoil Per Ton**" metric measures the effectiveness of the mining operation to maximize the quantity of spoil material returned to the mine bench. Lowering this indicator will lessen the various impacts associated with excess spoil disposal.

Objective: The objective is to maximize the amount of material placed back on to the mine area.

The "**Excess Spoil Per Foot of Stream**" measures the efficiency of spoil placement and the optimization of the valley fill design. The higher this number, the less streams are impacted and the configuration of the fill design is more efficient.

Objective: The objective is to place excess spoil in the most efficient location available that maximizes the spoil storage per foot of stream impact.

The "**Tons Per Foot of Stream Impact**" is a composite metric that compares the mine resource with the spoil per foot of stream impact. This metric is useful for a comparison of multiple projects. The higher this number, the greater the efficiency and value of the operation.

Objective: The objective is to minimize the overall stream impact per ton of coal mined.

5.2 STREAM IMPACTS

For purposes of this report, stream impacts are defined as any jurisdictional stream segment that is impacted either temporarily or permanently through activities associated with the extraction of coal and subsequent placement of spoil material. Temporary impacts to jurisdictional streams most often occur during construction of in-stream sediment structures or stream crossings. The stream bed is normally covered with material during construction of the facility and the material is removed from the stream during reclamation. Permanent impacts to jurisdictional streams normally occur during construction of hollow fills or when coal extraction progresses through the stream and the stream bed is excavated. Generally, extracted streams are classified as ephemeral. By definition, permanent stream impacts cannot be reclaimed and this length of stream is lost.

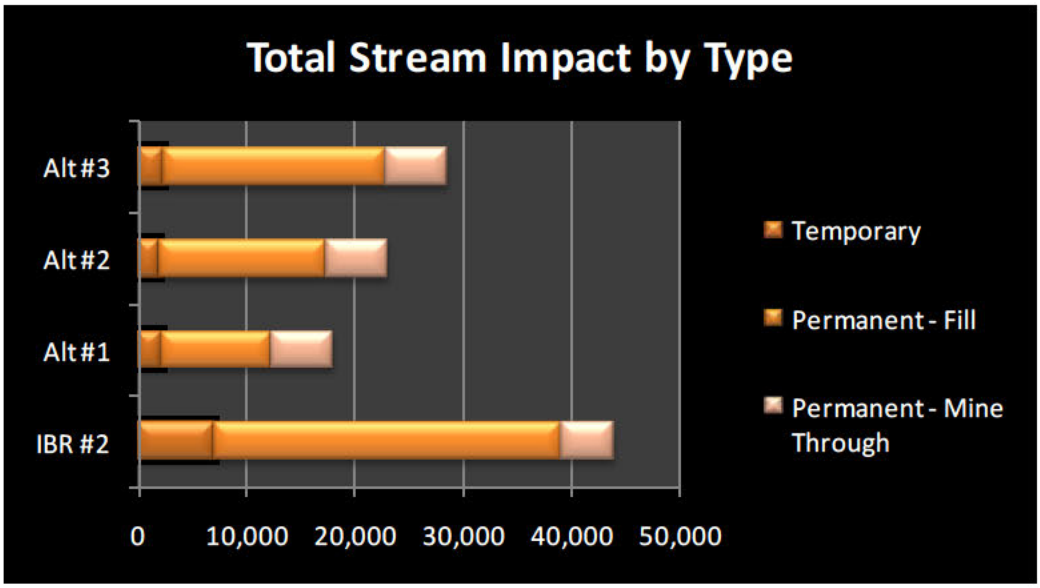
The temporary and permanent stream impacts for the IBR #2 plan and the three Alternatives, as described below, include the permanent impacts associated with mining through streams. MW has based its stream delineation and subsequent impact lengths off of a 3/16/2006 map titled "Spruce No. 1 Mitigation Plan, Stream Delineation Map" which references IBR2. No Perennial streams were shown on this map. This same stream delineation also appears on February 2004 maps titled "During Mining Drainage Map" and "Proposal Map," which were prepared by Decota Consulting Company, Inc., a firm experienced in preparing stream delineations for the USACE for jurisdictional determination. MW did not receive the official USACE Jurisdictional Determination and has therefore assumed the supplied Stream Delineation Map is in accordance with an approved JD.

MW identified a discrepancy between the impacts for IBR #2 as defined in the §404 permit (39,518 ft) and the CMP (43,946 ft).

The stream delineation used in the analysis is indicated on **Drawing #4.**

The classification of the stream impacts by type are:

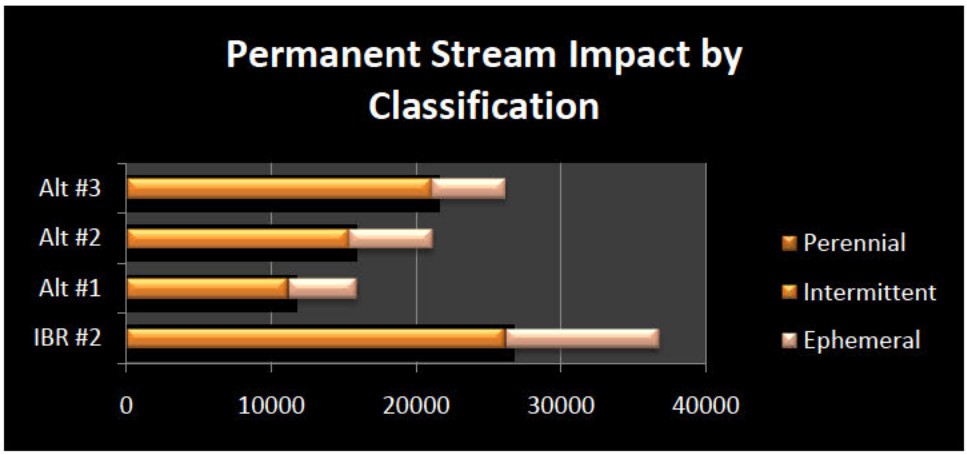
	STREAM IMPACTS			
Alternative	Temporary	Permanent - Fill	Permanent - Mine Through	Total
IBR #2	7,132	31,979	4,835	43,946
Alt #1	2,131	10,250	5,687	18,068
Alt #2	1,951	15,468	5,687	23,106
Alt #3	2,300	20,501	5,687	28,488



The permanent stream impacts are classified by perennial, intermittent, ephemeral and mined-through categories. The stream classification is similarly detailed in the §404 permit application. However, MW identified a difference in the mine through stream lengths between the data in the §404 permit application (4,835 ft) and the stream lengths calculated from the drawing (5,687 ft). These impacts should be identical since the mined area is common to all of the alternatives.

The permanent stream impacts for the IBR #2 and each alternative evaluated are:

	Permanent Impact - Stream Type			
Alternative	Perennial	Intermittent	Ephemeral	Total
IBR #2		26,184	10,630	36,814
Alt #1	0	11,162	4,775	15,937
Alt #2	0	15,354	5,801	21,155
Alt #3	0	21,063	5,125	26,188



Because no perennial streams were delineated on the stream delineation map for IBR #2 (**Drawing 4**), and lacking a U.S. Army Corps of Engineers jurisdictional determination letter, MW assumed such streams to be intermittent. The "Mine Through" stream impact values were determined using the Stream Delineation drawing (all mine-through impacts are considered permanent). Based solely on the potential total stream impacts, the alternative with the least permanent stream impacts is Alternative #1. Although Alternative #2 has approximately 6,000 more feet of stream impacts than Alternative #1, it has over 15,000 feet less than IBR #2. Alternative #3, while having more stream impacts than Alternative #1 and Alternative #2, still reduces stream impacts compared to IBR#2 by over 10,000 feet.

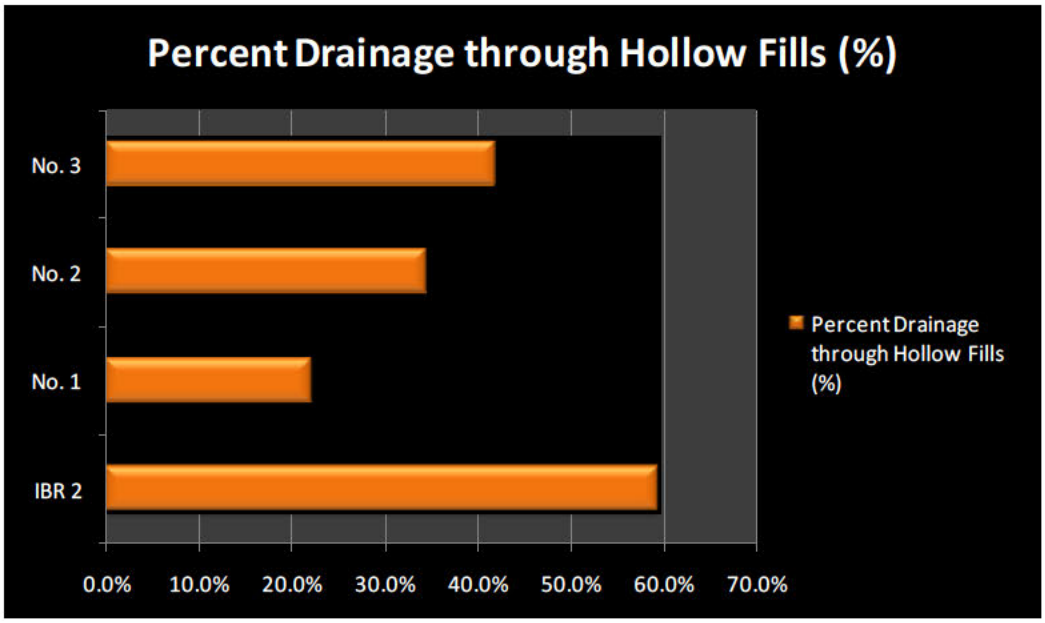
5.3 DRAINAGE THROUGH FILLS

MW conducted an analysis to determine the percentage of the total drainage area that drained through the hollow fills. Drainage areas were defined using the original topography along with the proposed regrade of the permit area. These watersheds were to include the permit area along with any area that would drain into the disturbed area, which includes hollow fills, sediment or SWROA ponds, and road fills. The watersheds that would drain through the hollow fills were initiated at the toe of the fill and followed the drainage line up the hill and along the ridge until it returned back to the toe of the fill, creating a closed area. A similar approach was used when determining the drainage area that would flow into the ponds. In one instance, the ridge line continued outside of the permit area, necessitating the inclusion of this area in the total drainage area.

Drainage areas were determined for the IBR #2 and the three (3) Alternatives presented below.

Drainage Through Fills

Alternative	Drainage Area through Hollow Fills (ac)	Total Drainage Area (ac)	Percent Drainage through Hollow Fills (%)
IBR No. 2	1,658	2,791	59.4%
No. 1	486	2,198	22.1%
No. 2	779	2,261	34.5%
No. 3	975	2,326	41.9%



These areas are represented in **Drawings #7, 8, 9, and 10**.

Based on the information provided above, the alternative with the lowest acreage of drainage area flowing through hollow fills, and the lowest percentage of the total area flowing through hollow fills, is Alternative #1. Alternatives #2 and #3, while having slightly higher total drainage areas than Alternative #1 and more drainage area and percent drainage through hollow fills, both have far lower drainage through hollow fills in terms of actual acreage and percent of drainage than IBR #2.

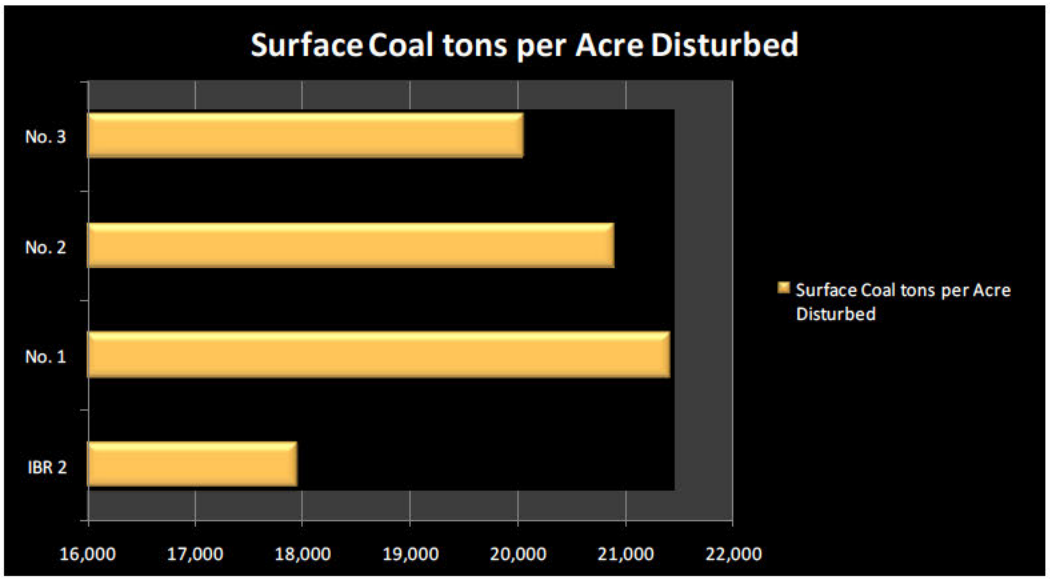
5.4 Tons per Acre

MW performed an analysis to determine the surface coal tons to be mined per acre of area disturbed during the mining process. The coal ton values were determined using surface mine reserves, as calculated using the MW geologic model. For IBR #2, the coal tonnage defined in the EID was used. Acres to be disturbed include any area that is to be affected during the mining process. Included in this area are the permit area, fills, sediment and SWROA ponds, and road fills.

The tons per acre analysis for the IBR #2 and the three (3) alternatives is reflected below.

Tons per Acre

Alternative	Coal Tons	Proposed Surface Acres to Disturb	Surface Coal tons per Acre Disturbed
IBR #2	40,910,000	2,278	17,959
Alt #1	41,854,229	1,954	21,415
Alt #2	41,854,229	2,002	20,906
Alt #3	41,854,229	2,087	20,055



Based on the figures above, Alternative #1 produces the most surface coal tons per acre disturbed. Therefore, this option recovers the highest amount of surface coal while limiting the acres of land affected during mining. Alternative #2 and Alternative #3 both recover only slightly less coal tons per acre disturbed than Alternative #1, with IBR #2 recovering less coal tons per acre disturbed than any of the alternatives considered.

5.5 EXCESS SPOIL PER TON

This analysis compared the amount of excess spoil placed outside of the mineral removal area to the recoverable coal tons. The coal tonnages for the three MW alternatives were obtained from the geologic model. The coal tonnage for the IBR#2 alternative was obtained from the Applicant's section 404 permit application. As shown by the figures below, Alternative #2 would produce the least amount of spoil per ton of coal mined. Alternative #3, Alternative #1, and IBR #2 would each produce more amounts of excess spoil per ton of coal recovered than Alternative #2.

	Coal Tonnage	Excess Spoil	Spoil per Ton
	tons	LCY	LCY/ton
IBR #2	40,910,000	110,631,108	2.7
Alt #1	41,854,229	115,713,838	2.8
Alt #2	41,854,229	91,462,071	2.2
Alt #3	41,854,229	108,824,699	2.6

5.6 SPOIL PER FOOT OF STREAM IMPACT

This analysis reviewed the amount of excess spoil per foot of stream impact. The stream impact is defined as the permanent impact associated with fill and excludes the mine through stream lengths, as these are defined as being within the mined area, and not the excess spoil disposal area.

	Permanent Streram Impact	Excess Spoil	Spoil per Foot
IBR #2	31,979	110,631,108	3,459
Alt #1	10,250	115,713,838	11,289
Alt #2	15,468	91,462,071	5,913
Alt #3	20,501	108,824,699	5,308

This analysis indicates that the Seng Camp fill selected for Alternative #1 provides a much higher efficiency in terms of excess spoil per foot of permanent stream impact than any other alternative. Alternative #2 and Alternative #3 each provide for about half the excess spoil per foot of stream impact compared to Alternative #1. IBR #2 represents the alternative with the least amount of spoil per foot of stream impact, making it the most inefficient alternative under this metric.

5.7 TONS PER FOOT OF STREAM IMPACT

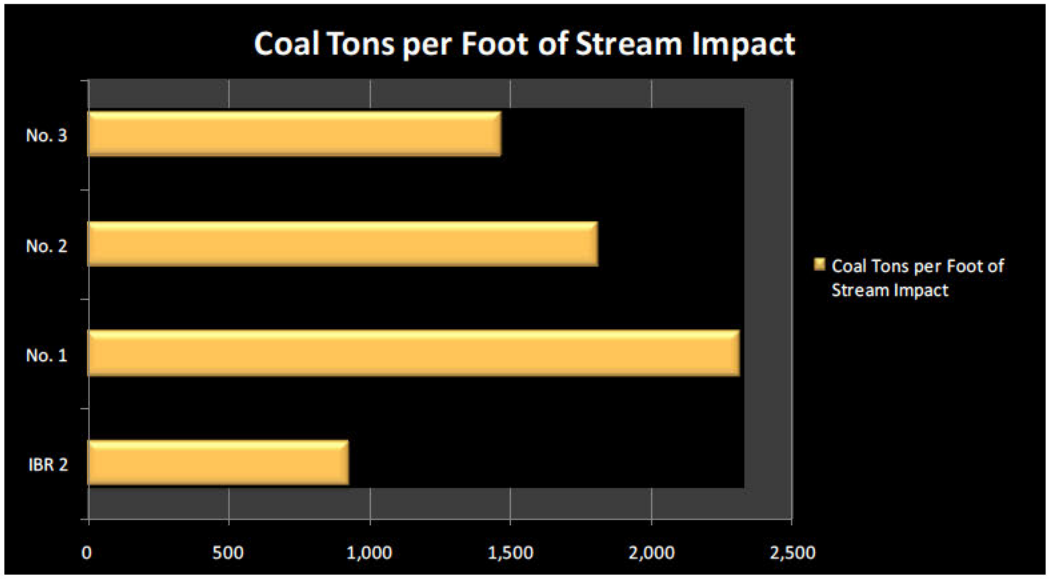
MW conducted an analysis to determine the ratio of coal tons per linear feet of total impacted streams. The calculated coal tons for Alternatives #1 through #3 were found using surface mine reserves, as referenced in the MW geologic model. Total stream impacts were categorized as permanent or temporary impacts. These were further categorized as intermittent, ephemeral and mined-through, which are shown in the Stream Impacts analysis. The coal tons and total stream

impact values for the IBR #2 Alternative were found in the Applicant's section 404 permit application.

The calculated tons of recoverable coal per foot of total stream impact are:

Coal Tons per Foot of Stream Impact

Alternative	Coal Tons	Total Stream Impacts (linear feet)	Coal Tons per Foot of Stream Impact
IBR #2	40,910,000	43,946	931
Alt #1	41,854,229	18,068	2,316
Alt #2	41,854,229	23,106	1,811
Alt #3	41,854,229	28,488	1,469



Based on the determined coal tons per foot of impacted stream, the alternative with the highest ratio is Alternative #1. Alternative #2 has the next highest ratio, followed by Alternative #3. IBR#2 is the alternative with the least amount of coal tons recovered per foot of stream impacts, with a ratio of less than half of Alternative #1.

5.8 SLOPE

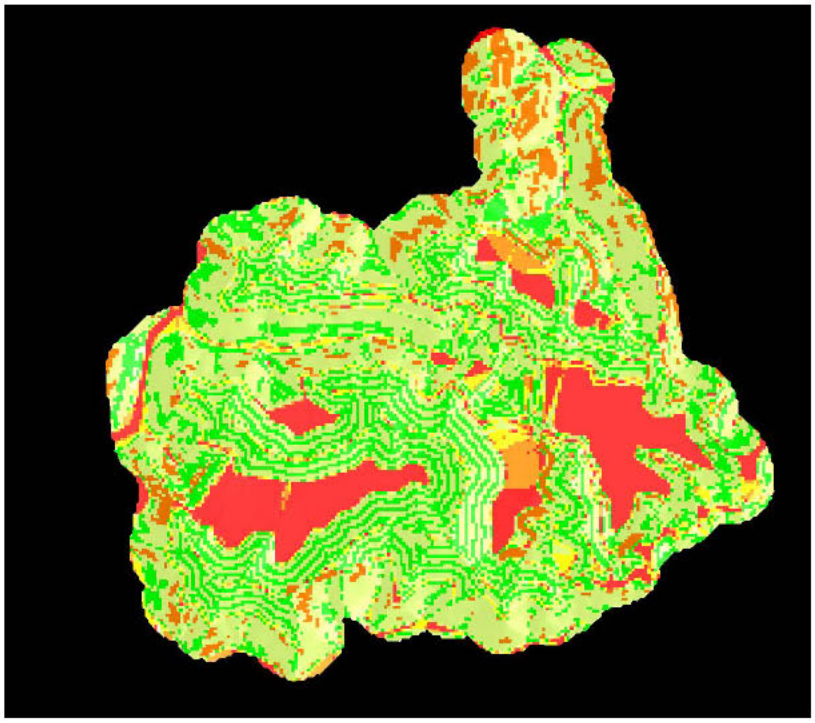
The average slope of a given watershed reflects anthropogenic alterations to the natural slope of the headwater watershed. Under natural conditions in West Virginia, headwater stream systems form within moderately steep to extremely steep mountain coves where average slope exceeds 45%. Steep slopes facilitate movement of water downslope to the stream channel and removal of detrital material downstream to perennial streams. Changes in the watershed slope can alter movement of water and nutrients downstream at a reduced rate.

The scoring of average percent slope places 30-45% or unaltered areas in an ideal condition category and excessively high (>65%) and very low (<10%) slopes in an adverse condition category.

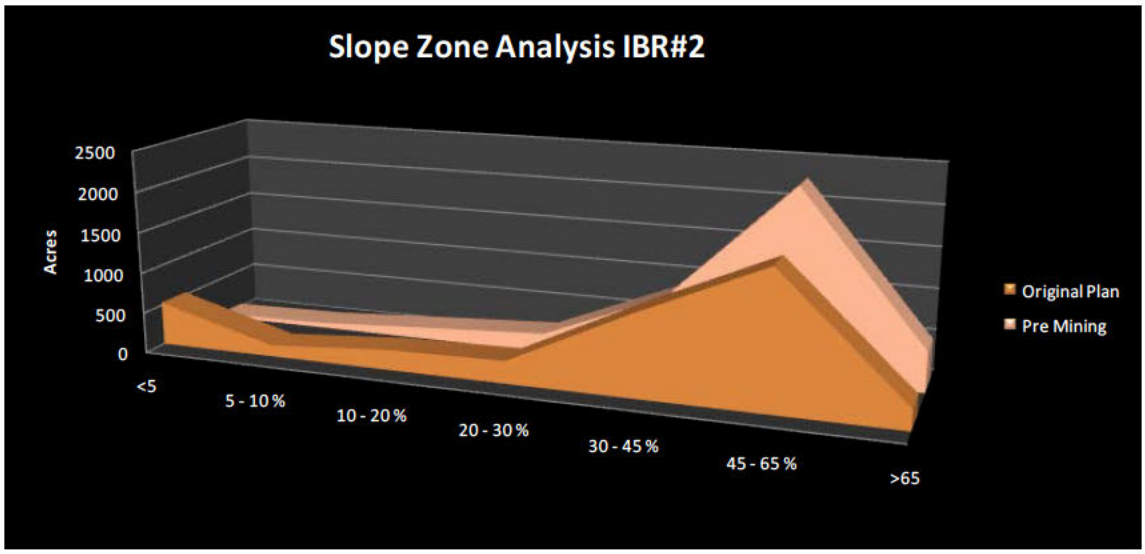
Traditional fills with flat decks will reduce the rate of flow of water and nutrients downstream. In addition, interflow through the fills may leach undesirable nutrients out of the rock and into streams. The analysis of the three alternatives and the IBR #2 configuration are depicted on the graphs below.

Slope Analysis IBR #2

The change in slope between the pre-mining and post mining (IBR #2) configuration are:

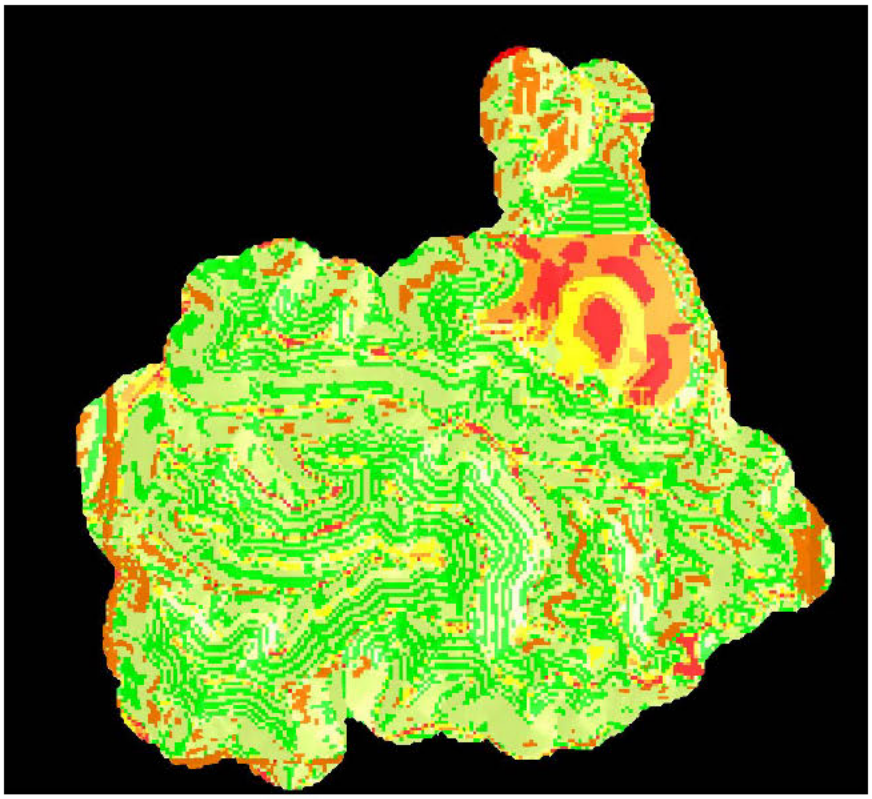


	<5	5 - 10 %	10 - 20 %	20 - 30 %	30 - 45 %	45 - 65 %	>65
IBR #2	532.1	137.8	245.4	274.7	998.8	1665.1	247.6
Pre-Mining	37.4	61.7	147.4	229.5	845.7	2287.6	492.2

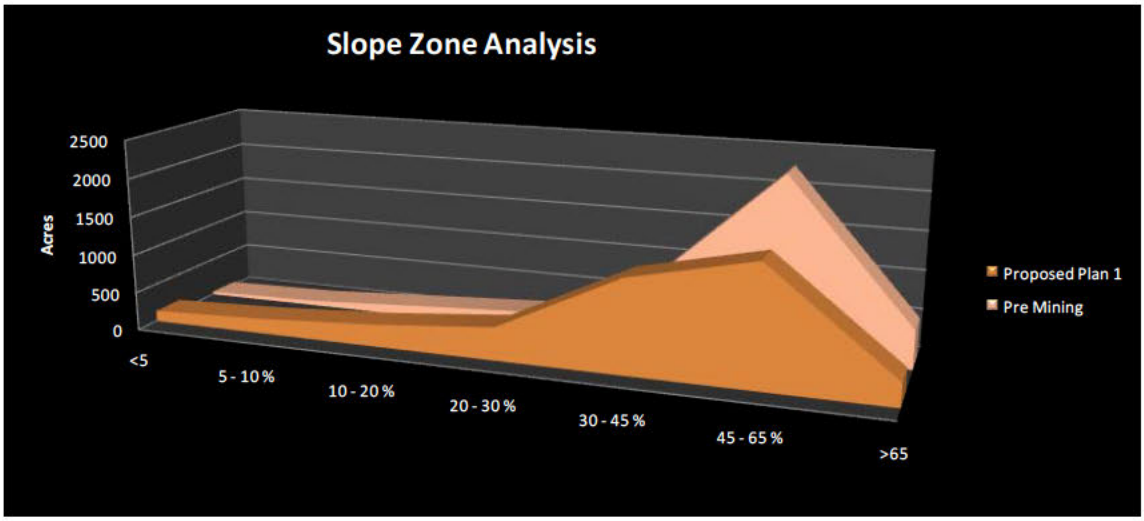


Slope Analysis Alternative #1

The change in slope between the pre-mining and post mining (Alt #1) configuration are:

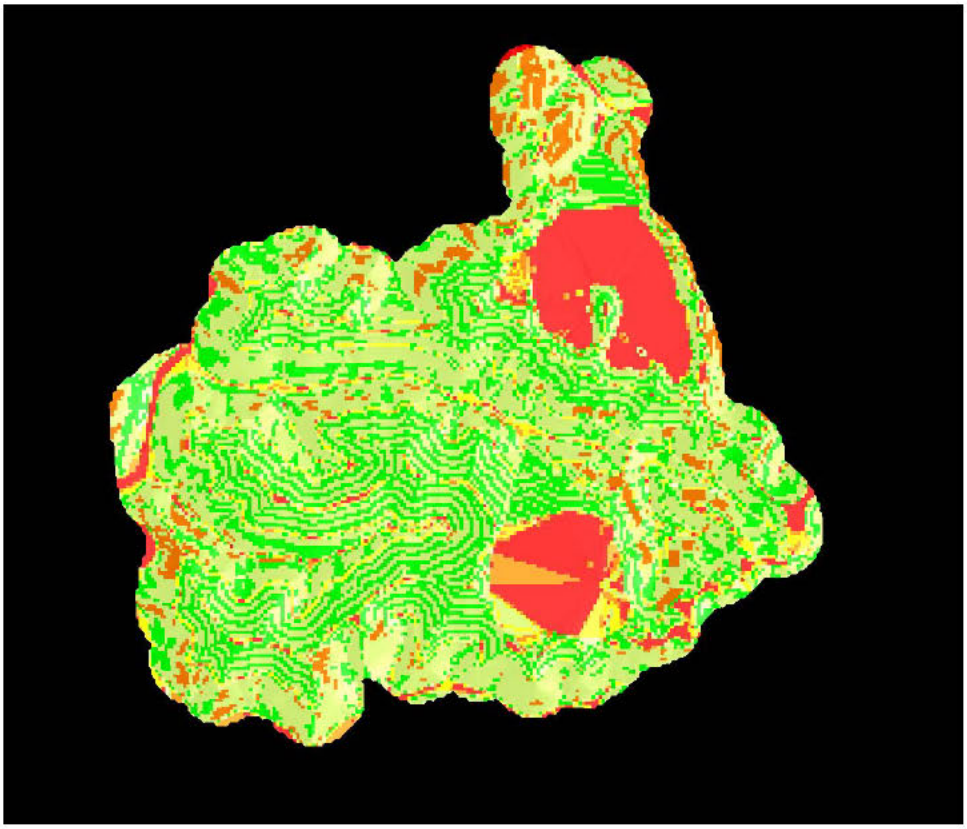


	<5	5 - 10 %	10 - 20 %	20 - 30 %	30 - 45 %	45 - 65 %	>65
Alternative #1	141.1	196.2	287.9	426.8	1199.8	1547.0	302.7
Pre-Mining	37.4	61.7	147.4	229.5	845.7	2287.6	492.2

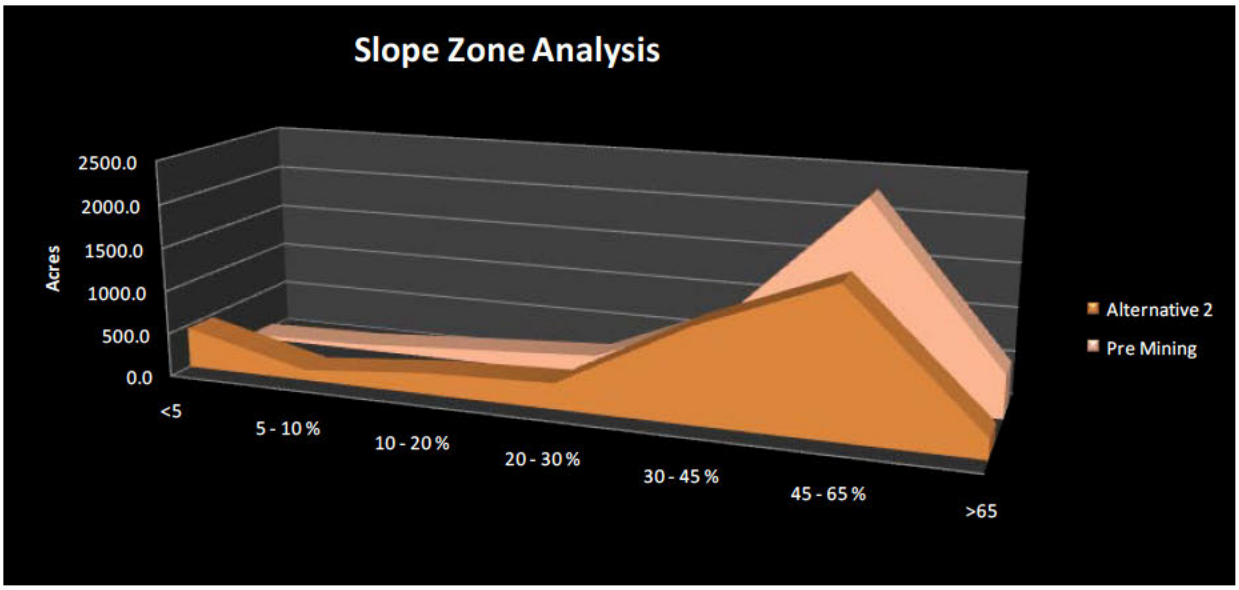


Slope Analysis Alternative #2

The change in slope between the pre-mining and post mining (Alt #2) configuration are:

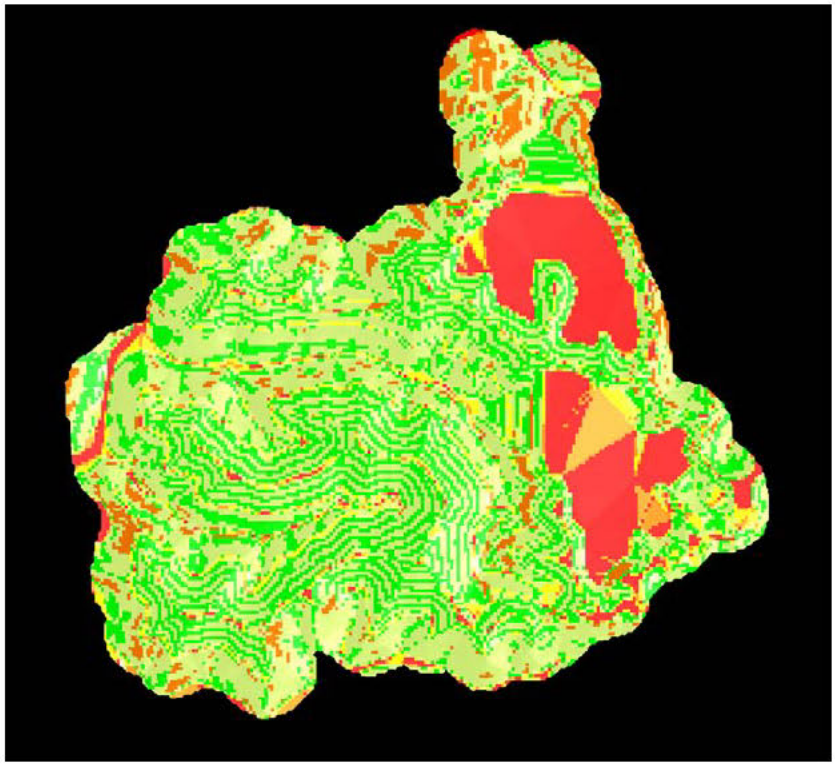


	<5	5 - 10 %	10 - 20 %	20 - 30 %	30 - 45 %	45 - 65 %	>65
Alternative 2	465.4	119.2	243.9	295.3	1081.2	1669.9	226.6
Pre Mining	37.4	61.7	147.4	229.5	845.7	2287.6	492.2

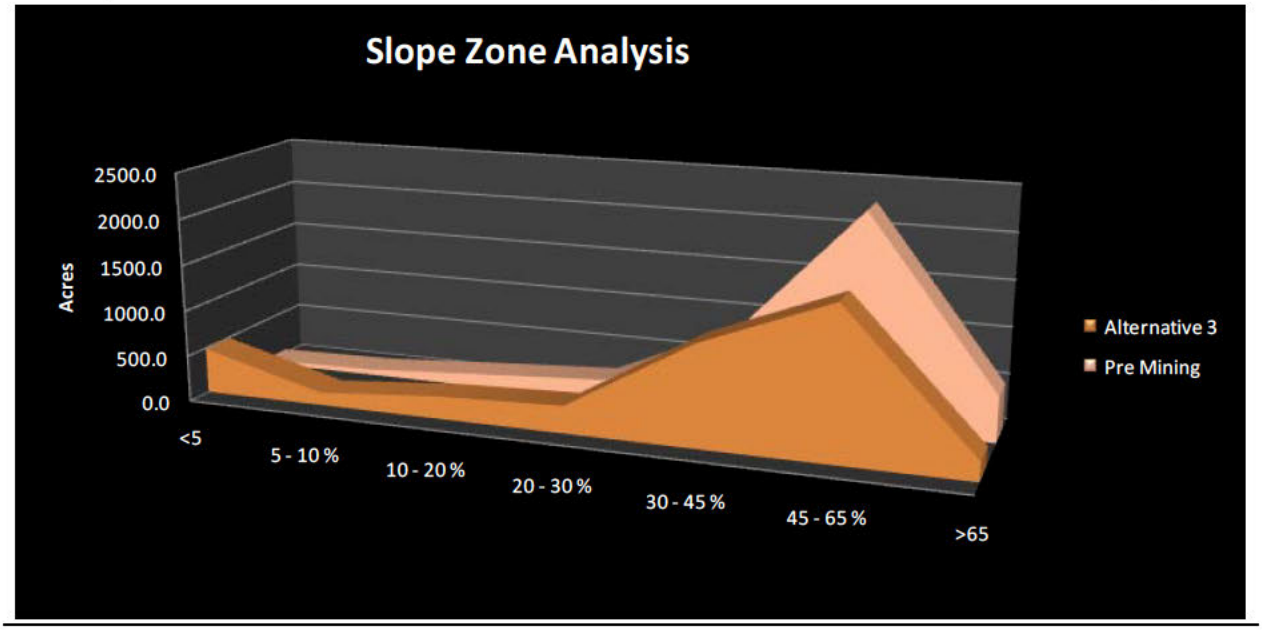


Slope Analysis Alternative #3

The change in slope between the pre-mining and post mining (Alt #3) configuration are:



	<5	5 - 10 %	10 - 20 %	20 - 30 %	30 - 45 %	45 - 65 %	>65
Alternative 3	489.9	138.7	246.0	295.0	1093.8	1631.7	206.3
Pre Mining	37.4	61.7	147.4	229.5	845.7	2287.6	492.2



As depicted on the graphics and charts above, Alternative #1, Alternative #2 and Alternative #3 minimize less favorable slopes (0% to 30%). Such slopes are associated with increased infiltration of surface water through fill and backfill areas, thereby increasing the potential for release of toxic pollutants. Alternative #1 is shown to have the least increase in acreage of less than 5% slope; those areas that would have the greatest potential for infiltration of surface water through the fills.

6. Alternative #1

6.1 SELECTION CRITERIA

In selecting Alternative #1 for additional review, MW ensured that each alternative was evaluated using the same basic parameters and limitations in order to ensure an accurate comparison. Shown below are the basic parameters each alternative shares:

- The boundary for coal extraction is similar for each Alternative
- The volume of overburden overlying the coal is similar for each Alternative
- A swell factor of 25% is used in each Alternative
- Procedures for calculating the IBKF surface were similar for each Alternative
- All Alternatives would be required to adhere to the basic surface mining regulations of West Virginia
- The stream delineation criterion is common to all Alternatives

Presented below is a compilation of the mining metrics discussed in the previous section and the respective rank of each Alternative:

Summary of Metrics

Alternative	Total stream impacts	Drainage through fills	Tons per acre	Excess spoil per ton	Spoil per foot of stream impact	Tons per stream impact	Slope analysis
IBR #2	43,946	59.4%	17,959	2.7	3,459	931	998.8
Alternative No. 1	18,068	22.1%	21,415	2.8	11,289	2,316	1199.8
Alternative No. 2	23,106	34.5%	20,906	2.2	5,913	1,811	1081.2
Alternative No. 3	28,488	41.9%	20,055	2.6	5,308	1,469	1093.8

Ranking

								Total
IBR #2	4	4	4	3	4	4	4	27
Alternative No. 1	**1**	**1**	**1**	**4**	**1**	**1**	**1**	**10**
Alternative No. 2	2	2	2	1	2	2	2	13
Alternative No. 3	3	3	3	2	3	3	3	20

As shown in the Table above, Alternative #1 has the lowest score based on the total score from the evaluated metrics.

In addition to the ranking of the mining metrics analysis, there are several existing conditions that lend additional credence to the selection of Alternative #1 for additional review.

- Alternative #1 provides for all excess spoil storage in Seng Camp Hollow. Seng Camp has been extensively disturbed due to previous mining and disturbances from the initial mining operations for IBR #2. By placing all excess spoil in Seng Camp, the other streams (Pigeonroost and Oldhouse) are spared any impacts from the mining operations, other than stream mine-through impacts.
- The IBKF volume in Alternative #1 utilizes all the efficiencies of the West Virginia AOC process and is able to place 10% more spoil on the bench than the IBR #2 proposed action.

- The magnitude of the difference of overall stream impacts from Alternative #1 to the other alternatives is substantial. Because of the utilization of a single fill in Alternative #1, five fewer miles of stream are impacted when compared to IBR #2.
- The overall footprint of the proposed permit area is significantly reduced in comparison to IBR #2.
- Although Alternative #1 would produce the highest amount of excess spoil per ton of coal mined, it would only produce slightly more spoil than the IBR #2 alternative. In addition, the amount of spoil per ton of coal mined produced by Alternative #1 above that of Alternative #2 is not overly significant considering the other factors outlined in this analysis.

6.2 REVISED REGRADE

In order to obtain accurate volumetrics for Alternative #1, a revised regrade configuration with a revised IBKF (Initial Backfill) model was constructed utilizing the West Virginia AOC model. Parameters for the revised IBKF included:

- Bench widths conforming to West Virginia AOC policy
- 2:1 outslopes with a 20 foot safety bench every 100 feet in elevation
- At the peak of each individual regraded ridgeline, a minimum dimension width of 100 feet was used to insure constructability

The revised IBKF surface demonstrated the ability to store approximately 350 MM cubic yards of swelled overburden, which in turn predicated the volume of the Seng Camp Hollow Fill to be approximately 157 MM cubic yards of spoil material.

The original IBKF surface, as shown in documents included in the IBR #2 permit, was calculated (using a 2 surface grid volume) to have a volume of approximately 317 MM cubic yards of swelled overburden. As a result, the revised IBKF was able to store an additional 33 MM cubic yards of swelled overburden, which in turn led to reduced stream impacts, reduced spoil distribution outside of the mineral extraction area, and reduced drainage through fills.

6.3 DRAINAGE

The basic mining premise for Alternative #1, is that the excess spoil from the mining operations will be placed in a single valley fill located in Seng Camp Creek. The configuration of the drainage control for the mined areas will then fall into two categories: In-Stream Sediment Structures and On-Bench Sediment Structures.

In-Stream Sediment Structures

As shown on **Drawing #2**, there are two existing in-stream sediment structures north of the toe of the proposed Seng Camp Hollow Fill. Using the Final Regrade configuration for Alternative #1, the sediment storage required for the Seng Camp Hollow is approximately 52 acre feet. In order to accommodate this sediment storage, the two existing sediment structures could be reconstructed into one in-stream sediment structure to increase the sediment storage. In addition to this reconstruction, there is potential for excavating an incised pond (on-bench pond) east of the two existing in-stream ponds for additional sediment storage.

On-Bench Sediment Structures

The balance of the drainage control (other than Seng Camp Hollow) would be handled by on-bench sediment structures namely sediment ditches. As shown on **Drawing #3**, Alternative #1 proposes fifty-nine sediment ditches to contain the run-off drainage from the mining operations. All sediment ditches will discharge into existing natural drainageways.

NPDES Sampling points are proposed at the outlets of all In-Stream and On-bench Sediment Structures as shown on **Drawing #3.**

The Alternative #1 thus eliminates all but two of the in-stream sediment structures that are contained within IBR #2 and the potential liabilities associated with drainage through hollow fills. In addition to the elimination of the sediment structures, all of the auxiliary disturbances such as access roads to the sediment structures are eliminated.

6.4 MINE ACCESS

The proposed operation will require access to the Mountain Laurel facilities located at the mouth of Seng Camp. This access will be achieved by a combination of hillside excavation and road construction up the face of the Seng Camp Valley Fill. The road will begin near the confluence of an unnamed tributary and Seng Camp to the 1,400 foot elevation. From this point, the road will be constructed up the face of the valley fill to the 1,650 foot elevation. From there, it will rise along the western abutment of the valley fill to the 1,800 foot elevation.

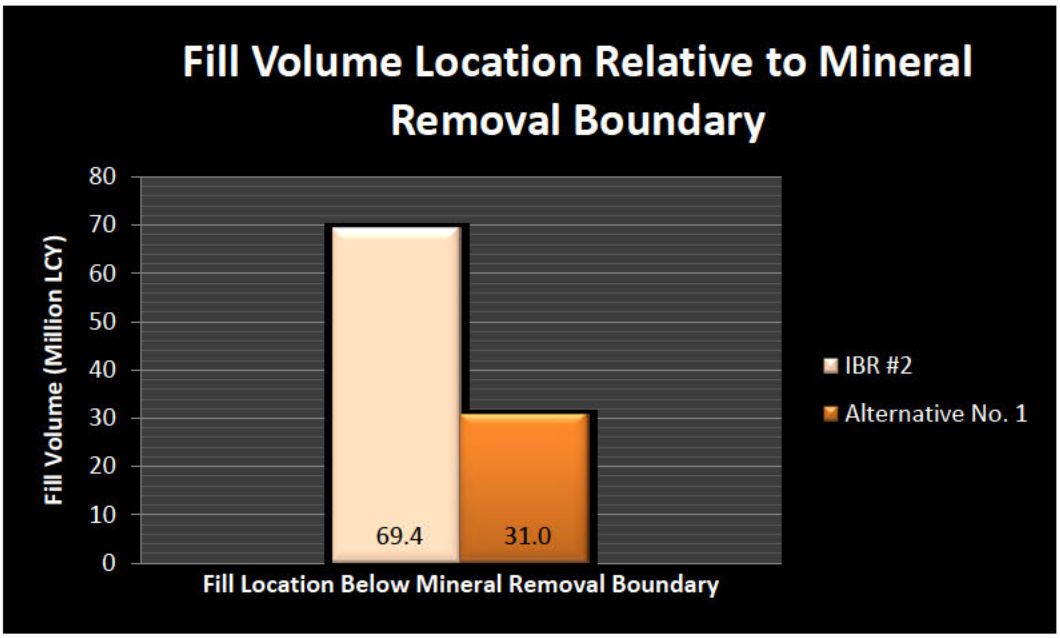
From the start of the road to the 1400 foot elevation, the road will be 80 feet wide and on an 11 percent grade. Subsequently, the road will widen to 100 feet wide and will be on about a 10 percent grade until it terminates at the 1800 foot elevation.

Internal roads will be constructed from this point to various locations throughout the permit area to facilitate the transport of personnel, supplies, coal and spoil.

6.5 FILL VOLUME BELOW COAL REMOVAL BOUNDARY

The following metric compares the volume of fill placed below the pavement of the Middle Coalburg Seam, which is the lowest seam mined. Groundwater will flow along this pavement boundary down dip. Any fill placed below this level will become a conduit for groundwater seepage from the Middle Coalburg pavement and thus susceptible for the interaction of the groundwater and fill material. The increased volume of groundwater that has the opportunity to interact with the fill material increases the potential for the production of dissolved solids. It is important, therefore, to minimize the fill material that could become exposed to groundwater flow.

As shown in the figure below, Alternative #1 places 20% of the total fill below the mineral removal boundary. The IBR #2 proposed the placement of 44% of total fill below the mineral removal boundary. This is more than twice that outlined in Alternative #1.



6.6 Basal Seam Drainage

This metric measures the drainage area of the pit floor, whose drainage will report ot the perimeter of a hollow fill. The flow on the pit floor is controlled by the dip of the coal seam.

This drainage will infiltrate the fill material and increase the potential for degradation of water quality as it exits the toe of the hollow fill, as discussed above. The prior metric evaluated the quantity of material that could be influence by the groundwater flow, while this metric focuses on the volume of that groundwater.

Alternative	Fills	Regrade Drainage Through Fill (acres)
IBR #2	6 Fills	735.7
Alternative #1	1 Fill (Seng Camp)	100.7

As shown in the above table, Alternative #1, with only one (1) hollow fill, has only 100.7 acres draining through the Seng Camp valley fill, representing 5.8% of the total mine pavement that drains toward a fill. For comparison, the IBR #2 has 42.3% draining toward a fill. A graphical representation of these areas can be found on Drawing Nos. 12 and 13.

6.7 DRAINAGE TO FILL METRIC

In order to allow comparison between mining project with different coal tonnages and different configurations some method of normalizing the data outlined in the previous two sections is required.

The drainage area flowing into the fill represents the flow that will discharge at the down dip outcrop of the coal pavement, within the confines of the fill. The area is a suitable measure as any rainfall onto that portion of the mined area, that does not either evaporate, get lost to evapotransporation or run off as surface water, will migrate down to the coal pavement.

As discussed in the previous section, the volume of fill below the lowest seam being mined is that portion of the fill that will be influenced by flow from the adjacent coal seam outcrop. The portion of the fill above this elevation will only be affected by infiltration of precipitation onto the fill surface above.

The coal tonnage is the best measure of the overall size and efficiency of the operation and is therefore applicable as a common denominator.

The metric is based on the mine area that would discharge within the confines of the valley fill multiplied by the volume of film material through which it could flow. The denominator is the coal tonnage. Using this data, the comparison of the IBR#2 data with the proposed Alternative #1 is:

Project Name	Coal Tonnage	Fill Below Lowest Seam	Acres into Fill	Fill x Acres per Coal Ton
	Tons	*LCY*	*Acre*	*lcy*acre/ton*
IBR #2	40,910,000	69,400,000	735.7	1,248
Alternative #1	41,854,229	31,000,000	100.7	75

6.8 ECONOMICS

Introduction

A preliminary study of the project economics was conducted on the basis of volume and distance to move spoil to disposal and backfill areas. The Applicant's preferred alternative (IBR #2) included six disposal areas located near the point of origin of spoil material. Material placement for Alternative #1, a single fill in Seng Camp, is compared against the IBR #2.

Equipment selected for IBR #2 would also apply to Alternative #1. From the EID, the Applicant has indicated the following equipment would be employed on the project:

Table 1 - Equipment List from Table 2-16 of the EID.

Equipment Item	Number/Qty.	Average Annual Operating Hours/Unit
54-cubic yard Electric Shovel	1	4140
28-cubic yard Overburden Front-end Loader	1	4580
15-cubic yard Overburden Front-end Loader	1	4580
150-ton Overburden Haul Trucks	6	4140
300-ton Overburden Haul Trucks	12*	4580
Coal Front-End Loader	10	4140
D11 Production Dozers	6	4140
Utility Dozers	12	4580
Production Drills	5	4580
Coal Haul Trucks	15	4580
Motor Grader	3	4580
Water Trucks	3	4580
Miscellaneous Service Vehicles	20	4580
Other Mobile Equipment	4	4140

Annual Operating hours is effective production hours. All scheduled maintenance, holidays, availability, and operator efficiency has been included in the above estimates.

** The table in the supplied EID indicated 12 trucks at 4580 hours. It's recognized that this may be a typographic error because the hours do not match the shovel, and the likely fleet should be 6 trucks. The analysis will utilize the unaltered table data though.*

Ownership of equipment and operating cost is a subject that generally relies upon numerous assumptions based on the mine operator's own experience and familiarity with the maintenance culture, operations management, and accounting practices within his/her company.

Sequencing

The placement of material, with respect to the mining sequence, is detailed in the EID for IBR #2. In broad summary, the mining sequence is (Refer to EIS Exhibit 2-14):

1. Mine the Contour Cut (Area 2B) at the head of Pigeonroost Branch and place material in Valley Fill 2A.
2. Continue mining south (Area 3) and complete construction of Valley Fill 2A.
3. Enter Oldhouse Branch and construct Valley Fill 4, then construct Valley Fill 3 with material from Area 4.
4. After Area 4 is complete, mine north (Area 2A and Area 2) and utilize Valley Fill 1A and 1B in Seng Camp.
5. Complete the mining in Area 1.
6. Backfill, regrade, and complete reclamation for the project.

Utilizing the same area nomenclature, Alternative #1 proposes a different sequence. The details of the sequencing are indicated on **Drawing #11**. In broad summary:

1. Contour mine Area 2A and begin the Seng Camp fill.
2. Mine Area 2 and continue filling Seng Camp.
3. Mine the north portion of Area 2B contour and continue filling Seng Camp.
4. Mine Area 1, utilizing both Seng Camp and Area 2 backfill for spoil placement. Mining of Area 2B contour should continue, utilizing the previously contoured strip for backfill.
5. Construct a road across Pigeonroost Branch and begin mining Area 4, hauling all initial spoil to Area 2 backfill, Area 1 backfill, and complete Seng Camp, including reclamation of mine areas north of Pigeonroost Branch.
6. Mine both Area 4 and Area 3, utilizing remaining backfill storage areas south of Pigeonroost Branch.

Haulage Study

Haulage was studied for both IBR #2 and Alternative #1. The analysis for each case calculated the ton-miles required to haul material from the centroid of a given mine area to the centroid of each fill or backfill area. Distances were considered in the x-y plane only. Elevations and grades have been ignored due to the limited evaluation period, but would be considered as an additional evaluation factor in a more detailed analysis. Material handled by production dozers has been ignored, assuming all material will be hauled by truck. The basic equation for haulage is:

$$Haulage\ (ton - miles) = Spoil\ (tons) \times Distance_{\ Centroid-Centroid}\ (miles)$$

Where:

- Spoil (tons) calculated on a density of 2.23 tons/bcy, 1.78 tons/lcy (25% swell);
- Distance is a straight line between centroids; and
- Centroids for fills are based on mass, not plan-view areas.

For instances where material haulage was confined to the active mining area, an assumed distance of 2,000 ft. was employed.

Table 2 - Haulage Study for IBR #2

Mine Area	Spoil Generated (LCY)	Disposal Location	Disposal Amount (LCY)	Haul Distance (ft)	Haulage (ton-miles)
AREA 1	34,381,285	Regrade Area 2	28,837,726	5,813	56,581,147
AREA 1		Regrade Area 1	5,543,559	2,000	3,741,902
AREA 2	58,190,441	Regrade Area 2B	29,380,010	1,996	19,794,521
AREA 2		Regrade Area 3	4,928,560	5,951	9,898,292
AREA 2		Regrade Area 2A	7,223,083	1,157	2,820,092
AREA 2		Regrade Area 2	16,658,788	2,000	11,244,682
AREA 2A	11,856,797	ValleyFill 1B	383,643	1,234	159,778
AREA 2A		ValleyFill 1A	6,916,010	1,157	2,701,111
AREA 2A		Regrade Area 2A	4,557,144	2,000	3,076,072
AREA 2B	37,038,375	ValleyFill 2A	37,038,375	714	8,925,249
AREA 3	28,646,073	ValleyFill 2A	4,280,501	2,989	4,317,872
AREA 3		Regrade Area 2B	24,365,572	2,381	19,576,650
AREA 4	336,650,756	ValleyFill 4	44,214,017	1,582	23,612,044
AREA 4		ValleyFill 3	4,173,369	2,596	3,657,031
AREA 4		Regrade Area 4	249,595,071	2,000	168,476,673
AREA 4		Regrade Area 3	24,566,208	5,636	46,730,993
AREA 4		ValleyFill 2B	14,102,090	4,331	20,613,597
TOTALS	**506,763,727**		**Weighted Avg.**	**2,373**	**405,927,706**

Table 3 - Haulage Study for Alternative #1

Mine Area	Spoil Generated (LCY)	Disposal Location	Disposal Amount (LCY)	Haul Distance (ft)	Haulage (ton-miles)
AREA 1	34,381,285	Seng Camp Stg.3a	34,381,285	7,079	82,145,228
AREA 2	58,190,441	Seng Camp Stg.1	19,439,097	2,883	18,914,638
AREA 2		IBKF Area 2A	9,795,061	1,157	3,824,263
AREA 2		Seng Camp Stg.2	28,956,283	2,084	20,369,601
AREA 2A	11,856,797	Seng Camp Stg.1	11,856,797	1,924	7,698,062
AREA 2B1	15,928,628	Seng Camp Stg.2	15,928,628	3,969	21,336,384
AREA 2B2	21,109,748	IBKF Area 2B1	9,275,597	5,059	15,836,351
AREA 2B2		Seng Camp Stg.2	2,916,438	6,625	6,520,979
AREA 2B2		Seng Camp Stg.3a	8,917,713	6,204	18,672,446
AREA 3	28,646,073	IBKF Area 2B2	13,341,969	1,198	5,393,526
AREA 3		IBKF Area 3	15,304,104	2,000	10,330,270
AREA 4a	32,769,681	Seng Camp Stg.3a	32,769,681	5,496	60,783,880
AREA 4b	72,663,083	IBKF Area 1	20,752,473	4,342	30,413,467
AREA 4b		IBKF Area 2 I	7,306,827	6,755	16,659,188
AREA 4b		Seng Camp Stg.3a	4,421,124	7,742	11,551,730
AREA 4b		IBKF Area 2 II	30,014,777	5,633	57,058,666
AREA 4b		Seng Camp Stg.3b	10,167,882	6,296	21,607,112
AREA 4c	19,530,573	IBKF Area 2 II	9,787,713	5,727	18,918,289
AREA 4c		IBKF Area 4	9,742,860	2,000	6,576,431
AREA 4d	43,481,289	IBKF Area 4	43,481,289	2,000	29,349,870
AREA 4e	168,209,896	IBKF Area 3	3,397,450	5,837	6,693,412
AREA 4e	0	IBKF Area 4	164,812,446	2,000	111,248,401
TOTALS	**506,763,727**		**Weighted Avg.**	**3,402**	**581,902,196**

1. Seng Camp valley fill and Area 2 backfill have been segmented into several components to better represent haul distances from each area.
2. Areas 2B and Area 4 have been subdivided in order to calculate more representative haul distances.

This method of haulage analysis shows that the difference in the weighted average haul distance is 1,029 feet (43%) for the entire mine property. In today's economy, it is generally understood and accepted that mine haul distances should be maintained at less than 1-mile (5,280 ft.). As shown in the chart below, the average haul distance for both IBR #2 and Alternative #1 meet this objective.

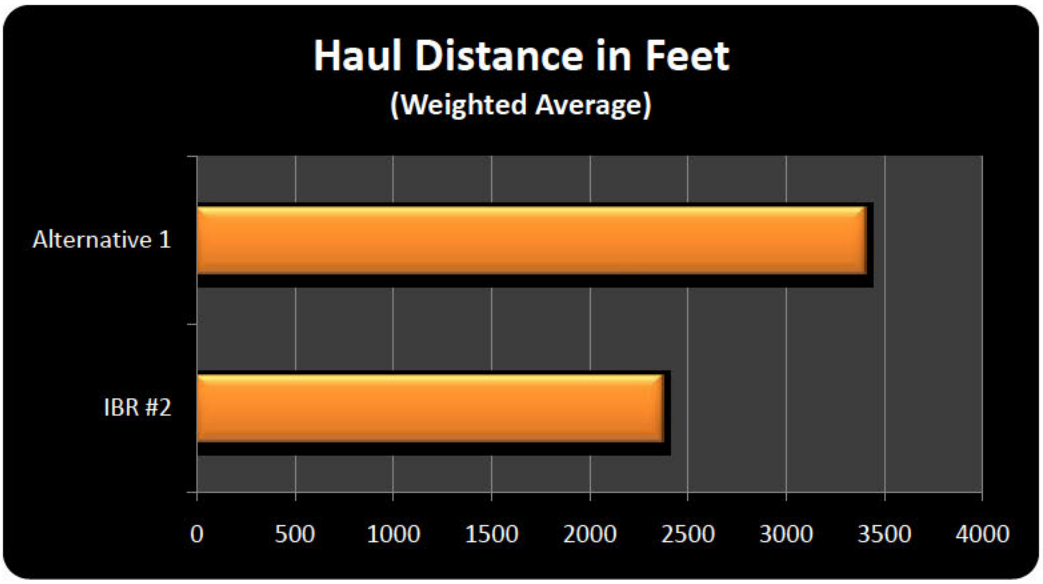
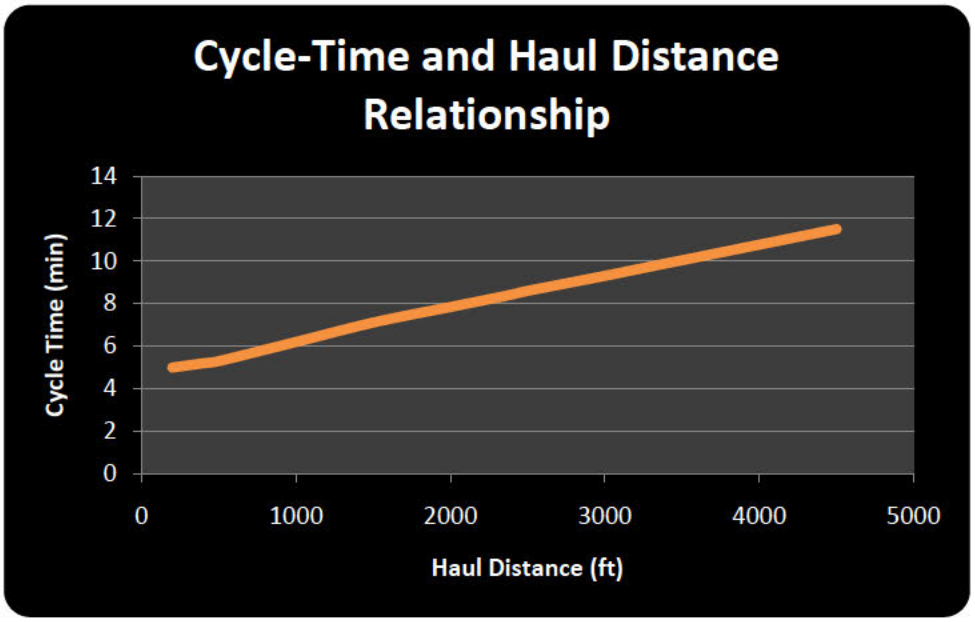


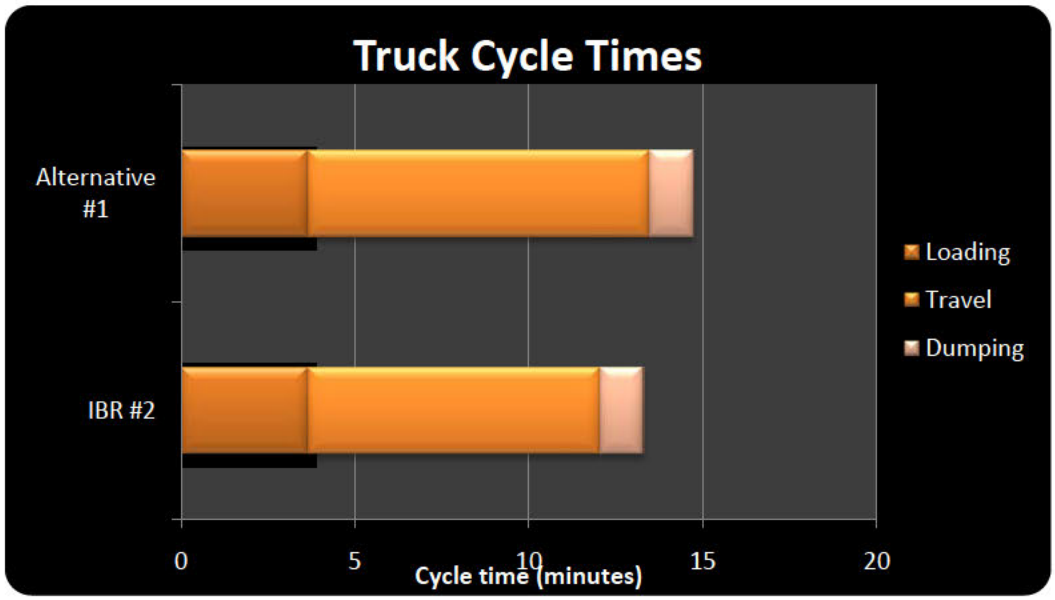
Figure 2- Comparison of Haul Distance Between IBR #2 and Alternative #1

The relationship between cycle time and haul distance is only somewhat linear after a sufficient distance is traveled when acceleration becomes zero and the effective grade is constant. Stated another way, longer travel distances will generally have slightly higher average travel speeds during the haulage cycle than shorter travel distances, assuming that all grades are equal. For large mining trucks, the distance required to achieve top speed (acceleration = zero) is typically a few hundred feet, under ideal conditions.



Fleet Requirements

To load 300-ton payload trucks with an electric shovel requires approximately 4-passes per truck. At an average shovel cycle time of 40-seconds, the first cycle requiring slightly longer while the truck maneuvers under the dipper, MW estimated a shovel can load 20 trucks per hour. At an assumed rock density of 2.2 bcy/ton, annual shovel production would be about 13.4-million bcy per year. Note that bcy is a commonly used unit of production. This is approximately half of the Applicant's stated annual overburden removal.



With the 43% difference in weighted average haul distance, the cycle time difference is estimated to be 1.43 minutes, or 17%. Further, to keep the shovel operating efficiently at a pace of 20-truckloads per hour, IBR #2 is estimated to require 3 trucks at all times, while Alternative #1 only requires one additional truck. Fleet requirements would likely be 5 and 6 units respectively, and would increase as distances and grades increased. For example, an estimated 6 trucks would be required in the truck-shovel production unit where haul distances approached 7,000 feet. This would likely equate to a truck fleet size of 9 units. The Applicant has indicated a fleet size of 12 units would be required; therefore the proposed fleet could accommodate the haul distances for either IBR #2 or Alternative #1. No additional equipment would be required beyond what has been proposed.

It should be noted also that equipment has changed since this permit was submitted. The 54-yd electric shovels (i.e. Bucyrus® 495) commonly employed at the time of the IBR #2 permit application have been largely replaced by 72-yd machines (i.e. Bucyrus® 495-HR). The newer machines can load trucks in 3 passes, and have demonstrated production rates around 17-million bcy per year due to the increased size and improved reliability of electric control systems. Additionally, trucks have increased in size to a nominal payload of 360-tons, though the 320-ton payload truck has remained very popular.

Cost Analysis

Haulage Cost Components that will remain unchanged, no matter what fill design is utilized. These cost components include:

- Unit ownership cost;
- Loading cost (shovel and wheel loaders), including ownership, operation, and maintenance (the same number of buckets and man-hours will be required to move material into trucks); and
- Loading time and dump time for each truck.

Haulage Cost Components that will vary with number of ton-miles include:

- Quantity of haul units (trucks) required to meet production goals;
- Number of employees required to operate and maintain a larger fleet;
- Annual fuel cost; and
- Average cycle time (travel time component) will increase as distance increases.

Significant assumptions in calculating an incremental haulage cost due to changes in distance have been made herein. Major assumptions include:

- The incremental difference will be due to travel distance and is a function of the rate of travel for that component of cycle time.
- Most large capacity trucks are capable of travel speeds exceeding 25 mph loaded and 35 mph empty. Conservative average travel speeds of 12 mph loaded and 22 mph empty have been utilized for comparative analysis.

With the addition of a haul unit, the results of the incremental cost analysis showed only a marginal cost increase while maintaining shovel operating efficiency and meeting annual production targets. This figure is simply a crude estimate by the methodology outlined above, but illustrates that the additional haulage distance to the Seng Camp fill is only a small added cost to the overall operation.

Table 4 - Variable Costs of Material Handling

Cost Component	Cost Estimate	Units	Converted to $/ton-mile
Fuel (300-ton trucks) 53 gal/hr	$3.00	/gallon	$0.0811
Tires (300-ton trucks) 3,000 hrs/tire	$25,000	/tire	$0.0256
Labor (including burden) One extra truck operator (/hr)	$37.50	/hour	$0.0192
Annual Total (27.64 MM bcy/year at additional haul of 1,029 ft.)			**$1,512,342 per year**

1. *Annual bcy/year converted to tons per year to keep units consistent.*
2. *1,029 ft additional haul distance converted to miles.*
3. *Difference in ton-miles per hour utilizes a cycle time difference of 1.43 minutes, assumes 320-tons per cycle, and shovel productive capacity of 20 trucks per hour.*

6.9 COST SAVINGS

It is projected that some cost savings exist with the proposed change to the mine design, most relating to the reduction in stream impacts and the disturbed area.

To compensate for impacts to streams, the applicant has developed a Compensatory Mitigation Plan. This permit review has not evaluated the costs of the proposed mitigation, but industry experience indicates that a rate of approximately $400 per linear foot is applicable. Based on the reduced stream impacts of 25,878 ft (as detailed in Section 5.2 of this report), the mitigation savings will amount to approximately $10.4M.

The reclamation costs for a mine are directly related to the disturbed acreage. An average cost per acre for reclamation is approximately $2,000 to cover final grading and vegetation. Based on the reduced areal extent of the project to 324 acres (as detailed in Section 5.4 of this report), the reclamation saving is approximately $0.6M.

In addition, the number of sediment control ponds will be reduced from nine to the three ponds that have already been constructed in Seng Camp. This reduction will result in savings to the applicant of approximately $0.3M, assuming a cost per pond of $50,000.

6.10 STABILITY ANALYSIS

In Alternative #1, all excess swelled overburden is placed in the Seng Camp Hollow Fill. The design of the fill incorporates the following parameters:

- The face of the fill exhibits 2:1 slopes with safety benches every 50 feet in height.
- Drainage (groin) ditches are constructed at the intersection of the fill with the original groundline. These ditches transport surface drainage from areas adjacent to the fill and from the face of the fill.
- A portion of the mine access road is incorporated into the face of the fill
- The top of the fill has been landformed to approximate a rolling terrain with defined watersheds.

Stability analyses were conducted on the Seng Camp Hollow Fill utilizing Rocscience SLIDE®, a computerized version of the Modified Bishop Method of Slices. The strength parameters used for the analysis are as follows:

- Unit Weight 120 lb per cubic feet;
- Cohesion 0; and
- Internal angle of friction is 38 degrees.

The strength parameters were taken from the Stability Analyses conducted in IBR #2. The stability analysis results show the minimum static factor of safety for hollow fills of 1.5 was met. See **Drawings #5 and #6** for stability analysis results.

7. Best Management Practices

7.1 AOC Requirements

The WVDEP Final AOC Guidance Document Policy (02/19/2004) has traditionally been the tool employed for fill optimization and minimization of stream impacts. Review of the Applicant's permit indicates that this guidance has been employed to determine the configuration of each of the six proposed fills.

As demonstrated by each of the proposed Alternatives to the Applicant's IBR #2, further minimization of stream impacts can be achieved by designing beyond the requirements outlined in the AOC Guidance Document. The key element is to maintain the drainage areas so they are not altered as a result of the final regrade configuration.

Per the AOC guidance and WV 38CSR2, backfill areas will be graded at 2:1 slopes with benches every 100' in elevation. Slopes will be stabilized and revegetated in accordance with the planting plan approved by WVDEP.

7.2 Fill Construction

Fill construction for Alternative #1 is confined exclusively in Seng Camp, located down dip within the coal reserve. As outlined by WV 38CSR2 §14.14.g.1.A and §14.14.g.1.B, Durable Rock fills will be constructed with 80% or greater durable rock and shall not consist of acid forming or toxic forming material, will not slake and water, and will not degrade to soil material.

The schedule of toxic forming material has grown to not only include Aluminum, Manganese, and Iron, but also Selenium and other sulfates and carbonates that can leach out or dissolve in water. As part of an approved permit, the applicant will have completed chemical analysis of the overburden to identify toxic material in the strata and developed a toxic material handling / disposal plan approved by WVDEP. Best management practices have shown that placing toxic material high in the backfill and capping it with low permeability material offers the lowest probability of leaching harmful elements. Toxic materials will be excluded from the fills insomuch as is possible. Therefore, a mine design with a high percentage of excess spoil disposal above the elevation of the lowest seam being mined decreases the potential for leachate development.

An underdrain, constructed of sufficiently large material, shall be placed within the fill to serve as a continuous drainage medium.

7.3 Compacted Fill

In order to minimize the potential increase in dissolved solids due to water migrating through a fill, it is recommended that the fill be constructed in lifts beginning from the toe, using haulage equipment to compact each lift as it is placed. This process is similar to the approach used in placing material in the mined area backfill.

7.4 Seepage Collection

Groundwater flow along the pavement of the lowest seam being mined will discharge on the down dip side of the ridge line. If this outcrop is exposed, the groundwater flow will co-mingle with any surface water in the perimeter sediment control ditch. However, if this discharge is

within the confines of a valley fill, it will provide constant flow into (and through) the fill material.

To reduce the interaction of groundwater with the excess spoil, Best Management Practices dictate intercepting the groundwater flow along the down-dip outcrop of the mine floor with a French drain and routing the flow to the groin ditches. This will be necessary for the Seng Camp fill as the coal dips to the northwest and some base flows from the lowest seam can be expected.

7.5 LOW PERMEABILITY ZONES

In order to reduce the infiltration of water into the fill, a potential Best Management Practice is to construct horizontal low permeability zones within the outslope of the fill so that any surface water infiltrating the fill is stopped from seeping through the fill where it could potentially dissolve adverse elements or increase dissolved solids.

7.6 LANDFORMING

The use of the mining metrics identified the reduction in the percentage of the drainage flowing through fills as a positive indicator The slope analysis also identified the objective that the post-mining slope distribution closely match the pre-mining slope distribution.

Traditionally valley fills have flat decks and terraced outlsopes. However, this configuration does not match the pre-mining configuration and the presence of large deck areas increases the potential for surface water to infiltrate into the fill. Flow into the fill influences the dicharge at the toe of the fill and also increases the potential for interaction with the spoil particulates.

The use of landforming on the top surface of the fill adds natural slopes to the zone and also increases the slope angle so that it closely resembles the pre-mining slope and drainage patterns. Replicating pre–mining slope also encourages pre-mining vegetation, which in turn reduces water infiltration.

8. Summary

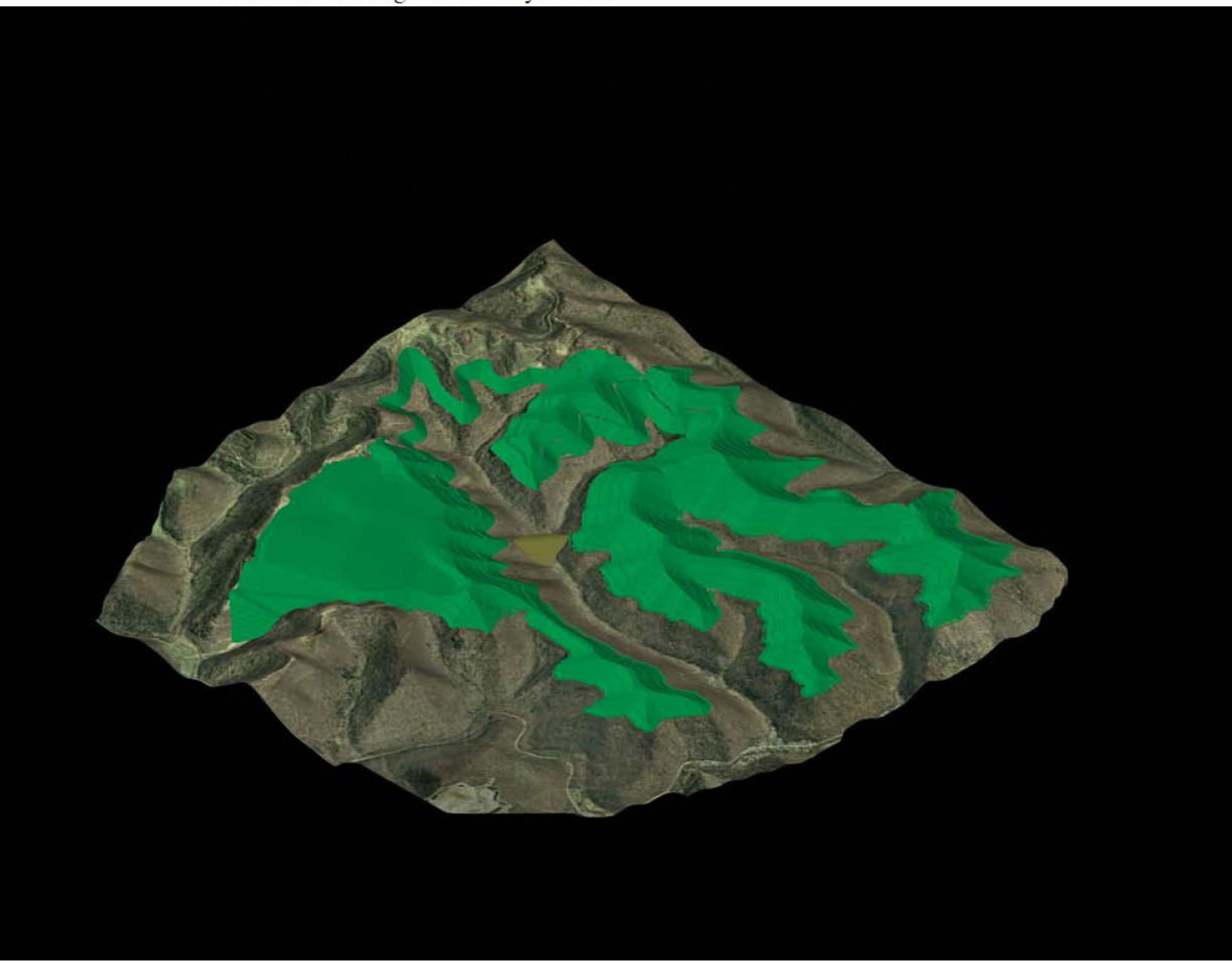
This analysis of the Spruce No. 1 Mine permit demonstrates that an alternative mine design (Alternative #1) can meet the project objective and is practicable, in so much that it is capable of being done using existing mining technology.

In fact, each of the three alternatives analyzed in this report indicate significant environmental benefits when compared to the proposed Mingo Logan IBR #2 configuration.

The objective of the analysis was to mine the same resource as proposed by Mingo Logan and this objective has been met.

The key differences between Alternative #1 and IBR #2 are:

- The stream impacts (temporary and permanent) have been reduced from 43,946 feet (IBR #2) to 18,068 feet (Alternative #1), 41% of the originally proposed impacts.
- The Alternative #1 design reduces the surface water flow through valley fills from 59.4% of the mine drainage area to only 22.1%.



9. Review of Comments

9.1 MINGO LOGAN COAL COMPANY

MW has reviewed portions of the comments from Mingo Logan regarding the pending CWA §404 (c) action and our responses to Section E of that document are detailed below.

E. Mingo Logan has Demonstrated that the Permitted Action is the Least Environmental Damaging Practicable Alternative

The analysis conducted as part of this "Spruce Permit Review" identified three alternatives that all had fewer impacts than the proposed action. In particular, Alternative #1, which contains only one fill in comparison to the six proposed in IBR #2, does not require sequential fills. In addition, this alternative has stream impacts that are only 41% of those proposed by Mingo Logan in IBR #2 and Alternatives #2 and #3 also contain far less stream impacts than IBR #2 (48% and 64% of the stream impacts of IBR #2, respectively). Each alternative considered in this analysis scored higher than IBR #2 in almost all of the seven metrics analyzed, with Alternatives #2 and #3 scoring higher than IBR #2 on all of the metrics.

Discussion of the specific subsections of the Mingo Logan comments are:

> <u>E-1 The Corps conducted a robust and complete alternatives analysis of the Spruce #1 Mine</u>
>
> The EIS reviewed a no action alternative, an off-site alternative, and seven on-site surface mining alternatives, including the Mingo Logan's preferred alternative (IBR #2), for which the EIS also analyzed fill placement and off-site spoil disposal alternatives. The off-site disposal alternatives considered either placement of 100% of the overburden back on the mine bench or hauling 100% of the 110 million cubic yards of excess spoil off-site via Pigeonroost, both of which were determined to be impractical. The EIS section entitled "Fill Placement Alternative" described West Virginia's AOC/Fill Optimization Process Guidance Document (Guidance Document), but did not suggest or analyze any alternatives related to fill placement. In addressing valley fill location alternatives, the EIS described the process used to identify potential valley fill locations, which included slope sufficiency and stability and the "ESDA Bank" Analysis procedure described in the Guidance Document, but did not actually propose or analyze any on-site spoil disposal alternatives. Following these statements, the EIS identified that Alternative 7 (IBR #2) was the least environmentally damaging practicable alternative.
>
> Although the EIS evaluated seven different alternatives, none of the alternatives evaluated the fill placement options and valley fill locations identified in this report as Alternative #1, #2, and #3, all of which maintain the overall recoverable coal while significantly reducing the environmental impacts compared to Alternative 7. Thus the EIS did not review at least three alternatives that were practicable, but less environmentally damaging than Alternative 7.

E-2 EPA's reconsideration of the Corp's Analysis violates EPA's own rules and unjustly ignores Mingo Logan's changes to the Project in response to EPA's previously expressed concerns.

Each alternative analyzed by MW in this report maintains the previous revisions to the permit that eliminated any filling of White Oak Branch, while maintaining the overall recoverable coal and reducing environmental impacts in relation to IBR #2. In addition, as shown by the analysis contained in this report, each alternative proposed by MW is less environmentally damaging than the Applicant's IBR #2 project. None of these alternatives were presented by the Applicant or analyzed by the Corps.

E-3 EPA's Fill "Approval" alternative is not practicable

The Alternative #1 option developed by MW is not a sequential fill approach, as the mine design proposes a single efficient fill with the capacity to hold all of the required excess spoil. As demonstrated above in this report, this approach would not incur significant cost and it is practicable. Most significantly, the analysis confirms that it is less environmentally damaging than the proposed action of Mingo Logan.

Furthermore, Alternatives #2 and #3, as shown above, would also minimize environmental impacts in comparison to IBR #2 while recovering the same amount of coal, making these alternatives practicable, as well.

E-3 (a) A sequential fill "Approval" alternative would not met the project purpose

Alternative #1 avoids all of the concerns expressed by Mingo Logan with regard to sequential fills. This "Spruce Permit Review" concurs with Mingo Logan that the project is one of the largest and lowest ratio (overburden to coal tonnage) surface minable reserves in Central Appalachia. Alternative #1 does not place any constraints on the operation of a large scale mining operation with the type of equipment specified in the EID.

In addition, Alternatives #2 and #3 would recover the same amount of coal as proposed in IBR #2, thus meeting the Applicant's project purpose, as well.

E-3 (b) Costs makes sequential approval impracticable

Alternative #1 would not require sequential approval since it is a single fill. Therefore, the whole reserve could be mined and the proposed large scale equipment is still practicable, as is the proposed coal handling facility.

E-3 (c) Logistics make sequential approval impracticable

None of the concerns expressed by Mingo Logan are applicable if the single fill included in the Alternative #1 is selected.

E-4 A sequential fill "Approval" alternative is not less environmentally damaging

Alternative #1 would not require sequential fill approval and has significantly less environmental impact than the approach proposed by Mingo Logan. These reduced impacts include less permanent stream impacts, only one valley fill, and a lower percentage of the drainage flowing through a valley fill. All of these reduced

environmental impacts are achieved while mining the same quantity of coal. All of the coal identified in Mingo Logan's proposed action would still be mined under Alternative #1.

In addition, this analysis has shown that Alternative #2 and Alternative #3, while both employing sequential fills, also have less environmental impacts than Mingo Logan's proposal. Alternatives #2 and #3 were shown to reduce stream impacts and the drainage area flowing through valley fills and to result in more efficient mining than IBR #2. Thus, at least two alternatives exist that employ sequential fills and are less environmentally damaging than Mingo Logan's approach.

E-5 The fill "Approval" alternative is not lawful

The Alternative #1 has only one valley fill and this is located in Seng Camp where there are two fills already permitted and one existing NPDES point. Mining is currently being conducted in this watershed. With only one fill there is no sequential approval or condition on future mining, so even if the fill "Approval" alternative was lawful, Alternative #1 is not contained within that category.

9.2 UNITED COMPANY

Morgan Worldwide has reviewed the letter from Mr. James W McGlothlin to Mr. Shawn Garvin, dated May 13, 2010, which details the concerns of The United Company. The United Company (through its wholly owned subsidiary United Affiliates Corporation) is the lessor of the majority of the coal covered by the proposed Spruce Mine. United appears concerned about the revenue loss if the permit is not allowed to proceed.

Based on the recoverable coal tonnage reported in the EID in the submittal to the Corps, the revenue to United is indicated on the following chart:

Coal Resource	40,910,000 tons
Average selling price	$50 per ton
Total Revenue	$2,045,500,000
Royalty Rate	8%
Royalty Revenue	$163,640,000
Mine Life	15 years
Annual Royalty	$10,909,333

The royalty rate is imputed from comments in the McGlothlin letter and is not substantiated by any review of the lease. In addition, it is not known if United is receiving any minimum royalties (recoupable or not) from Mingo Logan.

If the project is postponed, United is impacted by the loss of revenue over the period of delay. The best approach to evaluating that impact is to compare the net present value of the project

with two different start dates. For the purpose of the analysis, the base case assumes a commencement of coal production in 2012, the delay case moves the start date to 2015. Using a discount factor of 15% the delay in project commencement has a financial impact to United of about $8.3M over the life of the mine. However, it would have an immediate effect of eliminating the receipt of $33M of royalty payment over the three year delay period.

Since the alternatives evaluated by MW all mine all of the coal within the existing proposed mining area, there is no reduction in the overall royalty payment to United. Furthermore, the elimination of sequential fills in Alternative #1 removes any segmentation of mining and the potential for reducing the mining area due to non-approval of future fills.

Stefania Shamet/R3/USEPA/US
11/08/2010 04:49 PM

To Christopher Hunter
cc
bcc
Subject Fw: comment summary

----- Forwarded by Stefania Shamet/R3/USEPA/US on 11/08/2010 04:49 PM -----

From: Stefania Shamet/R3/USEPA/US
To: John Pomponio/R3/USEPA/US@EPA
Date: 11/08/2010 03:15 PM
Subject: Fw: comment summary

----- Forwarded by Stefania Shamet/R3/USEPA/US on 11/08/2010 03:14 PM -----

From: Regina Poeske/R3/USEPA/US
To: Stefania Shamet/R3/USEPA/US@EPA
Date: 11/08/2010 03:13 PM
Subject: comment summary

SUMMARY OF COMMENTS_sds.doc

Regina Poeske
Office of Monitoring and Assessment
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Learn more about the Office of Monitoring & Assessment at http://epa.gov/reg3esd1/3ea50.htm

Summary Of Comments
On the Spruce No. 1 Proposed Determination

The Region received approximately 50,000 written comments and approximately 100 oral comments at the public hearing. With respect to the written comments, all but approximately 30 were of the "post-card" variety.

Of the written comments, approximately 70 percent support EPA's assertion of its Section 404(c) authority, and 30 percent oppose. Of the oral comments, approximately 35 percent supported EPA's assertion of its Section 404(c) authority, and 65 percent opposed it.

The following is a general summary (by subject) of the comments received. A more detailed summary is also attached.

Proposal to Withdraw or Restrict Generally

Those commenters who generally supported a proposed determination to withdraw or restrict (USFWS, environmental groups, the traditionally disadvantaged community, members of the public) did so generally on the basis of impacts to either the community or to the environment.

Those commenters who generally opposed the proposed determination (Congressman Rahall, House Minority staff, WVDEP, industry and the regulated community, one local government in Ky, members of the public) generally did so on one or more of the following bases: (1) EPA had previous opportunities to use other authorities to stop this project and never did so, it is too late now; (2) economic contribution of mining; (3) assertion of environmental impacts either insufficient or inadequately supported.

EPA's Authority/Legality of the Action

Those commenters that commented that EPA lacks authority to initiate the Section 404(c) process did so primarily on the ground that the permit has issued and that Section 404(c) authority does not extend past permit issuance. Mingo Logan presented a lengthy legal argument on this topic. Both congressional commenters also expressed a view that 404(c) does not extend past permit issuance. In addition to legal arguments, commenters also pointed to policy implications of a post-permit 404(c) action, including undermining the Corps and WVDEP authority and introducing uncertainty. Specifically, there is concern that the regulated community must have certainty once a permit is issued in order to plan and move forward, and this action introduces an unacceptable level of uncertainty and lack of closure. WVDEP also commented that EPA had overstepped its authority and was inappropriately second-guessing determinations made by WVDEP as part of the NPDES and/or Section 401 process.

Other commenters stated a belief that EPA has legal authority.

Characteristics of the Impacted Resources

Mingo Logan commented that EPA should defer to the findings of the Corps and WVDEP, and also that the streams at issue are generally "unremarkable." Mingo Logan and two other commenters also questioned whether the impacted streams are within Clean Water Act Jurisdiction.

Other commenters (including NGOs and a private citizen) commented that the Spruce Fork and/or Coal River were already affected by mining and the localized resources to be impacted were important to the overall watershed.

Water Quality Issues

Those commenters who disagree with the proposed action generally commented that EPA should defer to the WVDEP's NPDES and CWA Section 401 processes (this commented is repeated under several categories). Other commenters stated that water quality has improved over the years due to regulatory oversight and that EPA has sufficiently supported its water quality conclusions. Mingo Logan commented that its discharge data from the constructed portion of the project did not reflect exceedances of selenium. Mingo Logan also commented that it is in compliance with its permit. With respect to conductivity, there were comments that there are no national water quality criteria for conductivity and that 500 uS/cm is an arbitrary level.

WVDEP commented that a shift in the macroinvertebrate community (as documented in Pond, Passmore, et al. 2008) did not correlate to any significant impairment in the ecosystem. WVDEP stated that recent WVSCI data does not show impairment in Spruce Fork.

Other commenters generally agreed with EPA's proposed determinations regarding water quality. Several commenters agreed with EPA's proposed determination that the project would increase selenium levels and conductivity levels. One commenter stated that WVDEP had identified Spruce Fork and Seng Camp Creek as impaired waters, but had delayed development of total maximum daily loads. There were also comments expressing general concern about surface water quality and drinking water quality.

Wildlife

Commenters expressed general concern regarding wildlife, including connection between streams and other wildlife (both aquatic and terrestrial).

With respect to specific forms of wildlife, FWS generally agreed with EPA's concern regarding macroinvertebrates. FWS also expressed a view that macroinvertebrates play an important role in the ecosystem. Other commenters stated that macroinvertebrates are outside EPA's jurisdiction, that impacts to macroinvertebrates

should not outweigh economic impacts from reduced mining. Mingo Logan and CH2M Hill commented that EPA's concern about loss of sensitive taxa was unsupported.

FWS and other commenters expressed agreement that salamanders are an important part of the ecosystem and concern about impacts to salamanders. Another commenter stated that impacts to salamanders should not outweigh economic considerations. Mingo Logan commented that there are no rare or endangered species at the Spruce No. 1 site.

Commenters expressed concern regarding adverse impacts to fish, including citation to studies purporting to conclude that MTM activities adversely affect fish communities. Other commenters pointed to studies that there are no fish impacts. Mingo Logan commented that there were few fish in the streams that would beburied.

A small number of commenters expressed concern to bird species. FWS supported the proposed determination with respect to impacts on birds and also expressed concern regarding bats. Mingo Logan commented that birds would not be unacceptably adversely affected. It stated that previous logging at the site had already reduced or eliminated habitat at the Site and that downstream areas would provide alternative habitat and food source. With respect to bats, Mingo Logan stated that mist net surveys did not identify protected species in the area.

Mitigation

FWS generally supported the proposed determination that the Corps/applicant had underestimated and mischaracterized the spatial extent of stream resources to be impacted and that the mitigation plan lacked sufficient detail to determine whether impacts would be offset. Other commenters expressed concern with lack of evidence that the mitigation techniques being proposed would besuccessful.

WVDEP and Mingo Logan stated that the proposed mitigation measures are sufficient. Mingo Logan pointed to the recent Fourth Circuit decision as support that its mitigation plan is sufficient.

Consistency with Section 404(b)(1) Guidelines

FWS generally stated that it believed there were other less environmentally damaging practicable alternatives. Earthjustice stated generally that EPA's proposed determination is consistent with the 404(b)(1) Guidelines.

The American Petroleum Institute stated that EPA was too late in the process (after permit issuance) for a 404(b)(1) analysis.

Mingo Logan pointed out that it had already redesigned the project to minimize impacts.

Potential to Contribute to Conditions that Support Growth of Golden Algae

Mingo Logan and CH2M Hill state that the causative factors associated with blooms of golden algae are not present in the Spruce Fork watershed.

Economic Issues

The two congressional commenters expressed concern that EPA is generally stopping Appalachian surface mining and produced statistics on job loss and loss to small businesses and potential to increase energy costs. The regulated community expressed concern that the uncertainty introduced by a Section 404(c) action post-veto would discourage investment. It also commented on the negative impacts to the local community, and capital loss to Mingo Logan. Most private citizens who referenced economic impacts expressed concern about loss of jobs. One landowner at the Spruce 1 mine estimated $2 billion in lostrevenues,$100 million in lost severance tax revenue to WV and other losses. One locality in KY stated that it had benefited from recreational facilities (a golf course) constructed on post mineland,and that other post mineland had been used forexpansion.

Environmental groups commented that degradation of water quality and the environment would have a long term negative economic affect. One commenter pointed to economic impacts to families who are displaced by the operation. Another commenter stated that the large-scale surface mining operations generally use fewer employees than other types of mining operations.

Cumulative Effects

FWS expressed concern about the cumulative effects from deforestation and loss of headwater resources.

Environmental groups commented that many downstream resources are already impacted by mining and that construction of the project would exacerbate those impacts.

Mingo Logan stated that analysis of cumulative impacts from loss of forest resources is beyond EPA's authority. It also commented that mitigation will offset cumulative impacts.

Environmental Justice

Earthjustice expressed concern that the project would disproportionately affect disadvantaged communities. It also expressed concern regarding potential impact to drinking water wells. It also pointed to a recent study that purported to document a relationship between residence in a high coal mining area and increased human cancer mortality.

Mingo Logan commented that the Corps' Spruce EIS adequately addresses environmental justice concerns. It also commented that no public water supply will be affected.

One commenter pointed out that mining supplies jobs and tax revenue that are important to economically disadvantaged communities.

Air Quality

A small number of commenters expressed concern about exposure to high levels of dust.

Js Wilson/DC/USEPA/US
11/09/2010 05:01 PM

To Timothy Landers
cc David Evans
bcc
Subject Re: Fw: Rescheduled: MTM Permitting Strategy Follow-up (Nov 10 05:15 PM EST in 3309 ARN Call in number: (b) (6) [redacted]

(b) (5) [redacted] Although there is some 404 connection it is really a 402 issue.

Scott Wilson, Energy Coordinator
Industrial Permits Branch (4203M)
Office of Wastewater Management
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, DC 20460
202-564-6087

Timothy Landers | Scott, Any idea what this meeting might be abou... | 11/09/2010 04:54:27 PM

From: Timothy Landers/DC/USEPA/US
To: Js Wilson/DC/USEPA/US@EPA
Cc: David Evans/DC/USEPA/US@EPA
Date: 11/09/2010 04:54 PM
Subject: Fw: Rescheduled: MTM Permitting Strategy Follow-up (Nov 10 05:15 PM EST in 3309 ARN Call in (b) (6) [redacted]

Scott,
Any idea what this meeting might be about? Could this be a follow-up to last week's discussion with HQ and R4 on 402 permitting options?

----- Forwarded by Timothy Landers/DC/USEPA/US on 11/09/2010 04:52 PM -----

From: David Evans/DC/USEPA/US
To: Brian Frazer/DC/USEPA/US@EPA, Denise Keehner/DC/USEPA/US@EPA, Christopher Hunter/DC/USEPA/US@EPA, Timothy Landers/R6/USEPA/US@EPA
Date: 11/09/2010 04:10 PM
Subject: Fw: Rescheduled: MTM Permitting Strategy Follow-up (Nov 10 05:15 PM EST in 3309 ARN Call in (b) (6) [redacted]

This is a very odd set of invitees, AAs, RAs, random additional people including myself and Marcel, but none of you. We'll need to figure out purpose and optimal attendees for this.

Dave

David Evans, Director
Wetlands Division
Office of Wetlands, Oceans and Watersheds
(202) 566-0535

----- Forwarded by David Evans/DC/USEPA/US on 11/09/2010 04:09 PM -----

Rescheduled: MTM Permitting Strategy Follow-up
Wed 11/10/2010 5:15 PM - 6:00 PM
Attendance is **required** for David Evans

Chair: **Bob Sussman/DC/USEPA/US**
Sent By: **Georgia Bednar/DC/USEPA/US**
Location: 3309 ARN (b) (6) [redacted]

Bob Sussman has rescheduled this meeting. You have not added this entry to your calendar.

Required:	Ann Campbell/DC/USEPA/US@EPA, David Evans/DC/USEPA/US@EPA, dorfman.jordan@epa.gov, Georgia Bednar/DC/USEPA/US@EPA, Gregory Peck/DC/USEPA/US@EPA, Gwendolyn KeyesFleming/R4/USEPA/US@EPA, Jim Giattina/R4/USEPA/US@EPA, Jim Hanlon/DC/USEPA/US@EPA, Jon Capacasa/R3/USEPA/US@EPA, Karyn Wendelowski/DC/USEPA/US@EPA, Kevin Minoli/DC/USEPA/US@EPA, Linda Boornazian/DC/USEPA/US@EPA, Marcel Tchaou/DC/USEPA/US@EPA, MichaelG Lee/DC/USEPA/US@EPA, Nancy Stoner/DC/USEPA/US@EPA, Shawn Garvin/R3/USEPA/US@EPA, Stan Meiburg/R4/USEPA/US@EPA, Steven Neugeboren/DC/USEPA/US@EPA, William Early/R3/USEPA/US

Description

Christopher Hunter/DC/USEPA/US

11/10/2010 08:32 AM

To hunter.christopher

cc

bcc

Subject Mining Data

Mining_Activities_5-12(5-28-09).xls

OIG Permit Inquiry 11-10-10.xls

10-15-10 Senator Inhofe Request.pdf

2010-05-21 MTM Permit List - EPW.pdf

Chris Hunter
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Office of Wetlands, Oceans, & Watershed
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United States Senate

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
WASHINGTON, DC 20510-6175

October 15, 2010

Arthur A. Elkins, Jr.
Inspector General
Environmental Protection Agency
Office of Inspector General
1200 Pennsylvania Avenue, N.W. (2410T)
Washington, DC 20460

Dear Mr. Elkins:

I have attached to this letter a list identifying over 200 Clean Water Act (CWA) 404 permits. I am concerned that EPA is needlessly delaying these permits, especially since most of them have been previously reviewed multiple times over the past three years.

I originally requested that EPA's Office of Inspector General report back to me the total amount of time that EPA has spent reviewing these permits. However, I was contacted by EPA's Assistant Administrator of Water, Peter Silva, who informed me that EPA's Office of Water does not keep an hourly accounting of their time. This is very surprising and troubling.

I would request that within the scope of the attached list of permits, your office determine the following and report back to me:

- The status of the attached mountaintop mining permit applications and the length of time to review each permit.
- The reasons for the length of review for each permit.
- The number of permits from the attached list that EPA has processed according to the "enhanced review" and "conductivity" procedures, as well as the average length of time to process a permit under these procedures.

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Coal mining is a lengthy and complicated process. A stable regulatory system is essential not only to protect the environment but also the capital investment and jobs created by these operations. Yet the status of these permits remains an open question, a fact that has forced small businesses to shut down, destroying jobs and causing economic harm in local communities. To avoid further economic harm, EPA must process these permits in a more timely and predictable manner.

Thank you for your time and attention to this matter. Due to the time sensitive nature of this request, I would like a response as soon as possible. Should your staff have any questions, please contact Matthew Hite at (202) 224-6328.

Sincerely,

James M. Inhofe
Ranking Member
Senate Committee on
Environment and Public Works

Enclosure

Based on Corps 5-12-09 Data	
Applicant name	Project Name
Alex Energy	Republic No.1
Central Appalachian Mining	Big Branch
Jeffco Resources	North Barnesville
Kimble Clay & Limestone	Hunt
CONSOL of Ky	Peg Fork
Highland Minging	Reylas
Sand Hill Coal Co	Big Valley Mine
CONCO	Mill Creek Mine
Bluestone Coal	Deep Mine 65
Ohio Valley Coal	No.2 Slurry Exp.
Clintwood Elkhorn	CEMC
Oxford Mining Company LLC	Degrave Area
A&G Coal	A&G Coal
Consolidated Coal Company	Consolidated Coal Company
Consolidated Coal Company	Wilson Hollow
Cumberland River Coal	Cumberland River Coal
Maple Coal Co	Sycamore North
Buckeye	Hamilton
Jewell Smokeless	JSCC
Gatliff Coal	Jamieson Construction
D&C Mining	D&C Mining
Kimble Clay Limestone	Harmon Hill
Appalachian Fuels	Big Creek
Sapphire Coal	Sapphire Coal
Load-Out	Locust Fork
Ohio American Energy	Salt Run North
ICG Hazard	ICG Hazard
Black Diamond	Norton Coal
Eastern Associated Coal	Pond Fork #2 Gas Deep Mine
Nally & Hamilton	Nally & Hamilton
Powdermill Processing	Stone1 U/G Mine,PrepPlant,Refuse Fill
Nally & Hamilton	Nally & Hamilton
Atlantic Lessoco	Peerless #1
CAM Mining	CAM Mining

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Martin County C	Martin County
Martin County C	Martin County
Martin County C	Martin County
ICG Hazard	ICG Hazard
Pocahontas Coal Co	East Gulf Complex
Pocahontas Coal Co	Beckley Highwall #2
Pine Branch C	Pine Branch C
Consolidated Coal Company	Loveridge Mine #22
Knox Creek Coal	
Candle Ridge Mining	Candle Ridge Mining
Independence Coal Company	Consitution Surface Mine
Appolo Fuels	Jellico Strip
CH Development	CH Development
Bluestone	ContourAuger1
Green Valley Coal Company	Blue Branch Refuse
Marrowbone Development	Teywood W & Marrowbone
Premier Elkhorn	U/T Old Beefhide
Bear Fork	Bear Fork S.M
Oxford	Peabody 3
Independence Coal Company	Glory Surface Mine
Consol of KY	Slone Br Mine
Consol of KY	Area 80
Brooks Run Mining	Brandy St & Cove Mtn
Hobet Mining	Hewett
Sturgeon Mining	Sturgeon Mining
ICG Hazard	ICG Hazard
ICG Hazard	ICG Hazard
Catenary Coal Co.	Laurel Fork
Catenary Coal Co.	Tenmile Fork Deep Mine
Ikerd Coal	Ikerd Coal
Nally & Hamilton	Nally & Hamilton
Licking River Resources	Licking River Resources
CAM Mining	Cane Branch
Matt/Co	Matt/Co
Buckingham Coal	Buckingham Wash Plant
Premier Elkhorn Coal	Premier Elkhorn Coal
Laurel Cr Coal	#7
Leeco, Inc.	Stacy Branch Surface Mine
Apex Energy	Apex Energy
Oxford	Mizer
Clintwood Elkhorn	Clintwood Elkhorn
Candle Ridge Mining	Candle Ridge Mining

Consol of KY	Razorblade Surface Mine
A&G Coal Corp	Ison Rock Ridge
Pioneer Fuel	Little Eagle
Appolo Fuels	Buckeye Springs Mine 2
Miller Bros. Coal	Miller Bros. Coal
Johnson Floyd Coal	Johnson Floyd Coal
Argus Energy	Argus Engergy
CAM Mining	CAM Mining
Apex Energy	Apex Energy
Buckeye Ind Mining	Wilson
The Raven Co.	The Raven Co.
Leeco, Inc.	Elk Lick
Premier Elkhorn Coal	Premier Elkhorn Coal
Miller Bros. Coal	Frasure Branch Mine
Cheyenne Resources	Cheyenne Resources
Miller Bros. Coal	Miller Bros. Coal
Miller Bros. Coal	Miller Bros. Coal
ICG Knott Co.	ICG Knott Co.
Pine Branch Coal	Pine Branch Coal
FCDC	FCDC
Licking River Resources	Licking River Resources
Matt/Co	Matt/Co
ICG Hazard	ICG Hazard
Clintwood Elkhorn	Clintwood Elkhorn
Frasure Creek Mining	Frasure Creek Mining
Oxford Mining	Page S.M.
Miller Bros. Coal	Miller Bros. Coal
CAM Mining	CAM Mining
Wildcat	#2 Surface
Consol of KY	Consol of KY
Pioneer Fuel	MT5B
Premier Elkhorn Coal	Premier Elkhorn Coal
Premium Coal	Refuse Area#3
Bluestone Coal	Pocahontas #11
Chas Coal	Chas Coal
BDCC Holdings	Cherries Branch
Wolverine Resources	Jake Fork and Stoney Branch Surface Mine
Czar Coal	Czar Coal
Central Appal Mining	Remining #3
Martin County Coal	Findlay Branch Mine
Czar Coal	Czar Coal
CAM Mining	Tom's Branch Surface Mine
Premium Coal	Area 19
Frasure Creek Mining	Frasure Creek Mining

ICG Hazard	Bearville North
Premium Energy, Inc.	Premium Mills Surface Mine
Eastern Associated Coal	Huff Creek Haul Road
Enterprise Mining	Enterprise Mining
ICG Hazard	ICG Hazard
Wolverine Resources	Wolverine Resources
Alex Energy, Inc.	Lonestar Surface Mine
Alex Energy, Inc.	Federal Surface Mine
Highland Minging	Georges Crk Surf Mine
Hobet Mining	Surface Mine No. 45
CoalMac, Inc.	Pine Creek Surface Min
Eastern Associated Coals	Huff Creek Surface Mine
Ohio American Energy	Red Bird South
Nelly & Hamilton	Nelly & Hamilton
FCDC	FCDC
Performance Coal Company	Upper Big Branch Deep Mine
CONSOL of Energy	Buffalo Mt. Surface Mine
Middle Fork Dev.	Middle Fork Dev.
Oxford Mining	Horn
Oxford Mining	Long Sears Adj
Surface Mining Inc	Young Property
Colony Bay Coal Co.	Colony Bay Surface Mine
Oxford Mining	Kaiser Mathias
Fraeure Creek Mining	Spring Fork Surface Mine NO. 2
McElroy Coal Company	5 North # 11Bleeder Shaft
ICG Eastern, LLC	Jenny Creek Surface Mine
Argus Energy WV, LLC	Devilstrace No. 2 Punchout
Consol of Kentucky	Spring Branch No. 3 Deep Mine
Oxford Mining Company LLC	Ellis Area
Miller Bros. Coal	Miller Bros. Coal
Apex Energy	Apex Energy
Panther, LLC	Wet Branch Refuse
B&N Coal	Whigville III
Oxford	Halls Knob
Fraeure Creek Mining	Fraeure Creek Mining
Coyote Coal Company	Joes Creek Surface Mine

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North Fork Collieries	Gilmore Surface Mine
Hampden Coal	Harrys Br
Apex Mining	Apex Mining
Tunnel Ridge,LLC	Tunnel Ridge Prep Plant/Refuse Area
McElroy Coal Company	McElroy Refuse Area
Cambrian Coal Group	Cambrian Coal Group
Sands Hill	Big Rock
Newagle Mining Corporation	Hoover Fork Deep Mine
Sandlick Coal Company	Foresters Creek
FCDC Coal	FCDC Coal
Appolo Fuels	Fonde-Highwall
Infinity Energy	Infinity Engergy
Kanawha Eagle	Coalburg5 & Eagle2
Hillside Mining	Workman Br
GTM Energy Partners	GTM Energy Partners
Emerald Coal Resources, LP	Emerald Coal Resources, LP
Apex Energy	Apex Energy
Valley Mining	
Oxford Mining Company LLC	Lafferty Adjacent Area
Nally & Hamilton	Nally & Hamilton
Cloverfork Mining & Excavation	Cloverfork Mining & Excavation
National Coal	National Coal
Strugeon Mining	Sturgeon Mining
Pine Ridge Coal	Hirlams Hol Refuse Fill
Hope Coal Co.	Piper Mine
Buckeye Ind Mining	Beaver Excav
Freeport Mining, LLP	Freeport Mining, LLP
Nally & Hamilton	Nally & Hamilton
Paramount Coal	PCCV
Clintwood Elkhorn	CEMC
EME Homer City Generation L.P.	EME Refuse Disposal Site
Jamieson Construction	Jamieson Construction
Nally & Hamilton	Nally & Hamilton
Davis Creek Energy	Area# 4
New Yellow Ck. Coal	New Yellow Creek Mine
DRC Coal	White Oak Surface Mine #1
Nally & Hamilton	Nally & Hamilton

Consolidated Coal Company	Bailey Mine
Oxford	Garrett
Argus Energy, LLC	Wiley Branch Surface Mine Amendment No. 3
B&N Coal	Whigville
Nally & Hamilton	Kayjay #8
Nally & Hamilton	Nally & Hamilton
M&B Excavating	Thompson South Mine
Horizon Resources, LLC	Synergy Surface Mine No. 2
Consolidated Coal Company	Oak Spring Slope and Supply Yard
Nally & Hamilton	Nally & Hamilton
B'ham Coal & Coke	Powhatan Mine
A&G Coal	A&G Coal
Patriot Mining Company	Wades Run extension
Eastern Associated Coal	Rocklick Branch Refuse Fill
New Acton Mining	Slate Creek Mine
Clintwood Elkhorn	Clintwood Elkhorn
Chevron Mining	North River R-34
Fraeure Creek Mining	Fraeure Creek Mining
Travis Creek Mining	Trafford Mine
Coresco Overland Conveyor Belt	Coresco, LLC
Black Warrior Minerals	Manchester East
Miller Bros. Coal	Bear Hollow Mine
Leeco, Inc.	Leeco, Inc.
Miller Bros. Coal	Miller Bros. Coal
Enterprise Mining	Trace Fork Surface Mine
National Coal of AL	L. Massey North
Twin Pines Coal Co.	Lick Creek Mine
Reed Minerals Inc.	No. 5 Mine
Aldwych, LLC	Four Oaks Mine #2
Lone Mountain Processing	Prep Plant
ICG Knott Co.	Lige Hollow Amburgy Mine
Paramount Coal	Dry Fork
Fraeure Creek Mining	Fraeure Creek Mining
Fraeure Creek Mining	Fraeure Creek Mining
Hope Coal Co.	Trey Mine
Patrick Processing	Patrick Processing
Miller Bros. Coal	Miller Bros. Coal

Cambrian Coal	Cambrian Coal Group
Buckeye	Freed Road
Premier Elkhorn	
Catenary Coal Co.	Moccasin Hollow
Mid Vol	Paradise
National Coal of AL	Kansas Mine No. 2
National Coal of AL	L. Massey South

Based on Corps 5-12-09 Data												
Applicant name	Project Name	Permit Number	SMCRA Number	WV	OH	KY	TN	VA	PA	AL	County	Decision Date
Alex Energy	Republic No.1	2003-238	S-3025-00	1							Kanawha	
Central Appalachian Mining	Big Branch	2004-1400				1					Pike	
Jeffco Resources	North Barnesville	2005-1057	10361		1						Belmont	
Kimble Clay & Limestone	Hunt	2005-478	D-2226-2		1						Tuscarawas	
CONSOL of Ky	Peg Fork	2006-2294	S-5018-06	1							Mingo	
Highland Mmging	Roylas	2006-663 / 2007-99	S-5015-06	1							Logan	
Sand Hill Coal Co	Big Valley Mine	2001-407	D-2114		1						Vinton	
CONCO	Mill Creek Mine	2003-468	858-5063			1					Johnson	
Bluestone Coal	Deep Mine 65	2003-794	U-4002-02	1							Wyoming	
Ohio Valley Coal	No 2 Slurry Exp.	2003-853	D-0360		1						Belmont	
Clintwood Elkhorn	CEMC	2004-1860						1			Buchanan	4/27/2009
Oxford Mining Company LLC	Dagrava Area	2004-396	D-2266-1		1						Belmont	4-May-09
A&G Coal	A&G Coal	2005-11	867-0455 AM-1			1					LETCHER	
Consolidated Coal Company	Consolidated Coal Company	2005-2160							1		Greene	4-Apr-09
Consolidated Coal Company	Wilson Hollow	2005-2461		1							Monongalia	26-Jan-09
Cumberland River Coal	Cumberland River Coal	2006-2131	867-9004, AM-1, P-2			1					LETCHER	3/30/2009
Maple Coal Co	Sycamore North	2006-2394	S-3007-95- AM1	1							Kanawha - Fayette	
Buckeye	Hamilton	2006-483	10394		1						Stark	
Jewell Smokeless	JSCC	2006-6158						1			Dickenson	
Gatliff Coal	Jamieson Construction	2006-917	807-0344			1					BELL	
D&C Mining	D&C Mining	2006-928	848-0261			1					HARLAN	4/8/2009
Kimble Clay Limestone	Harmon Hill	2007-1101	D-2327		1						Tuscarawas	
Appalachian Fuels	Big Creek	2007-1161	U-3008-08	1							Fayette	
Sapphire Coal	Sapphire Coal	2007-1645	867-0471			1					Letcher	3/12/2009
Load-Out	Locust Fork	2007-284	S-5023-01	1							Boone	
Ohio American Energy	Salt Run North	2007-323	D-2180-1		1						Jefferson	
ICG Hazard	ICG Hazard	2007-334	666-0281 A 8			1					Leslie	3/25/2009
Black Diamond	Norton Coal	2007-3433						1			Buchanan	
Eastern Associated Coal	Pond Fork #2 Gas Deep Mine	2007-347	U-5001-07	1							Boone	
Nally & Hamilton	Nally & Hamilton	2007-439	866-0304			1					Leslie	
Powdermill Processing	Stone1 U/G Mine,PrepPlant,Refuse Fill	2007-488	U-5017-08	1							Wayne	
Nally & Hamilton	Nally & Hamilton	2007-948	861-0485			1					KNOX	
Atlantic Leaseco	Peerless #1	2007-961	U-3008-07	1							Nicholas	4/6/2009
CAM Mining	CAM Mining	2008-1361	898-4295 R9			1					Pike	
Martin County C	Martin County	2008-1457	880-5012			1					Martin	
Martin County C	Martin County	2008-1458	880-8018			1					Martin	
Martin County C	Martin County	2008-1459	880-5147			1					Martin	
ICG Hazard	ICG Hazard	2008-666	867-0446 A1			1					Perry	
Pocahontas Coal Co	East Gulf Complex	2008-801		1								
Pocahontas Coal Co	Beckley Highwall #2	2008-995	S-3015-08	1							Raleigh	
Pine Branch C	Pine Branch C	2009-198	897-0498			1					Perry	
Consolidated Coal Company	Lovemdge Mine #22	2009-293		1							Marion	
Knox Creek Coal		2009-577						1			Buchanan	
Candle Ridge Mining	Candle Ridge Mining	2003-1276	897-0430 A1			1					Perry	
Independence Coal Company	Constitution Surface Mine	2004-624		1							Boone	
Appolo Fuels	Jellico Strip	2004-609	3112				1				CLAIBORNE	
CH Development	CH Development	2004-1391	861-0467			1					KNOX	
Bluestone	ContourAuger1	2005-217	S-4014-01	1							Wyoming	
Green Valley Coal Company	Blue Branch Refuse	2005-1115		1							Nicholas	
Marrowbone Development	Taywood W & Marrowbone	2005-1198	S-5008-02 S-5021-01	1							Mingo	
Premier Elkhorn	U/T Old Beefhide	2005-934	898-5694 Am5			1						
Bear Fork	Bear Fork S.M	2004-336	898-0715			1						
Oxford	Peabody 3	2005-421	D-2295		1						Coshocton/Muskingum/Guernsey	
Independence Coal Company	Glory Surface Mine	2004-1451		1							Boone	
Consol of KY	Stone Br Mine	2006-127	880-5260 Am1			1						
Consol of KY	Area 80	2006-126	880-0390 Am4			1					Knott	
Brooks Run Mining	Brandy St & Cove Mtn	2004-1155	S-2001-05	1							Webster	
Hobet Mining	Howett	2003-65	S-5027-99	1							Boone	
Sturgeon Mining	Sturgeon Mining	2005-1893	895-0171			1					Owsley	
ICG Hazard	ICG Hazard	2006-756	897-0457 A2			1					Perry	
ICG Hazard	ICG Hazard		897-0457 A2			1					Perry	
Catenary Coal Co	Laurel Fork	2006-821	U-3001-98 IBR5	1							Kanawha	
Catenary Coal Co.	Tenmile Fork Deep Mine	2005-167	U-3004-06	1							Kanawha	
Ikerd Coal	Ikerd Coal	2004-1108	918-0392			1					Whitley	

Nally & Hamilton	Nally & Hamilton	2006-1647	807-0342			1					Bell	
Licking River Resources	Licking River Resources	2006-1290	877-0167, 877-0168			1					Magoffin	
CAM Mining	Cane Branch	2007-69	898-0803			1					Pike	
Matt/Co	Matt/Co	2006-1124	836-5488, 836-0317			1					Floyd	
Buckingham Coal	Buckingham Wash Plant	2004-1152			1						Perry	
Premier Elkhorn Coal	Premier Elkhorn Coal	2007-193	898-0400			1					Pike	
Laurel Cr Coal	#7	2006-2405	U-5004-06	1								
Leeco, Inc	Stacy Branch Surface Mine	2007-217	897-0480			1					Perry	
Apex Energy	Apex Energy	2007-335	898-0607			1					Pike	
Oxford	Mizer	2005-1275	10397		1						Tuscarawas	
Clintwood Elkhorn	Clintwood Elkhorn	2006-1296	898-4150 A1			1					Pike	
Candle Ridge Mining	Candle Ridge Mining	2007-401	895-0177			1					Owsley	
Consol of KY	Razorblade Surface Mine	2007-393	667-0456			1					Letcher	
A&G Coal Corp	Iron Rock Ridge	2007-1351						1			Wise	Suspended
Pioneer Fuel	Little Eagle	2007-282	U-4012-06	1							Wyoming	
Appolo Fuels	Buckeye Springs Mine 2	2005-1691	3191				1				CLAIBORNE	
Miller Bros. Coal	Miller Bros. Coal	2007-669	836-0338			1					Floyd	
Johnson Floyd Coal	Johnson Floyd Coal	2007-706	858-0206			1					Johnson	
Argus Energy	Argus Engergy	2007-400	864-0195			1					Lawrence	
CAM Mining	CAM Mining	2007-867	898-0779			1					Pike	
Apex Energy	Apex Energy	2007-1044	898-0712			1					Pike	
Buckeye Ind Mining	Wilson	2006-484			1							
The Raven Co	The Raven Co	2007-1104	836-0292 A1			1					Floyd	
Leeco, Inc.	Elk Lick	2007-595	860-0455			1					Knott	
Premier Elkhorn Coal	Premier Elkhorn Coal	2007-594	898-0800			1					Pike	
Miller Bros. Coal	Frasure Branch Mine	2007-1132	836-0349			1					Floyd	
Cheyenne Resources	Cheyenne Resources	2005-851	667-0440			1					Letcher	
Miller Bros. Coal	Miller Bros. Coal	2007-1224	860-5304			1					Knott	
Miller Bros. Coal	Miller Bros. Coal	2007-1131	836-0335 A2			1					Floyd	
ICG Knott Co	ICG Knott Co.	2007-1230	860-8012			1					Knott	
Pine Branch Coal	Pine Branch Coal	2007-1190	897-0355 A3			1					Perry	
FCDC	FCDC	2007-1445	836-0339			1					Floyd	
Licking River Resources	Licking River Resources	2007-815	877-0176			1					Magoffin	
Matt/Co	Matt/Co	2007-1205	836-0307			1					Floyd	
ICG Hazard	ICG Hazard	2007-1515	897-0456 A10			1					Perry	
Clintwood Elkhorn	Clintwood Elkhorn	2007-1518	898-0799			1					Pike	
Frasure Creek Mining	Frasure Creek Mining	2007-1026	836-0341 A1			1					Floyd	
Oxford Mining	Pago S.M.	2007-1021	10372		1							
Miller Bros. Coal	Miller Bros. Coal	2007-1582	813-0319			1					Breathitt	
CAM Mining	CAM Mining	2007-1504	898-0783 A3			1					Pike	
Wildcat	#2 Surface	2006-2033	S-3018-06	1							Kanawha	
Consol of KY	Consol of KY	2007-1644	877-0166			1					Magoffin	
Pioneer Fuel	MT5B	2007-286	S-3010-06	1							Raleigh	
Premier Elkhorn Coal	Premier Elkhorn Coal	2008-95	898-0817			1					Pike	
Premium Coal	Refuse Area#3	2002-1435	3064				1				ANDERSON	4/6/2009
Bluestone Coal	Pocahontas #11	2003-995	S-4013-01	1							McDowell	
Chas Coal	Chas Coal	2008-138	807-0352			1					Bell	
BDCC Holdings	Chemes Branch	2008-114	897-0445 A1			1					Perry	
Wolvenne Resources	Jake Fork and Stoney Branch Surface Mine	2008-115	836-0356			1					Floyd	
Czar Coal	Czar Coal	2008-226	880-6002 A4			1					Martin	
Central Appal Mining	Remining #3	2004-867	S-45014-04	1							Mingo	
Martin County Coal	Findlay Branch Mine	2007-1660	880-0066			1					Martin	
Czar Coal	Czar Coal	2008-408	880-0156			1					Martin	
CAM Mining	Tom's Branch Surface Mine	2007-1301	836-0335			1					Floyd	
Premium Coal	Area 19	2004-62	3143				1				ANDERSON	
Frasure Creek Mining	Frasure Creek Mining	2007-1206	877-0782			1					Magoffin	
ICG Hazard	Bearville North	2007-1406	860-0462			1					Knott	
Premium Energy, Inc.	Premium Mills Surface Mine	2005-1211		1							McDowell	
Eastern Associated Coal	Huff Creek Haul Road	2008-75	O-5023-07	1							Wyoming - Boone Logan	
Enterprise Mining	Enterprise Mining	2008-654	860-0464			1					Knott	
ICG Hazard	ICG Hazard	2008-777	897-0455 A3			1					Perry	
Wolvenne Resources	Wolvenne Resources	2008-781	836-0348			1					Floyd	
Alex Energy, Inc	Lonestar Surface Mine	2007-285		1							Nicholas	
Alex Energy, Inc	Federal Surface Mine	2007-182		1							Nicholas	

Highland Mining	Georges Crk Surf Mine	2006-2196	S-5002-01- AM1	1							Logan	
Hobet Mining	Surface Mine No. 45	2003-65	S-5002-07	1							Lincoln	
CoalMac, Inc.	Pine Creek Surface Min	2008-830	S-5006-07	1							Logan	
Eastern Associated Coals	Huff Creek Surface Mine	2008-562		1							Wyoming/Logan	
Ohio American Energy	Red Bird South	2006-660	10395		1						Belmont	
Nally & Hamilton	Nally & Hamilton	2007-820	807-0355			1					BELL	
FCDC	FCDC	2007-1397	836-0350			1					Floyd	
Performance Coal Company	Upper Big Branch Deep Mine	2008-114	U-3016-95	1							Raleigh	4/1/2009
CONSOL of Energy	Buffalo Mt. Surface Mine	2008-491		1							Mingo	
Middle Fork Dev.	Middle Fork Dev	2008-525	877-0191			1					Magoffin	
Oxford Mining	Horn	2006-2256	10379		1						Tuscarawas	
Oxford Mining	Long Sears Adj	2005-753	D-2290-1		1						Noble	
Surface Mining Inc	Young Property	2007-708	10391		1						Tuscarawas	
Colony Bay Coal Co.	Colony Bay Surface Mine	2006-2290	S-7-81	1							Boone	
Oxford Mining	Kaiser Mathias	2007-499	10405		1						Tuscarawas	
Frasure Creek Mining	Spring Fork Surface Mine NO. 2		S-5018-08	1							Mingo	
McElroy Coal Company	5 North # 11Bleeder Shaft	2009-266		1							Marshall	
ICG Eastern, LLC	Jenny Creek Surface Mine	2005-370	S-5009-00	1							Mingo	
Argus Energy WV, LLC	Devilstrace No. 2 Punchout			1							Wayne	
Consol of Kentucky	Spring Branch No. 3 Deep Mine			1							Mingo	
Oxford Mining Company LLC	Ellis Area	2007-1180	10399		1						Jefferson	
Miller Bros. Coal	Miller Bros. Coal	2008-727	813-0310 A1			1					Breathitt	
Apex Energy	Apex Energy	2008-139	898-0646 A1			1					Pike	
Panther, LLC	Wet Branch Refuse	2009-154	O-3010-08	1							Kanawha	
B&N Coal	Whitgville III	2008-2160	10403		1						Noble	
Oxford	Halls Knob	2005-1385	10400		1						Guernsey	
Frasure Creek Mining	Frasure Creek Mining	2008-239	813-0328			1					Breathitt	
Coyote Coal Company	Joes Creek Surface Mine	2008-805		1							Boone/Kanawha	
North Fork Collieries	Gilmore Surface Mine	2008-1368	919-0067			1					Wolfe	
Hampden Coal	Harrys Br	2008-935	U-5010-08	1								
Apex Mining	Apex Mining	2008-212	898-0814			1					Pike	
Tunnel Ridge,LLC	Tunnel Ridge Prep Plant/Refuse Area	2006-427	O-1009-87	1							Ohio	
McElroy Coal Company	McElroy Refuse Area	2008-563		1							Marshall	
Cambrian Coal Group	Cambrian Coal Group	2008-93	898-0807			1					Pike	
Sands Hill	Big Rock	2006-2247	10396		1						Vinton	
Nowagie Mining Corporation	Hoover Fork Deep Mine	2008-321	U-5007-98	1							Logan	
Sandlick Coal Company	Foresters Creek	2006-66	848-0259			1					Harlan	
FCDC Coal	FCDC Coal	2007-1498	836-0332			1					Floyd	
Appolo Fuels	Fonde-Highwall	2004-2228	3192, 807-0314			1					BELL	
Infinity Energy	Infinity Engergy	2008-918	848-0264			1					Harlan	
Kanawha Eagle	Coalburg5 & Eagle2	2009-15	U-5036-08	1							Boone	
Hillside Mining	Workman Br	2009-189	pending	1								
GTM Energy Partners	GTM Energy Partners	2008-572	P-3829								Jackson	4/17/2009
Emerald Coal Resources, LP	Emerald Coal Resources, LP	1996-61011							1		Greene	
Apex Energy	Apex Energy	2002-1435	898-0603 A2			1					Pike	
Valley Mining		2002-1435	D-1015-12		1						Stark	
Oxford Mining Company LLC	Lafferty Adjacent Area	2003-98	D-2198-1		1						Belmont	
Nally & Hamilton	Nally & Hamilton	2004-1254	848-0206 AM-1			1					HARLAN	
Cloverfork Mining & Excavation	Cloverfork Mining & Excavation	2004-1836	848-0244			1					Harlan	
National Coal	National Coal	2005-854	3188				1				ANDERSON	
Sturgeon Mining	Sturgeon Mining	2006-1053	895-0175			1					Owsley	
Pine Ridge Coal	Hinams Hol Refuse Fill	2006-117	O-69-83	1							Boone	3/11/2009
Hope Coal Co.	Piper Mine	2006-1375								1	Bibb	
Buckeye Ind Mining	Beaver Excav	2006-2001	10388		1						Stark	
Freeport Mining, LLP	Freeport Mining, LLP	2006-2207							1		Greene	
Nally & Hamilton	Nally & Hamilton	2006-2522	807-0348 AM-1			1					BELL	

Paramount Coal	PCCV	2006-5999						1			Dickenson	
Clintwood Elkhorn	CEMC	2006-7163						1			Buchanan	Suspended
EME Homer City Generation L.P.	EME Refuse Disposal Site	2007-1079	32753702						1		Indiana	
Jamieson Construction	Jamieson Construction	2007-1641	900-0047			1					Pulaski	
Nally & Hamilton	Nally & Hamilton	2007-1642	807-0353			1					BELL	
Davis Creek Energy	Area# 4	2007-1767	3217				1				CAMPBELL	
New Yellow Ck. Coal	New Yellow Creek Mine	2007-2162								1	Marion	
DRC Coal	White Oak Surface Mine #1	2007-345	3215				1				Campbell	
Nally & Hamilton	Nally & Hamilton	2007-450	918-0403			1					Whitley	
Consolidated Coal Company	Bailey Mine	2007-463							1		Greene	
Oxford	Garrett	2007-874	App 10411		1						Tuscarawas	
Argus Energy, LLC	Wiley Branch Surface Mine Amendment No. 3	2007-89	S-5039-96	1							Lincoln and Wayne	
B&N Coal	Whigville	2008-106			1							
Nally & Hamilton	Kayjay #5	2008-1175	861-0497			1					KNOX	
Nally & Hamilton	Nally & Hamilton	2008-1178	861-0500			1					KNOX	
M&B Excavating	Thompson South Mine	2008-1313								1	Bibb	
Horizon Resources, LLC	Synergy Surface Mine No. 2	2008-1445		1							Boone	
Consolidated Coal Company	Oak Spring Slope and Supply Yard	2008-1782							1		Washington	
Nally & Hamilton	Nally & Hamilton	2008-1808	807-0354			1					BELL	
B'ham Coal & Coke	Powhatan Mine	2008-1809								1	Jefferson	
A&G Coal	A&G Coal	2008-2130	867-0287			1					HARLAN	
Patriot Mining Company	Wades Run extension	2008-2414		1							Monongalia	
Eastern Associated Coal	Rocklick Branch Refuse Fill	2008-76	S-5020-86	1							Boone	
New Acton Mining	Slate Creek Mine	2008-823								1	Walker	
Clintwood Elkhorn	Clintwood Elkhorn	2009-182	898-0815			1					Pike	
Chevron Mining	North River R-34	2009-232								1	Fayette	
Frasure Creek Mining	Frasure Creek Mining	2009-237	836-0326			1					Floyd	
Travis Creek Mining	Trafford Mine	2009-275								1	Blount	
Coresco Overland Conveyor Belt	Coresco, LLC	2009-288		1					1		Monongalia & Greene	
Black Warrior Minerals	Manchester East	2009-323								1	Walker	
Miller Bros. Coal	Bear Hollow Mine	2009-341	858-0223 A1			1					Johnson	
Leeco, Inc.	Leeco, Inc.	2009-344	897-5113			1					Perry	
Miller Bros. Coal	Miller Bros. Coal	2009-368	836-0362			1					Floyd	
Enterprise Mining	Trace Fork Surface Mine	2009-422	860-0448 A4			1					Knott	
National Coal of AL	L. Massey North	2009-443								1	Marion	
Twin Pines Coal Co.	Lick Creek Mine	2009-467								1	Shelby	
Reed Minerals Inc.	No. 5 Mine	2009-470								1	Walker	
Aldwych, LLC	Four Oaks Mine #2	2009-572								1	Lamar	
Lone Mountain Processing	Prep Plant	2009-576						1			Lee	
ICG Knott Co	Lige Hollow Amburgy Mine	2009-75	860-5324			1					Knott	
Paramount Coal	Dry Fork	2009-815						1			Wise	
Frasure Creek Mining	Frasure Creek Mining	2009-95	897-0500			1					Perry	
Frasure Creek Mining	Frasure Creek Mining	pending	877-0184			1					Magoffin	
Hope Coal Co.	Trey Mine									1	Jefferson	
Patrick Processing	Patrick Processing	2008-651	898-4313 R1			1					Pike	
Miller Bros. Coal	Miller Bros. Coal	pending	836-0338 A3			1					Floyd	
Cambrian Coal	Cambrian Coal Group	pending TAC	898-0819			1					Pike	
Buckeye	Freed Road	2007-17			1						Stark	2/10/2009
Premier Elkhorn		2004-1557	898-0365 Am4			1						
Catenary Coal Co	Moccasin Hollow	2006-2278		1							Kanawha	
Mid Vol	Paradise	2008-828	S-4009-06	1							McDowell	
National Coal of AL	Kansas Mine No. 2	2009-318								1	Walker	5/8/2009
National Coal of AL	L. Massey South	2009-416								1	Marion & Fayette	4/29/2009

																				INITIALLY PROPOSED								
7/28/2014	District	Permit Number	SMCRA Number	Applicant name	Project Name	NWP Type	Coordinate PN/PCN (Date or NYC[2])	New or expansion (N/E)	Remining (Y/N)	WV	OH	KY	TN	VA	PA	AL	County	401[1]	402[1]	Coal E1traction (million tons)	Valley fills (#)	Total stream impacts (linear feet)	Per. stream impacts	Int. stream impacts	Eph. stream impacts	Wetland impacts (acreage)	Stream mitigation (linear distance)	Wetland mitigation (acreage)
CEQ	LRH	2003-238	S-3025-00	Alex Energy	Republic No.1		1/8/2009	N	No	1							Kanawha	P	P	11.9 mil	4	10435	0	9,541	894	0	14,979	0
CEQ	LRH	2004-1400		Central Appaliachian Mining	Big Branch		7/18/2005	N	Yes			1					Pike	I	E		8	21790	0	18,874	2,916	0	14,346**	0
CEQ	LRH	2005-1057	10361	Jeffco Resources	North Barnesville		incomplete	N	No		1						Belmont	I	I	1.6 million	none	11260	4,670	5,710	880	0.07	10,280	0.11
CEQ	LRH	2005-478	D-2226-2	Kimble Clay & Limestone	Hunt		3/1/2007	N	No		1						Tuscarawas	I	I			24299	8,984	14,722	593	4.16	23,845	7.07
CEQ	LRH	2006-2294	S-5018-06	CONSOL of Ky	Peg Fork		4/24/2008	N	No	1							Mingo	I	I	No Info		22031	5,853	10,175	6,003	0	32,094	0
CEQ	LRH	2006-663 / 2007-99	S-5015-06	Highland Minging	Reylas		9/14/2007	N	No	1							Logan	I	I			13,154	2,300	7,426	3,428	0	19,420	0
		2000-2339	3064	Premium Coal	Refuse Area#3	21	3/13/2008	N	Y				1				ANDERSON	I	I		0							
	LRH	2001-407	D-2114	Sand Hill Coal Co	Big Valley Mine		2/14/2008	E	No		1						Vinton	I	I	6.6 million	none	10052	0	8,128	1,924	0	10,052	0.09
		2002-1455		Valley Mining	Sandy Creek	NWP		N	Y		1										0	465		209	256	2.27	356	3.4
	LRH	2003-468	858-5063	CONCO	Mill Creek Mine		6/1/2007	N	No			1					Johnson	I	E	250K	1	1,350	0	630	720	0	4,394	0
	LRH	2003-794	U-4002-02	Bluestone Coal	Deep Mine 65	50	4/8/2008	N	No	1							Wyoming		I		1	1,616	0	944	672	0	3,388	0
	LRP	2003-853	D-0360	Ohio Valley Coal	No.2 Slurry Exp.	50	NYC	E	N		1						Belmont	P	P			3889.00		2636.00	1253.00	0.12	3889.00	0.12
		2004-1589		Buckeye Industrial Mineral	Mapleton	NWP		N	Y												0	5499		549		0.85	147	1.28
ourse of Busines	NAO	2004-1860		Clintwood Elkhorn	CEMC	50	4/6/2009	N						1			Buchanan	I	I		1	1270		1270		0	1270	0
	LRP	2004-396	D-2266-1	Oxford Mining Company LLC	Dagrava Area	21	3/30/2009	E	Y		1						Belmont	I	I		NO	1536.00	1293.00	243.00		0.05	*1536	
	LRN	2005-11	67-0455 AM-	A&G Coal	A&G Coal	21	6/27/2008	E	Y			1					LETCHER	P	P		1	6,300	4000	2,300	0	0	6300	0
	LRP	2005-2160		Consolidated Coal Company	Consolidated Coal Company			E	N						1		Greene	I	I			34.00		34.00			150.00	
	LRP	2005-2461		Consolidated Coal Company	Wilson Hollow		15-Oct-06	N		1							Monongalia	I	I			14386.00		5449.00	8937.00	0.09	7100.00	
	LRN	2006-2131	-9004, AM-1,	Cumberland River Coal	Cumberland River Coal		11/10/2008	E	Y			1					LETCHER	I	I		0	1,962	1962	0	0	0.33	2382	0.66
	LRH	2006-2394	S-3007-95-AM1	Maple Coal Co	Sycamore North		7/6/2007	N	Yes	1							Kanawha - Fayette	I	I			14,015	0	13,486	529	0	13,419	0

	LRH	2006-483	10394	Buckeye	Hamilton	21	5/27/2008	N	N		1						Stark	P				0	0	0	0	1.17	0	1.9
	NAO	2006-6158		Jewell Smokeless	JSCC	21	3/31/2009	N						1			Dickenson	I	I		4	9546	7182	1474	890	0		
	LRN	2006-917	807-0344	Gatliff Coal	Jamieson Construction	21	3/23/2007	N	Y			1					BELL	I	I		2	1739	0	1069	670	0	946	0
	LRN	2006-928	848-0261	D&C Mining	D&C Mining	21	6/23/2008	N	Y			1					HARLAN	I	I		2							
	LRH	2007-1101	D-2327	Kimble Clay Limestone	Harmon Hill	21	1/20/2009	E	N		1						Tuscarawas			229000		1482	0	1000	482	0	1,482	0
	LRH	2007-1161	U-3008-08	Appalachian Fuels	Big Creek	50	2/17/2009	N	No	1							Fayette	P	P		0	350	350	0	0	0	1,050	0
		2007-1161	U-3008-08	Appalachian Fuels	Eagle2	50	2/17/2009			1																		
	LRL	2007-1645	867-0471	Sapphire Coal	Sapphire Coal	21	10/21/2008	N	Y			1					Letcher	I	P		1	1,298	0	1141	157	0	1,015	
	LRH	2007-284	S-5023-01	Load-Out	Locust Fork		5/16/2008	N	No	1							Boone	P	P	5.75 mil	4	19,463	0	16,491	2,924	0	20,232	0
	LRP	2007-323	D-2180-1	Ohio American Energy	Salt Run North	21	NYC	E	Y		1						Jefferson	P	P			3185.00		3185.00		0.62	3185.00	0.62
	LRL	2007-334	866-0281 A 8	ICG Hazard	ICG Hazard		4/4/2007	E	N			1					Leslie	I	I									
	NAO	2007-3433		Black Diamond	Norton Coal	21	NYC	N						1			Buchanan	I	P		2	1735	0	800	935			
	LRH	2007-347	U-5001-07	Eastern Associated Coal	Pond Fork #2 Gas Deep Mine	50	8/4/2008	N	No	1							Boone	P	Y		0	54	0	54	0	0.258	0	0
	LRL	2007-439	866-0304	Nally & Hamilton	Nally & Hamilton		5/30/2008	N	Y			1					Leslie	I	P		6	10254 (1037.2)	0	10,254	0	0	3254 (1741.5	0
	LRH	2007-488	U-5017-08	Powdermill Processing	Stone1 U/G Mine,PrepPlant, Refuse Fill		5/2/2008	N	No	1							Wayne	P	P	2.2 Mil	1	6441	263	6,141	300	1	10,600	1
	LRN	2007-946	861-0485	Nally & Hamilton	Nally & Hamilton	21	12/17/2007	N	Y			1					KNOX	I	I		2	4719	0	1513	2206	0	3,064	0
	LRH	2007-961	U-3008-07	Atlantic Leaseco	Peerless #1	50	4/8/2008	N	N	1							Nicholas	I	I		0	155	0	155				
	LRL	2008-1361	898-4295 R9	CAM Mining	CAM Mining	50	12/10/2008	E	N			1					Pike	Y	Y	500,000	0	125	125	0	0	0	**0	0
	LRL	2008-1457	680-5012	Martin County C	Martin County	21****	12/23/2008	E	Y			1					Martin	I	I		1	969 (252.4)	0	867	102	0	296* (375.4)	0
	LRL	2008-1458	880-8018	Martin County C	Martin County	21****	12/23/2008	E	Y			1					Martin	I	I		2	3033 (1846.4	0	1545	1488	0	470 * (2042)	0
	LRL	2008-1459	880-5147	Martin County C	Martin County	21****	12/23/2008	E	Y			1					Martin	I	I		2	2455 (742.6)	0	1540	915	0	868 * (941.9)	0
	LRL	2008-666	867-0446 A1	ICG Hazard	ICG Hazard	21	3/2/2009	E	Y			1					Perry	I	I		1	1131 (645)	0	816	315	0	249 *(923)	0
		2008-69		Paramount Coal	PCCV	21	NYC	N						1			Dickenson	I	I		2	5980	2450	2350	1180	0	2720	0
	LRH	2008-801		Pocahontas Coal Co	East Gulf Complex	21	10/10/2008			1																		
	LRH	2008-995	S-3015-08	Pocahontas Coal Co	Beckley Highwall #2	21				1							Raleigh											
	LRL	2009-198	897-0498	Pine Branch C	Pine Branch C	50	3/2/2009	N	Y			1					Perry	I	I	2,000,000	1	2,880	2125	755	0	0	**660	0
	LRP	2009-293		Consolidated Coal Company	Loverridge Mine #22	50	NYC	N	N	1							Marion	P	P			1200.00		1200.00				
	LRL	2009-577		Knox Creek Coal		21	NYC	N						1			Buchanan	I	P		3	2858	0	2418	440			
	LRL	2003-1276	897-0430 A1	Candle Ridge Mining	Candle Ridge Mining		4/12/2004	E				1					Perry											
	LRH	2004-624		Independence Coal Company	Consitution Surface Mine		7/15/2004	New	No	1							Boone	I	I	18 Mil	7	30925	0	21129	9796	0	37,005	0
	LRN	2004-609	3112	Appolo Fuels	Jellico Strip	21/ATF	9/21/2004	E	Y				1				CLAIBORNE	E/P	I			11,075		11,075		0	17,155	0
	LRN	2004-1391	861-0467	CH Development	CH Development	21	9/30/2004	N	Y			1					KNOX				0	5540	4853	687	0	0	5650	0
	LRH	2005-217	S-4014-01	Bluestone	ContourAuger1		4/13/2005	N	No	1							Wyoming	P	I	5.4 Mil	9	17300	0	6,100	11,200	0	Not yet submitted	0
	LRH	2005-1115		Green Valley Coal Company	Blue Branch Refuse		11/4/2005	Expansion	No	1							Nicholas	I	I			8022	7962	60	0	0.966	12,201	2.948

	LRH	2005-1198	S-5008-02 S-5021-01	Marrowbone Development	Taywood W & Marrowbone		11/7/2005	E	Y	1							Mingo	P	P	7.6 Mil	12	25415	0	20,347	5,068	0	Not yet submitted	0
	LRH	2005-934	898-5694 Am5	Premier Elkhorn	U/T Old Beefhide		1/6/2006	Y	Y			1																
	LRH	2004-336	898-0715	Bear Fork	Bear Fork S.M		1/9/2006	Y	Y			1																
	LRH	2005-421	D-2295	Oxford	Peabody 3		3/3/2006	E	No		1						Coshocton/Muskingum/Guernsey	P	P			6033				0.41	6033	0.62
	LRH	2004-1451		Independence Coal Company	Glory Surface Mine		3/10/2006	Expansion	No	1							Boone	I	I	14.3 Mil	4	22681	0	17436	5245	0	30,794	0
	LRH	2006-127	860-5260 Am1	Consol of KY	Slone Br Mine		3/15/2006	E	No			1						W										
	LRH	2006-126	860-0390 Am4	Consol of KY	Area 80		3/16/2006	E	No			1					Knott	W	I		1	2188	0	639	1549	0	2,600	0
	LRH	2004-1155	S-2001-05	Brooks Run Mining	Brandy St & Cove Mtn		3/22/2006	N	No	1							Webster		P									
	LRH	2003-65	S-5027-99	Hobet Mining	Hewett		5/1/2006			1							Boone											
	LRL	2005-1893	895-0171	Sturgeon Mining	Sturgeon Mining		6/30/2006	N	?			1					Owsley	P	P	?	5	20462	0	16,328	4134	0	11,181	0
	LRL	2006-756	897-0457 A2	ICG Hazard	ICG Hazard		6/30/2006	E	Y			1					Perry	I	I		5	8864	0	6,241	2623	0	10,840	0
	LRL		897-0457 A2	ICG Hazard	ICG Hazard		6/30/2006	E	Y			1					Perry	I	I		5	8864	0	6,241	2623	0	10,840	0
	LRH	2006-821	U-3001-98 IBR5	Catenary Coal Co.	Laurel Fork		8/21/2006	E	No	1							Kanawha											
	LRH	2005-167	U-3004-06	Catenary Coal Co.	Tenmile Fork Deep Mine		8/24/2006	N	No	1							Kanawha	I	P	7 Mil	1	0	0	0	0	0.6	0	Not yet submitted
	LRN	2004-1108	918-0392	Ikerd Coal	Ikerd Coal		8/25/2006	E	N			1					Whitley	I			3	5219	0	1675	3544	0	7064	0
	LRN	2006-1647	807-0342	Nally & Hamilton	Nally & Hamilton		10/24/2006	N				1					Bell	I			2	8828	5117	3,711	0	0	10,970	0
	LRL	2006-1290	877-0167, 877-0168	Licking River Resources	Licking River Resources		12/5/2006	N	?			1					Magoffin	P	P		8	7185	0	4,005	3180	0	5,966	0
	LRL	2007-69	898-0803	CAM Mining	Cane Branch		2/7/2007	N	N			1					Pike	I	I		2	4955	0	3,533	1422	0	2313**	0
	LRL	2006-1124	836-5488, 836-0317	Matt/Co	Matt/Co		2/14/2007	E	Y			1					Floyd	E			2	1790	0	1,490	300	0	2,125	0
	LRH	2004-1152		Buckingham Coal	Buckingham Wash Plant		2/26/2007	N	No		1						Perry	I	I			5824	0	4,263	1561	0	5065***	0
	LRL	2007-193	898-0400	Premier Elkhorn Coal	Premier Elkhorn Coal		3/14/2007	E	Y			1					Pike	P			3	3500	0	1,610	1890	0	12,719	
	LRH	2006-2405	U-5004-06	Laurel Cr Coal	#7	21	4/9/2007			1																		
	LRL	2007-217	897-0480	Leeco, Inc.	Stacy Branch Surface Mine		4/17/2007	E	N			1					Perry	I			6	22194	0	7,816	14378	0	21292	0
	LRL	2007-335	898-0607	Apex Energy	Apex Energy		5/2/2007	N	?			1					Pike	I	P	?	4	7123	615	2,159	4349	0	8,709	0
	LRH	2005-1275	10397	Oxford	Mizer		5/7/2007	N	No		1						Tuscarawas	I	I	430,000	none	4640	0	3,164	1476	0	3478	0
	LRL	2006-1296	898-4150 A1	Clintwood Elkhorn	Clintwood Elkhorn		5/7/2007	E	?			1					Pike	P	P		2	5258	3506		1752	0	**1,714	0
	LRL	2007-401	895-0177	Candle Ridge Mining	Candle Ridge Mining		5/8/2007	N	Y			1					Owsley	I	P		2	6166	4696	1,205	265	0	1,551	0
	LRL	2007-393	867-0456	Consol of KY	Razorblade Surface Mine		5/9/2007	N	N			1					Letcher	P	P		1	1490	0	1,198	292	0	1276	0
Of Interest	NAO	2007-1351		A&G Coal Corp	Ison Rock Ridge	21	5/31/2007	N						1			Wise	I	P	Y	14	14,640		14,640			10,790	
	LRH	2007-282	U-4012-06	Pioneer Fuel	Little Eagle		6/7/2007	N	No	1							Wyoming	I	I	7.7 Mil	1	954	954	0	0	0	1964	0
	LRN	2005-1691	3191	Appolo Fuels	Buckeye Springs Mine 2	21	6/25/2007	E	Y				1				CLAIBORNE	I	I		na	3,190	510	2,030	650	0	4,197	0
	LRL	2007-669	836-0338	Miller Bros. Coal	Miller Bros. Coal		7/13/2007	E	?			1					Floyd	Y	Y	410,372	1	850	0	530	320	0	**752	0
	LRL	2007-706	858-0206	Johnson Floyd Coal	Johnson Floyd Coal		7/19/2007	N	?			1					Johnson	I	P	?	3	6628	0	4,408	2220	0	9,300	0
	LRL	2007-400	864-0195	Argus Energy	Argus Engergy		8/15/2007	N	Y			1					Lawrence	I	P		10	24419	0	9,912	14507	0	**24,320	0
	LRL	2007-867	898-0779	CAM Mining	CAM Mining		8/15/2007	E	?			1					Pike	I	P	?	2	3293	0	2,526	767	0	**3123	0

	LRL	2007-1044	898-0712	Apex Energy	Apex Energy		8/28/2007	N	N			1					Pike	I	P	1,300,000	3	2296	0	0	2296	0	2,323	0
	LRH	2006-484		Buckeye Ind Mining	Wilson		8/31/2007				1																	
	LRL	2007-1104	836-0292 A1	The Raven Co.	The Raven Co.		9/2/2007	E	N			1					Floyd	I	I	436,400	1	1390	0	1,230	160	0	**2635	0
	LRL	2007-595	860-0455	Leeco, Inc.	E k Lick		9/4/2007	E	Y			1					Knott	I	I		6	21961	4942	10,612	6407	0	11489**	0
	LRL	2007-594	898-0800	Premier Elkhorn Coal	Premier Elkhorn Coal		9/7/2007	N	Y			1					Pike	I	I		6	6845	0	835	6010	0	5,615	0
	LRL	2007-1132	836-0349	Miller Bros. Coal	Frasure Branch Mine		9/21/2007	N	N			1					Floyd	I			2	5542	0	2,593	2949	0	5113**	0
	LRL	2005-851	867-0440	Cheyenne Resources	Cheyenne Resources		9/24/2007	E	N			1					Letcher	I	I		4	11030	0	9,230	1800	0	3662**	0
	LRL	2007-1224	860-5304	Miller Bros. Coal	Miller Bros. Coal		10/29/2007	N	Y			1					Knott	I	P		1	7971	1300	3,581	3090	0	7148**	0
	LRL	2007-1131	836-0335 A2	Miller Bros. Coal	Miller Bros. Coal		11/8/2007	E	N			1					Floyd	I	I		2	4825	0	4,196	629	0	2797**	0
	LRL	2007-1230	860-8012	ICG Knott Co.	ICG Knott Co.		11/27/2007	E	?			1					Knott	P	P	?	0	3364	56	273	3035	0	3,930	
	LRL	2007-1190	897-0355 A3	Pine Branch Coal	Pine Branch Coal		11/28/2007	E	Y			1					Perry	P			2	3865	1240	530	2095	0	11274	0
	LRL	2007-1445	836-0339	FCDC	FCDC		11/29/2007	N	Y			1					Floyd	I	I	2,400,000	8	9848	75	4,133	5640	0	**6500	0
	LRL	2007-815	877-0176	Licking River Resources	Licking River Resources	NW21(IP withdrawn)	11/29/2007	N	Y			1					Magoffin	P	P	1,200,000	3	3,535	0	2,870	665	0	1,249	0
	LRL	2007-1205	836-0307	Matt/Co	Matt/Co		12/5/2007	E	N			1					Floyd	I	P	700,000	2	4080	0	2,290	1790	0	4,545	0
	LRL	2007-1515	897-0456 A1	ICG Hazard	ICG Hazard		12/5/2007	E	?			1					Perry	P	P	?	4	9905	0	5,886	4019	0	7,059	0
	LRL	2007-1518	898-0799	Clintwood Elkhorn	Clintwood Elkhorn		12/5/2007	N	?			1					Pike	P	P	?	6	15,731	6533	6,886	2312	0	4,205	0
	LRL	2007-1026	836-0341 A1	Frasure Creek Mining	Frasure Creek Mining		12/13/2007	E	Y			1					Floyd	P	I		1	270	0	270	0	0	3,590	0
	LRH	2007-1021	10372	Oxford Mining	Page S.M.	21	12/17/2007				1																	
	LRL	2007-1582	813-0319	Miller Bros. Coal	Miller Bros. Coal		12/28/2007	N	N			1					Breathitt	I	P	5,100,000	12	19589	0	16,685	2904	0	**13899	0
		2007-733	880-5071	Martin County Coal	Martin County Coal		12/28/2007	E	Y			1					Martin											
	LRL	2007-1504	898-0783 A3	CAM Mining	CAM Mining		1/16/2008	E	Y			1					Pike	I	I		1	1976	0	352	1624	0	1682**	0
	LRH	2006-2033	S-3016-06	Wildcat	#2 Surface		3/5/2008	N	Y	1							Kanawha		I									
	LRL	2007-1644	877-0166	Consol of KY	Consol of KY		3/12/2008	E	?			1					Magoffin	P	P	?	1	3297	2112	810	375	0	**2084	0
	LRH	2007-286	S-3010-06	Pioneer Fuel	MT5B		3/12/2008	Y	Y	1							Raleigh		I									
	LRL	2008-95	898-0817	Premier Elkhorn Coal	Premier Elkhorn Coal		3/12/2008	N	?			1					Pike	P	P	?	2	5275	0	3,031	2244	0	747	0
	LRN	2002-1435	3064	Premium Coal	Refuse Area#3	21	3/13/2008	N	Y				1				ANDERSON	I	I		0							
	LRH	2003-995	S-4013-01	Bluestone Coal	Pocahontas #11	21	3/31/2008		No	1							McDowell											
	LRL	2008-138	807-0352	Chas Coal	Chas Coal		3/31/2008	N	?			1					Bell	P	P	?	6	10724	0	7,664	3060	0	5,792	0
		2009-382	8502	Tennessee Land Reclamation Section	Cherry Branch Reclamation Project	37	4/8/2008	N	N				1				Sequatchie			0	0	0	0	0	0	0	0	0
	LRL	2008-114	897-0445 A1	BDCC Holdings	Cherries Branch		4/9/2008	E	Y			1					Perry	P			4	13166	0	7,955	5211	0	12765**	0
	LRL	2008-115	836-0356	Wolverine Resources	Jake Fork and Stoney Branch Surface Mine		4/17/2008	N	N			1					Floyd	P	P		7	14600	0	10,723	3877	0	4859**	0
	LRL	2008-226	880-8002 A4	Czar Coal	Czar Coal		4/22/2008	E	Y			1					Martin	I			1	2012	0	1,593	419	0.69	154**	1.38
	LRH	2004-867	S-45014-04	Central Appal Mining	Remining #3	49	4/30/2008		YES	1							Mingo											
	LRL	2007-1660	880-0066	Martin County Coal	Findlay Branch Mine		5/12/2008	E	Y			1					Martin	I	I		4	10695	0	7,935	2760	0	15602	0
	LRL	2008-408	880-0156	Czar Coal	Czar Coal		5/14/2008	Y	N			1					Martin	Y	Y	1,800,000	3	8107	0	5,743	2364	0	6,187	0
	LRL	2007-1301	836-0335	CAM Mining	Tom's Branch Surface Mine		5/15/2008	E	N			1					Floyd	P			1	10030	2340	1,690	6000	0	17540**	0
	LRN	2004-62	3143	Premium Coal	Area 19		5/30/2008	N	Y				1				ANDERSON	I	I		0							
	LRL	2007-1206	877-0782	Frasure Creek Mining	Frasure Creek Mining		7/8/2008	?	?			1					Magoffin	P	P	?	6	8275	0	8,275	0	0	10,984	

	LRL	2007-1406	860-0462	ICG Hazard	Bearville North		7/8/2008	N	N			1					Knott	P			3	14960	0	8,769	6191	0	24868**	0
	LRH	2005-1211		Premium Energy, Inc.	Premium Mills Surface Mine		7/9/2008	New	No	1							McDowell	P	P		8	46071	0	40952	5757	0	NYS	0
	LRH	2008-75	O-5023-07	Eastern Associated Coal	Huff Creek Haul Road	21	7/11/2008	N	No	1							Wyoming - Boone - Logan	I	I	NA	2	2,173	0	2,173	0	0	0	0
	LRL	2008-654	860-0464	Enterprise Mining	Enterprise Mining		7/29/2008	N	?			1					Knott	P	P	?	2	12204	0	9,260	2944	0	10,350	0
	LRL	2008-777	897-0455 A3	ICG Hazard	ICG Hazard		7/31/2008	E	?			1					Perry	P	P	?	1	4236	0	2,632	1604	0	**481	0
	LRL	2008-781	836-0348	Wolverine Resources	Wolverine Resources		7/31/2008	N	?			1					Floyd	P	P	?	5	14320	4567	7,466	2287	0	**10331	0
	LRH	2007-285		Alex Energy, Inc.	Lonestar Surface Mine		8/6/2008	New	No	1							Nicholas	P	P	4 Mil	2	12655	1247	7709	3169	0	26,397	0
	LRH	2007-182		Alex Energy, Inc.	Federal Surface Mine		8/19/2008	New	No	1							Nicholas	P	P	2.1 Mil	5	22733	0	17493	5240	0	36216	0.34
	LRH	2006-2196	S-5002-01-AM1	Highland Minging	Georges Crk Surf Mine	21	9/5/2008	E	No	1							Logan	I	I		1	4,220	0	3,358	862	0	9,850	0
	LRH	2003-65	S-5002-07	Hobet Mining	Surface Mine No. 45		9/10/2008	New	No	1							Lincoln	P	P	2.1 Mil	0	32084	215	26507	5362	0	47,224	0
	LRH	2008-830	S-5006-07	CoalMac, Inc.	Pine Creek Surface Min		9/15/2008	New	No	1							Logan	I	I	2.86 Mil	3	14530	0	12922	1608	0	63,701	
	LRH	2008-562		Eastern Associated Coals	Huff Creek Surface Mine		9/22/2008	New	No	1							Wyoming/Logan	P	P	2.1 Mil	4	23733	0	10619	13114	0	NYS	0
	LRP	2006-660	10395	Ohio American Energy	Red Bird South		9/30/2008	N	Y		1						Belmont	P	P			2633				5.40		
	LRN	2007-820	807-0355	Nally & Hamilton	Nally & Hamilton	21	10/8/2008	N	Y			1					BELL	P	P		4	2218	0	2218	0	0	2235	
	LRL	2007-1397	836-0350	FCDC	FCDC		10/20/2008	N	?			1					Floyd	P	P	?	3	4070	0	2,940	1130	0	**2527	0
	LRH	2008-114	U-3016-95	Performance Coal Company	Upper Big Branch Deep Mine	50	12/3/2008	E	No	1							Raleigh	I	I		0	1,200	0	1,200	0	0	1,200	0
Of Interest	LRH	2008-491		CONSOL of Energy	Buffalo Mt. Surface Mine		12/3/2008	New	Yes	1							Mingo	P	P	16.8	13	52014	19582	24884	7548	0	NYS	
	LRL	2008-525	877-0191	Middle Fork Dev.	Middle Fork Dev.		1/8/2009	N	N			1					Magoffin	P	P		6	6308	0	5,308	1000	0	9607	0
	LRH	2006-2256	10379	Oxford Mining	Horn	21	1/15/2009	N	No		1						Tuscarawas					341	0	341	0	0	341	0
	LRH	2005-753	D-2290-1	Oxford Mining	Long Sears Adj	21	1/16/2009	E	N		1						Noble			500,000		2602	249	2135	218	0.17	3,191	2.4
	LRH	2007-708	10391	Surface Mining Inc	Young Property	21	1/20/2009	N	N		1						Tuscarawas			375000		1029	885	28	116	0.22	885	0.33
Course of Business	LRH	2006-2290	S-7-81	Colony Bay Coal Co.	Colony Bay Surface Mine		1/23/2009		No	1							Boone	P	P	1.7 Mil	4	7739	0	5991	1748	0	15,394	
	LRH	2007-499	10405	Oxford Mining	Kaiser Mathias	49	1/26/2009	N	Y		1						Tuscarawas			1,320,000		2352	0	0	0	0.98	2,352	1.47
	LRH		S-5018-08	Frasure Creek Mining	Spring Fork Surface Mine NO. 2		1/26/2009	New	No	1							Mingo	P	P	5.9 Mil	2	16313	0	14867	1446	0	21,708	0
	LRP	2009-286		McElroy Coal Company	5 North # 11Bleeder Shaft	50	2/2/2009	N		1							Marshall	P	P			1150.00		1150.00			1150.00	

	LRH	2005-370	S-5009-00	ICG Eastern, LLC	Jenny Creek Surface Mine		2/5/2009	Expansior	No	1							Mingo	P	I									
	LRH			Argus Energy WV, LLC	Devilstrace No. 2 Punchout	50	2/6/2009	N	N	1							Wayne	P	P	0	540	0	540	0	0	NYS	0	
	LRH			Consol of Kentucky	Spring Branch No. 3 Deep Mine	50	2/6/2009	N	N	1							Mingo	P	P	0	3636	0	3636	0	0	3,636	0	
	LRP	2007-1180	10399	Oxford Mining Company LLC	Ellis Area		2/10/2009	N	Y		1						Jefferson	P	P			11816	1314.00	10074.00	428.00	0.03		
	LRL	2008-727	813-0310 A1	Miller Bros. Coal	Miller Bros. Coal		2/27/2009	E	?			1					Breathitt	P	P	?	5	9397	2534	4,637	2226	0	**9061	0
	LRL	2008-139	898-0646 A1	Apex Energy	Apex Energy	21	3/2/2009	E	Y			1					Pike	I	P	859,000	2	1,842	0	1,542	300	0	1,515	0
	LRH	2009-154	O-3010-08	Panther, LLC	Wet Branch Refuse	21	3/11/2009	N	N	1							Kanawha	P	P	0	3979	0	3610	369	0	6,515	0	
	LRH	2008-2160	10403	B&N Coal	Whigville III	21	3/19/2009	E	N		1						Noble			400000		8702	0	7010	1692	0	2,900	0
	LRH	2005-1385	10400	Oxford	Halls Knob		3/20/2009	N			1						Guernsey	P	P			9306	214	6,269	2823	0.183	5679	0.48
	LRL	2008-239	813-0328	Frasure Creek Mining	Frasure Creek Mining		3/20/2009	E	Y			1					Breathitt	P	P		6	14005	0	7,094	6911	0	10518**	0
	LRH	2008-805		Coyote Coal Company	Joes Creek Surface Mine	49	3/20/2009	N	Y	1							Boone/Kanawha	P	P							43,839		
	LRL	2008-1368	919-0067	North Fork Collieries	Gilmore Surface Mine	21	3/23/2009	N	N			1					Wolfe	I	P		0	1980	0	880	1100	0	3,567	0
	LRH	2008-935	U-5010-08	Hampden Coal	Harrys Br	50	3/30/2009		No	1											0	1611	0	1382	229	0	2,603	0
	LRL	2008-212	898-0814	Apex Mining	Apex Mining	21	4/8/2009	E	Y			1					Pike	P	P									
	LRP	2006-427	O-1009-87	Tunnel Ridge,LLC	Tunnel Ridge Prep Plant/Refuse Area		4/10/2009	E	N	1							Ohio	P	P		1	15352		15009	343	2	14642	
	LRP	2008-563		McElroy Coal Company	McElroy Refuse Area		4/10/2009	E	N	1							Marshall	P	P		1	14384		9107	5277		0.01	
	LRL	2008-93	898-0807	Cambrian Coal Group	Cambrian Coal Group	21	4/13/2009	N	N			1					Pike	I	I	1,115,864	1	2,713	0	2,019	694	0	**489	0
	LRH	2006-2247	10396	Sands Hill	Big Rock	49	4/16/2009	N	Y		1						Vinton			1,900,000		7664	0	6725	939	4.06		
	LRH	2008-321	U-5007-98	Newagle Mining Corporation	Hoover Fork Deep Mine	50	4/21/2009	N	N	1							Logan	P	P	2	2672	357	2315	0	0	3,672	0	
	LRN	2006-66	848-0259	Sandlick Coal Company	Foresters Creek	49	5/6/2009	E	Y			1					Harlan	P	P		1	926		926				
	LRL	2007-1498	836-0332	FCDC Coal	FCDC Coal		11/15/2009	N	Y			1					Floyd	I	P	2,977,945	4	5255	0	4,055	1200	0	7,050	0
	LRN	2004-2228	192, 807-031	Appolo Fuels	Fonde-Highwall	21	5/03/2006	E	Y			1					BELL	I	I		na	1,162	40	1122	0	0	1845	0
	LRL	2008-918	848-0264	Infinity Energy	Infinity Engergy	pending NW 21	C&D					1					Harlan											
	LRH	2009-15	U-5036-08	Kanawha Eagle	Coa burg5 & Eagle2	50	incomplete		N	1							Boone			42 Mil		2380	0	1,080	1300	0	CMP incomplete	
	LRH	2009-189	pending	Hillside Mining	Workman Br	50	incomplete			1																		
	LRN	2008-572	P-3829	GTM Energy Partners	GTM Energy Partners	14	n/a	E	N								Jackson	I	I	0	0	100	0	100	0	0	0	0
	LRP	1996-61011		Emerald Coal Resources, LP	Emerald Coal Resources, LP		NYC								1		Greene	P	P		1	3600	3600			0.13		
	LRL	2002-1435	898-0603 A2	Apex Energy	Apex Energy		NYC	E				1					Pike											
	LRH	2002-1435	D-1015-12	Valley Mining		21	NYC	N	N		1						Stark					465	0	465	0	2.27	465	3.4
		2003-1415	898-0603 A2	Apex Energy	Apex Energy		NYC	E				1					Pike											
	LRP	2003-98	D-2198-1	Oxford Mining Company LLC	Lafferty Adjacent Area		NYC	E	Y		1						Belmont	P	P			4997	3665		1332	1.10	*4997	1.65
	LRN	2004-1254	48-0206 AM-	Nally & Hamilton	Nally & Hamilton	21	NYC	E				1					HARLAN				3	1,814	0	1,814	0	0	596	0
	LRN	2004-1836	848-0244	Cloverfork Mining & Excavation	Cloverfork Mining & Excavation		NYC	n	Y			1					Harlan				9	14508	0	150	13358	0	21595	0
	LRN	2005-854	3188	National Coal	National Coal	21	NYC	N					1				ANDERSON	I	I							0.14		0.73
	LRL	2006-1053	895-0175	Strugeon Mining	Sturgeon Mining	withdrawn	NYC	N	?			1					Owsley	I	I	?	0	3,165	0	3,165	0	0	7,033	0

	LRH	2006-117	O-69-83	Pine Ridge Coal	Hiriams Hol Refuse Fill		NYC	N	No	1							Boone	P	P	None	1	2320	0	2,320	0	0	949	0
	SAM	2006-1375		Hope Coal Co.	Piper Mine	21	NYC	N								1	B bb				NA	832	NA	150	682	0		
	LRH	2006-2001	10388	Buckeye Ind Mining	Beaver Excav	21	NYC				1						Stark					1496	0	1,496	0	0	1496	0
	LRP	2006-2207		Freeport Mining, LLP	Freeport Mining, LLP		NYC	N	N						1		Greene	P	P		N	3000	555	1300	1125	5.91	1207	11.88
	LRN	2006-2522	07-0348 AM-	Nally & Hamilton	Nally & Hamilton	21	NYC	E	y			1					BELL				1	3,630	350	3,280	0	0		
	NAO	2006-5999		Paramount Coal	PCCV	21	NYC	N						1			Dickenson	I	I		2	5980	2450	2350	1180	0	2720	0
	NAO	2006-7163		Clintwood Elkhorn	CEMC	21	NYC	E						1			Buchanan	I			1	5350		3900	1450		5350	0
	LRP	2007-1079	32753702	EME Homer City Generation L.P.	EME Refuse Disposal Site	50	NYC	E	N						1		Indiana	P	P		1	1,552	1210		342	0.067		
	LRN	2007-1641	900-0047	Jamieson Construction	Jamieson Construction		NYC	N	N			1					Pulaski				1	814	0	814	0	0		0
	LRN	2007-1642	807-0353	Nally & Hamilton	Nally & Hamilton	21	NYC	N				1					BELL				1	11,591	0	11,591	0	0	10,851	0
	LRN	2007-1767	3217	Davis Creek Energy	Area# 4	21	NYC	N	Y				1				CAMPBELL	P	P		0	285		285		0.5	742	10.1
	SAM	2007-2162		New Yellow Ck. Coal	New Yellow Creek Mine	21	NYC									1	Marion				NA	80	NA	80	0	0		
	LRN	2007-345	3215	DRC Coal	White Oak Surface Mine #1		NYC	N	Y				1				Campbell	P	P		0	850				1.23	4,810	17.2
		2007-346	n/a	TECO Coal	Colonial Hollow	27	NYC	n/a	n/a			1					Whitley			0	0	3,011	3011	0	0	0	3,011	0
		2007-348	n/a	TECO Coal	Sugartree Branch	27	NYC	n/a	n/a			1					Kno1			0	0	814	0	814	0	0	814	0
	LRN	2007-450	918-0403	Nally & Hamilton	Nally & Hamilton		NYC	N				1					Whitley				3	6588	0	3,379	3,209	0	6945	0
Course of Business	LRP	2007-463		Consolidated Coal Company	Bailey Mine		NYC	E	N						1		Greene	P	P		1	25835	8625	15960	1250	5.68		5.68
	LRH	2007-874	App 10411	Oxford	Garrett		NYC	N	N		1						Tuscarawas	P	P			12535				0.49	12535	0.74
	LRH	2007-89	S-5039-96	Argus Energy, LLC	Wiley Branch Surface Mine Amendment No. 3		NYC	E	No	1							Lincoln and Wayne	I	I			2724	150	2,324	250	0	6,425	0.18
	LRH	2008-106		B&N Coal	Whigville	21	NYC				1																	
	LRN	2008-1175	861-0497	Nally & Hamilton	Kayjay #5	21	NYC	N	Y			1					KNOX				1							
	LRN	2008-1178	861-0500	Nally & Hamilton	Nally & Hamilton	21	NYC	N	Y			1					KNOX				1							
	SAM	2008-1313		M&B Excavating	Thompson South Mine	21	NYC									1	B bb				NA	1985	NA	1985	0	0	1985	
	LRH	2008-1445		Horizon Resources, LLC	Synergy Surface Mine No. 2		NYC	Expansion	No	1							Boone	P	P									
	LRP	2008-1782		Consolidated Coal Company	Oak Spring Slope and Supply Yard		NYC	N							1		Washington	P	P		N	4488	2000	1997	491		2.73	
	LRN	2008-1808	807-0354	Nally & Hamilton	Nally & Hamilton	21	NYC	N				1					BELL				2	2437	0	2437	0	0	2050	0
	SAM	2008-1809		B'ham Coal & Coke	Powhatan Mine	21	NYC	E								1	Jefferson				NA	1366	NA	1366		1.65	5712.7 credits	1.98
	LRN	2008-2130	867-0287	A&G Coal	A&G Coal	21	NYC	N	Y			1					HARLAN				0	463	0	347	116	0	520	
	LRP	2008-2414		Patriot Mining Company	Wades Run extension		NYC	N	Y	1							Monongalia	P	P			6284	2826	3458		0.67		
	LRH	2008-76	S-5020-86	Eastern Associated Coal	Rocklick Branch Refuse Fill		NYC	N	NO	1							Boone	P	P	None	1	2759	0	2,300	459	0	2759	0

	SAM	2008-823		New Acton Mining	Slate Creek Mine	21	NYC									1	Walker				NA	1055	NA	0	1055	0.9	1055	1.08
	LRL	2009-182	898-0815	Clintwood Elkhorn	Clintwood Elkhorn	21	NYC	N	?			1					Pike	P	P	3,400,000	1	1,313	0	338	975	0	2,241	0
	SAM	2009-232		Chevron Mining	North River R-34	21	NYC	E								1	Fayette				NA	4310	NA	2050	2260			0.25 (bank)
	LRL	2009-237	836-0326	Frasure Creek Mining	Frasure Creek Mining	21	NYC	E	N			1					Floyd	P	P		1	530	0	0	530	0	949	0
	SAM	2009-275		Travis Creek Mining	Trafford Mine	21	NYC									1	Blount				NA	2735	NA	2735	0	1.42		
	LRP	2009-288		Coresco Overland Conveyor Belt	Coresco, LLC	21	NYC	E	N	1					1		Monongalia & Greene	P	P			432.00	432.00			0.11	0.00	0.00
	SAM	2009-323		Black Warrior Minerals	Manchester East	21	NYC									1	Walker				NA	2410	NA	1520	890		2800	0.28
	LRL	2009-341	858-0223 A1	Miller Bros. Coal	Bear Hollow Mine	21	NYC	N	N			1					Johnson	P	P		1	2610	0	2085	525	0	4333**	0
	LRL	2009-344	897-5113	Leeco, Inc.	Leeco, Inc.	50	NYC	N	Y			1					Perry	P	P		0	1,171	0	1,171	0	0	1,171	0
	LRL	2009-368	836-0362	Miller Bros. Coal	Miller Bros. Coal		NYC					1					Floyd											
	LRH	2009-422	860-0448 A4	Enterprise Mining	Trace Fork Surface Mine	21	NYC	E	Y			1					Knott	P	P		1	1,698	0	748	950	0	ILF (1,224')	0
	SAM	2009-443		National Coal of AL	L. Massey North	21	NYC	N								1	Marion				NA	16712	NA	10701	6011	0.53		
	SAM	2009-467		Twin Pines Coal Co.	Lick Creek Mine	21	NYC									1	Shelby				NA		NA					
	SAM	2009-470		Reed Minerals Inc.	No. 5 Mine	21	NYC	N								1	Walker				NA	10338	NA	8264	2074	0	10338	
	SAM	2009-572		Aldwych, LLC	Four Oaks Mine #2	21	NYC	N								1	Lamar				NA	14965	NA	9260	5705	0.24	14900	0.58
	NAO	2009-576		Lone Mountain Processing	Prep Plant	21	NYC	E						1			Lee	I	I	N/A	N/A	500	500				500	
	LRL	2009-75	860-5324	ICG Knott Co.	Lige Hollow Amburgy Mine	50	NYC	N	Y			1					Knott	P	P		2	1,010	0	840	170	0	997	0
	NAO	2009-815		Paramount Coal	Dry Fork	49	NYC	N	Y					1			Wise	I	P	Y	N/A	3880		3640	240	0.6		
	LRL	2009-95	897-0500	Frasure Creek Mining	Frasure Creek Mining	21	NYC	N	Y			1					Perry	P	P		2	3,075	0	1,407	1668	0	2859**	
	LRL	pending	877-0184	Frasure Creek Mining	Frasure Creek Mining	IP/NW-waiting	NYC	N	N			1					Magoffin	P	P	18,821,566	4	4,753	0	2,133	2620	0	3,911	0
	SAM			Hope Coal Co.	Trey Mine	21(renewal)	NYC	N								1	Jefferson				NA	361	NA	361	0	0		
	LRL	2008-651	898-4313 R1	Patrick Processing	Patrick Processing	50	pending TAC	E	?			1					Pike	P	P	?	0	300	0	300	0	0	300	0
	LRL	pending	836-0338 A3	Miller Bros. Coal	Miller Bros. Coal	21	pending TAC	E	?			1					Floyd	P	P	?	1	537	0	0	537	0	**0	0
	LRL	pending TAC	898-0819	Cambrian Coal	Cambrian Coal Group	21	pending TAC	N	Y			1					Pike	P	P	630,000	3	1,290	0	1,290	0	0	pending	0
	LRH	2007-17		Buckeye	Freed Road	21	Withdrawn	N	N		1						Stark											
	LRH	2004-1557	898-0365 Am4	Premier Elkhorn		21						1																
	LRH	2006-2278		Catenary Coal Co.	Moccasin Hollow			Expansior	No	1							Kanawha	I	I		1	2268	1668	560	40	0	NYS	0
	LRH	2006-828	S-4009-06	Mid Vol	Paradise			n	y	1							McDowell	P	P	3.76	1	4725	2,961	1,755	0	2.4	6940	5.6
	SAM	2009-318		National Coal of AL	Kansas Mine No. 2	21		N								1	Walker				NA	0	NA					
	SAM	2009-416		National Coal of AL	L. Massey South	21		E								1	Marion & Fayette				NA	262	NA	262	0	0	262	
Course of Business				ICG	Perry County	NWP21						1																
Course of Business				Pine Coal Sales	Surface Coal Mine in Perry County	NWP21						1																
Litigation/Standstill				Ale1 Energy	Republic No. 2					1																		

Litigation/Stands till				Appalchian Fuels	Fourmile North Surface Mine					1																			
Litigation/Stands till				Aracoma Coal	Camp Branch Surface mine					1																			
Litigation/Stands till				Elk Run Coal	Black Castle Contour Mine					1																			
Litigation/Stands till				Fola Coal	Ike No. 1 & No. 2 Surface Mines					1																			
Litigation/Stands till				Frasure Creek Mining	Falcon Surface mine					1																			
Litigation/Stands till				ICG	Thunder Ridge							1																	
Litigation/Stands till				Independence Coal	La1are East Mine					1																			
Litigation/Stands till				Independence Coal	Twilight MTR Surface Mine					1																			
Litigation/Stands till				Jupiter Holdings	Callisto Surface Mine					1																			
Litigation/Stands till				Loadout LLC	Nellis Surface Mine					1																			
Litigation/Stands till				Mingo Logan	Spruce No.1					1																			
Litigation/Stands till				Tyler Morgan	Fourmile Fork No. 2 & No. 3 Surface Mines					1																			
Of Interest / Not on COE				Hobet	Mine No. 45					1																			
Original six "imminent" permits.									totals	75	29	117	9	10	7	15													
Original 42 permits w/in 60 days																													
Backlog - PN issued before 3-31-09																262													
* = refuse fill																													
** = does not include In-lieu Fee Amount																													
*** This number represents on-site mitigation. An additional 15,797 linear feet of stream would be preserved in perpetuity at an off-site location																													
**** These are ATF NWP 21 and are are a result of an EPA Order on Consent for Compliance Docket No. CWA-04-2008-5767																													
[1] 401/402 Certification is Issued (I), Pending (P) or Expired (E)																													
[2] NYC=Not Yet Coordinated																													

CURRENT											Anticipated Decision					EPA Notations	
Coal E1traction (tons)	Valley fills (#)	Total stream impacts (linear feet)	Per. stream impacts	Int. stream impacts	Eph. stream impacts	Wetland impacts (acreage)	Stream mitigation (linear distance)	Wetland mitigation (acreage)	Cmts received USEPA?	Cmts received USFWS?	<30 Days	30-90 Days	>90 Days	Decision Date		Status of Action	EPA Comments
10.3 mil	3	10,914	0	8,589	1,025	0	22,125	0	Y	Y			1			Identifed as permit to review through CEQ process; No longer identified on Corps 60 day list - public comment period closed 4/3	Y, on 4/3
									Y	Y						Under review through CEQ process; Region to schedule mtng with Corps/mine co.; Corps e1pects to render decision in April	Y, under original PN and again through CEQ process
785,700	0	5630	1678	3072	880	0	5570	0	Y	Y		1				Under review through CEQ process; Corps will provide revised proposal upon receipt of such from the mine co.; Corps e1pects to render decision in May.	Y, under original PN
		22551	11442	10513	596	2.24	22551	3.36	N	Y		1				Identifed as permit to review through CEQ process; discussion initiated w/ Corps; Corps e1pects to render decision in May	N
									N	N						Identifed as permit to review through CEQ process; discussion initiated w/ Corps; Corps e1pects to render decision in May	N
									N	Y						Under review through CEQ process; Region to schedule mtng with Corps/mine co., Corps e1pects to render decision in April	Y, on 3/23/09
		740	0	740	0	0	1050	0	N	Y				4/6/2009			
same	same	same	same	same	same	same	same	same	N	N			1				
									n	n							
same	same	same	same	same	same	same	same	same	Y	Y		1					
									N	N	1						
		3889		2636	1253	0.12	3889	0.12	N	N		1					
									n	Y							
	1	1270		1270		0	1270	0	N	N			1	4/27/2009		PCN closes on 4/20	Pending
		1536.00	1293.00	243.00			0.05	1536.00	N	N	1			4-May-09			
	0	2300	1480	820	0	0	2300 and ILF	0	N	Y	1						
		34		34			150		Y	Y				4-Apr-09			
		14386		5449	8937	0.09	7100		N	Y				26-Jan-09			
	0	1962	1962	0	0	0	2385	0	N	Y				3/30/2009			

									N								
	4	9546	7182	1474	890	0			N	N		1				PCN closes on 4/23	Pending
	2	1739	0	1069	670	0	946	0	N	Y	1						
		3650	0	3650	0	0	3432	0	N	Y				4/6/2009			
									N								
									N	N			1 [No SMCRA]				
		1298 (129.4)	0	1141	157	0	1015 (317.2)	0	N	Y				3/12/2009			
same	same	same	same	same	same	same	same	same	N	N		1					
		3185		3185		0.62	3185	0.62	N	N		1					
		10962 (4723)	0	6537	4425	0	18,242* (6072	0	N	Y				3/25/2009			
	2	1735	0	800	935				N	N			1				
									N	N							
	6	10254 (1037.2)	0	10,254	0	0	3254 (1741.5)	0	N	Y		1					
	1	6178	0	5878	300	1	10,600	1	N	N			1				
	2	3719	0	1764	1955	0	4757	0	N	Y		1					
														4/6/2009			
pending	0	125 (12.5)	125	0	0	0	**0	0	N	Y		1					
	1	969 (252.4)	0	867	102	0	296* (375.4)	0	Y	Y	1						
	2	3033 (1846.4)	0	1545	1488	0	470 * (2042)	0	Y	Y	1						
	2	2455 (742.6)	0	1540	915	0	868 * (941.9)	0	Y	Y	1						
	1	1131 (645)	0	816	315	0	249 *(923)	0	Y	Y	1						
	2	5980	2450	2350	1180	0	2720	0	N	Y			1			PCN closes on 4/22	Pending
pending	1	2880 (282.6)	2125	755	0	0	pending	0	Y	Y		1					
		1200		1200					N	N		1					
	3	2858	0	2418	440				N	N			1				
		10677															
									N	Y			1				
		11075		11,075		0	17155	0	Y	Y			1				
	0	5540	4853	687	0	0	5650	0	n	y		1					
same	same	same	same	same	same	same	same	same	N	N			1				
									N	Y			1				

same	same	same	same	same	same	same	same	same	N	N			1				
									N	N			1				
									N	Y			1				
same	same	same	same	same	same	same	same	same	N	Y			1				
?	5	20,462	0	16,328	4134	0	11181	0	N	Y			1				
	5	8,864	0	6,241	2623	0	10840	0	N	Y			1				
	5	8,864	0	6,241	2623	0	10840	0	N	Y			1				
same	same	same	same	same	same	same	same	same	N	Y			1				
	3	5219	0	1675	3544	0	7064	0	N	Y			1				
	2	8828	5117	3711	0	0	10970	0	N	Y			1				
?	8	7,185	0	4,005	3180	0	5966		N	Y			1				
	2	4,955	0	3,533	1422	0	2313**	0					1				
	2	1,790	0	1,490	300	0	2125	0	N	N			1				
									N	Y							
	3	3,500	0	1,610	1890	0	12719	0	N	N			1				
												1					
	6	22,194	0	7,816	14378	0	21292	0	N	Y		1					
?	4	7,123	615	2,159	4349	0	8709	0	N	Y			1				
same	same	same	same	same	same	same	same	same									
	2	5,258	3506	0	1752	0	**1714		Y	Y			1				
	2	6,166	4696	1,205	265	0	1551	0	N	Y			1				
	1	1,490	0	1,198	292	0	1276	0	N	Y			1				
y	14	14640		14640			10790		N	N				Suspended		NWP authorized 7/07; SMCRA permit e1pected to issue week of 3/30. Citizen suit filed on 4/30.	Y, on 4/3
same	same	same	same	same	same	same	same	same	N	N			1				
		3190	510	2030	650	0	4197	0	N	Y			1				
pending	1	850	0	530	320	0	**752	0	N	Y			1				
?	3	6,628	0	4,408	2220	0	9300	0	N	Y		1					
?	10	24,419	0	9,912	14507	0	**24,320	0	N	Y			1				
?	2	4,487	0	2,526	767	0	**3123	0	N	Y			1				

pending	3	2,296	0	0	2296	0	2323	0	N	Y			1				
pending	1	1,390	0	1,230	160	0	**2635	0	N	Y			1				
	6	21,961	4942	10,612	6407	0	11489**	0	N	Y			1				
	6	6,845	0	835	6010	0	5615	0	N	Y			1				
	2	5,542	0	2,593	2949	0	5113**	0	N	Y			1				
	4	11,030	0	9,230	1800	0	3662**	0	N	Y		1					
	1	7,971	1300	3,581	3090	0	7148**	0	N	Y			1				
	2	4,825	0	4,196	629	0	2797**	0	N	Y			1				
?	0	3,364	56	273	3035	0	3930	0	N	Y			1				
	2	3,865	1240	530	2095	0	11274	0	N	Y		1					
?	8	9,848	75	4,133	5640	0	**6500	0	N	Y			1				
pending	3	3535	0	2870	665	0	1249	0	N	Y			1				
pending	2	4,080	0	2,290	1790	0	4545	0	N	Y			1				
?	4	9,905	0	5,886	0	0	7059	0	N	N			1				
?	6	15,731	6533	6,886	2312	0	4205	0	N	N			1				
	1	2,700	0	2,700	0	0	3590	0	N	Y			1				
pending	12	19,589	0	16,685	2904	0	**13899	0	N	N			1				
	1	850	0	800	50	0	549	0					1				
	1	1,976	0	352	1624	0	1682**	0	N	Y			1				
?	1	3,297	2112	810	375	0	**2084	0	N	Y			1				
?	2	5,275	0	3,031	2244	0	747	0	N	Y			1				
		740	0	740	0	0	1050	0	N	Y				4/6/2009			
?	6	10,724	0	7,664	3060	0	5792	0	N	N			1				
0	0	0	0	0	0	0	0	0			1						
	4	13,166	0	7,955	5211	0	12765**	0	N	Y		1					
	7	14,600	0	10,723	3877	0	4859**	0	N	Y			1				
	1	2,012	0	1,593	419	0.69	154**	1.38	N	Y		1					
	4	10,695	0	7,935	2760	0	15602	0	N	Y			1				
pending	3	8,107	0	5,743	2364	0	6187	0	N	Y			1				
	1	10,030	2340	1,690	6000	0	17540**	0	N	Y			1				
		2850	0	2850	0	0	3350	0	N	Y		1					
?	6	8,275	0	8,275	0	0		0	N	Y			1				

	3	14,960	0	8,769	6191	0	24868**	0	Y	Y			1				
									n	y			1				
									N	N							
?	2	12,204	0	9,260	2944	0	10350	0	N	Y			1				
?	1	4,236	0	2,632	1604	0	**481	0	N	Y			1				
?	5	14,320	4567	7,466	2287	0	**10331	0	N	Y			1				
									N	Y			1				
									N	Y			1				
												1					
									N	Y			1				
									n	y			1				
									N	Y		1					
									N	Y							
?	3	4,070	0	2,940	1130	0	**2527	0	N	Y			1				
same	same	same	same	same	same	same	same	same	N	N				4/1/2009			
									n	y			1			Comment period closed; not identified by Corps for action in ne1t 60 days	Y, on 1/20/09
	6	6,308	0	5,308	1000	0	9607	0	N	Y							
									N								
									N								
									N								
									Y	N			1			Public comment period closed 3/23	Y, 3a ltr on 3/23 & 3b ltr on 4/17
									N								
		16,313							n	y			1			Public comment period closed 4/3	Y, on 4/3
		1150		1150			1150		N	N	1						

7.3 Mil	12	22305	0	19963	2342	0	27,377	0	n	y			1			Public comment period closed	N
									N	N		1					
?	5	9,397	2534	4,637	2226	0	**9061	0	N	Y			1				
pending	2	1842	0	1542	300	0	1515	0	Y	Y		1					
									N								
									N	N			1				
	6	14,005	0	7,094	6911	0	10518**	0	N	Y			1				
	0	1980	0	880	1100	0	3,567	0	N	Y	1						
	0	same	0	same	same	0	same	0	N	N	1						
	2	3922	478	1190	2254	0	2338	0	PENDING	PENDING		1					
	1	15352		15009	343	1.86	14642						1				
	1	14384		9107	5277		0.01						1				
pending	1	2,713	0	2,019	694	0	**489	0	N	Y		1					
									N								
pending	4	5,255	0	4,055	1200	0	7050	0	Y	Y			1				
		1162	40	1122	0	0	1845	0	N	Y			1				
		1800															
												1					
													1				
0	0	100	0	100	0	0	0	0	n/a	n/a				4/17/2009			
		3600	3600			0.13							1				
		unknown															
		unknown															
		4997	3665		1332	1.1	4997	1.65					1				
	3	1814	0	1814	0	0	596	0					1				
	9	14508	0	150	13358	0	21595	0					1				
						0.14		0.71									
pending	0	3165	0	3165	0	0	7033	0	N	N			1				

same	same	same	same	same	same	same	same	same	N	N			1	3/11/2009			
	NA		NA														
		3000	555	1300	1125	5.91	1207	11.88					1				
	1	3630	350	3280	0	0	2014	0					1				
	2	5980	2450	2350	1180	0	2720	0	N	Y			1				
	1	5350		3900	1450		5350	0	N	N			1	Suspended			
	1	1,552	1210		342	0.067						1					
	1	814	0	814	0	0	2400	0					1				
	1	11591	0	11591	0	0	10851	0					1				
	NA		NA														
	0	850	0	850	0	1.23	4810	17.2					1				
0	0	3011	3011	0	0	0	3011	0					1				
0	0	814	0	814	0	0	814	0					1				
	3	6588	0	3379	3209	0	6945	0					1				
		25835	8625	15960	1250	5.68		5.68					1			PCN closes 4/24	Pending
									N	N			1				
									N	Y							
	NA		NA														
									n	y			1				
		4488	2000	1997	491		2.73						1				
	2	2437	0	2437	0	0	2050	0					1				
	NA		NA														
	1	6284	2826	3458		0.67							1				
same	same	same	same	same	same	same	same	same	N	N			1				

	NA		NA														
pending	1	1313	0	338	975	0	2241	0	N	N			1				
	NA		NA														
	1	530	0	0	530	0	949	0				1					
	NA		NA														
		432	432			0.11			N	N	1						
	NA		NA														
	1	2610	0	2085	525	0	4333**	0					1				
	0	1171	0	1171	0	0	1171	0					1				
		3267															
	1	1,698	0	748	950	0	ILF (1,224')	0					1				
	NA		NA														
	NA		NA														
	NA		NA														
	NA		NA														
N/A	N/A	500	500				500		N	N		1					
	2	1010	0	840	170	0	PENDING	0					1				
Y	N/A	3880		3640	240	0.6			NYC	NYC		1					
		3075											1				
18,821,566	4	4753	0	2133	2620	0	3911	0	N	N		1					
	NA		NA														
?	0	300	0	300	0	0	300	0	N	N			1				
?	1	537	0	**0	0	0	**0	0	N	N		1					
pending	3	1290	0	1290	0	0	pending	0	N	N			1				
									N	Y				2/10/2009			
									N	Y			1				
									n	y			1				
	NA	0	NA						Y	Y	1			5/8/2009			
	NA	262	NA	262			262			Y	1			4/29/2009			
		1,522														PCN closed 4/8	Y, on 4/8
		2,430	1,675													PCN closed 4/8	Y, on 4/8
		9,918														Permit issued; Under prelimary injunction until 4th Circuit mandate issues	N

		9,979														Permit Issued; Under standstill agreement	N
		15,059														Permit issued; Under prelimary injunction until 4th Circuit mandate issues	Y
		16,414														Permit issued; Under prelimary injunction until 4th Circuit mandate issues	Y
		27,746														Permit issued; Under prelimary injunction until 4th Circuit mandate issues	N
		5,635														Under standstill agreement	
		14,174														Permit reissued after voluntary remand; Notice provided under the standstill agreement agreement - work can begin May 7	Y, on original proposal prior to litigation and voluntary remand
		28,690														Permit issued; Under prelimary injunction until 4th Circuit mandate issues	N
		5,986														Permit issued; Under standstill agreement	N
		5,750														Permit issued; Under prelimary injunction until 4th Circuit mandate issues	N
		11,194														Permit issued; Subject to litigation - Trial set for late April, Answer filing date April 4 ; Under standstill agreeement	Y
		31,678														Permit issued, Under standstill agreement	Y
		19,282														Permit issued; Under standstill agreement	N
		32,000														Comment period closed; not identified by Corps for action in ne1t 60 days	N
											15	34	114				

Nature of Comments	Notes	48 Imminent	CEQ	Comment Letter	Comment Letter	A Letter	B Letter	15 Day	PD	FD	Corps 5-5	Corps 5-12	Corps Permit Number	
direct impacts to streams and the need to avoid and minimize these impacts, degradation of water quality downstream from the valley fill, and the cumulative effect of these impacts on the watershed and human health; 404q invoked	3b letter due 4/28	1	1	Alex-Engery-Rep-1_2003-238\Mining_Alex Energy Rep #1_ltr.PDF								1	200300238	
direct impacts to streams and the need to avoid and minimize these impacts, degradation of water quality downstream from the valley fill, no valid 402 permit for proposal, and the cumulative effect of these impacts on the watershed and human health.	Concerns discussed w/ CEQ	1	1	Big-Branch_2004-1400\R4_big branchcommentletter090323.pdf								1	200401400	
	CC 5-1-09;	1	1									1	200501057	
		1	1									1	200500478	
		1	1									1	200602294	
direct impacts to streams and the need to avoid and minimize these impacts, degradation of water quality downstream from the valley fill, and the cumulative effect of these impacts on the watershed and human health.	Concerns discussed w/ CEQ	1	1	Reylas_2006-663\R3_reylascommentletter090323.pdf	Reylas_2006-663\Mining_Reylas_Ltr.PDF							1	2006-663 / 2007-99	
		1											2000-2339	
		1										1	200100407	
		1											2002-1455	
		1										1	200300468	
		1										1	200300794	
		1										1	200300853	
		1											2004-1589	
potential for cumulative effects, direct impacts to headwater stream, possible downstream wq impacts, and mitigation		1										1	200401860	
		1										1	200400396	
		1										1	200500011	
		1										1	200502160	
		1										1	200502461	
		1										1	200602131	
		1										1	200602394	

		1										1	200600483	
Recommends that the proposal reviewed through IP process due to direct impacts to perennial stream, possible downstream wq impacts, potential for cumulative effects, and mitigation		1										1	200606158	
		1										1	200600917	
		1										1	200600928	
		1										1	200701101	
		1										1	200701161	
		1											2007-1161	
		1										1	200701645	
		1										1	200700284	
		1										1	200700323	
		1										1	200700334	
		1										1	200703433	
		1										1	200700347	
		1										1	200700439	
		1										1	200700488	
		1										1	200700946	
		1										1	200700961	
		1										1	200801361	
		1										1	200801457	
		1										1	200801458	
		1										1	200801459	
		1										1	200800666	
direct impacts to perennial stream, possible downstream wq impacts, potential for cumulative effects, and mitigation		1											2008-69	
		1										1	200800801	
		1										1	200800995	
		1										1	200900198	
		1										1	200900293	
		1										1	200900577	
												1	200301276	
												1	200400624	
												1	200400609	
												1	200401391	
												1	200500217	
												1	2005001115	

												1	200501198	
												1	200500934	
												1	200400336	
												1	200500421	
												1	200401451	
												1	200600127	
												1	200600126	
												1	200401155	
												1	200300065	
												1	200501893	
												1	200600756	
												1	200600756	
												1	200600821	
												1	200500167	
												1	200401108	
												1	200601647	
												1	200601290	
												1	200700069	
												1	200601124	
												1	200401152	
												1	200700193	
												1	200602405	
												1	200700217	
												1	200700335	
												1	200501275	
												1	200601296	
												1	200700400	
												1	200700393	
project may have more than minimal indiv or cumulative effect 7 should not be authrized under the NWP;direct impacts to streams and the need to avoid and minimize these impacts, degradation of water quality downstream from the valley fill, the cumulative effect of these impacts on the watershed and human health, and adequacy of mitigation	Cited in Kennedy op-ed in Wash. Post 3/24			Ison-Rock-Ridge_2007-1351\Mining_Ison Rock Ridge_ltr.PDF								1	200701351	
												1	200700282	
												1	200501691	
												1	200700669	
												1	200700706	
												1	200700400	
												1	200700867	

												1	200701044	
												1	200600484	
												1	200701104	
												1	200700595	
												1	200700594	
												1	200701132	
												1	200500851	
												1	200701224	
												1	200701131	
												1	200701230	
												1	200701190	
												1	200701445	
												1	200700815	
												1	200701205	
												1	200701515	
												1	200701518	
												1	200701026	
												1	200700499	
												1	200701582	
													2007-733	
												1	200701504	
												1	200602033	
												1	200701644	
												1	200700286	
												1	200800095	
												1	200201435	
												1	200300995	
												1	200800138	
													2009-382	
												1	200800114	
												1	200800115	
												1	200800226	
												1	200400867	
												1	200701660	
												1	200800408	
												1	200701301	
												1	200400062	
												1	200701206	

												1	200701406	
												1	200501211	
												1	200800075	
												1	200800654	
												1	200800777	
												1	200800781	
												1	200700285	
												1	200700182	
												1	200602196	
												1		
												1	200800830	
												1	200800562	
												1	200600660	
												1	200700820	
												1	200701397	
												1	200800114	
direct impacts to streams and the need to avoid and minimize these impacts, degradation of water quality downstream from the valley fill, the cumulative effect of these impacts on the watershed and human health, and adequacy of mitigation	Of interest to Gov. Manchin, tied to King Coal Hwy			Consol-KY-BuffaloMtn_2008-491\Consol-KY-BuffaloMtn_2008-491_1-20-09.pdf								1	200800491	
												1	200800525	
												1	200602256	
												1	200500753	
												1	200700708	
degradation of water quality downstream from the valley fill, the cumulative effect of these impacts on the watershed and human health, and adequacy of mitigation; 404q invoked				Colony-Bay_2006-2290\Mining_Colony Bay ltr.PDF								1	200602290	
												1	200701021	
direct impacts to streams and the need to avoid and minimize these impacts, degradation of water quality downstream from the valley fill, and the cumulative effect of these impacts on the watershed and human health; 404q invoked	3b letter due 4/28; Of interest to State - tied to King Coal Hwy			Frasure-Creek_2008-1908\Mining_Frasure_Creek_ltr.PDF								1		
												1	200900286	

												1		
												1		
												1		
												1	200701180	
												1	200800727	
												1	200800139	
												1	200900154	
												1	200802160	
												1	200501385	
												1	200800239	
												1	200800805	
												1	200801368	
												1	200800935	
												1	200800212	
												1	200600427	
												1	200800563	
												1	200800093	
												1	200602247	
												1	200800321	
												1	200600066	
												1	200701498	
												1	200402228	
												1	200800918	
												1	200900015	
												1	200900189	
		New COE										1	200800572	
												1	199661011	
												1	200201435	
												1	200201435	
													2003-1415	
												1	200300098	
												1	200401254	
												1	200401836	
												1	200500854	
												1	200601053	

												1	200600117	
												1	200801445	
												1	200602001	
												1	200602207	
												1	200602522	
		New COE										1	2006005999	
												1	200607163	
												1	200701079	
												1	200701641	
												1	200701642	
												1	200701767	
												1	200702162	
												1	200700345	
													2007-346	
													2007-348	
												1	200700450	
	Construction of the disposal areas for fine coal refuse slurry and coarse coal refuse											1	200700463	
												1	200700874	
												1	200700089	
												1	200800106	
												1	200801175	
												1	200801178	
												1	200801313	
												1	200500370	
												1	200801782	
												1	200801808	
												1	200801809	
												1	200802130	
												1	200802414	
												1	200800076	

												1	200800823	
												1	200900182	
												1	200900232	
												1	200900095	
												1	200900275	
												1	200900288	
												1	200900323	
												1	200900341	
												1	200900344	
												1	200900368	
												1	200900422	
												1	200900443	
												1	200900467	
												1	200900470	
												1	200900572	
												1	200900576	
												1	200900075	
												1	200900815	
												1	200900237	
												1	pending	
												1	200601375	
												1	200800651	
												1	pending	
												1	pending TAC	
												1	200700017	
												1	200401557	
												1	200602278	
												1	200600828	
												1	200900318	
												1	200900416	
concern with use of groin ditches for mitigation														
add'l minimization of and appropriate mitigation for impacts to perennial and intermittent channels.														
	Region has e1pressed con't concerns with this proposal													

	Region has e1pressed con't concerns with this proposal													
	Region has e1pressed con't concerns with this proposal													
	Region has e1pressed con't concerns with this proposal													
	Of interest to UMW; of concern to Region													
											0	237		

Greg Pond/R3/USEPA/US
11/10/2010 04:09 PM

To Ronald Landy
cc
bcc
Subject Re: Dewey Email

This is from Fred Kirchner, former USACE scientist. He truly believes the algal problems are related to MTM in the watershed. Please fwd to group.

Next step might be to do a GIS landcover, population trends, and permitter discharge analysis to see any changes over time?

DEW-Ca.xls DEW-COND.xls DEWP Fall 2008 057.jpg DEWP Fall 2008 058.jpg DEW-SULFATE.xls
ELT-32 Sufate vs Cond and Drinking Water.xls ELT-COND.XLS ELT-SULFATE.xls

Greg Pond
Office of Monitoring and Assessment
U.S. EPA Region 3
1060 Chapline Street, Suite 303
Wheeling, WV 26003-2995
(p) 304-234-0243
(f) 304-234-0260
pond.greg@epa.gov
Visit our website at http://epa.gov/reg3esd1/3ea50.htm

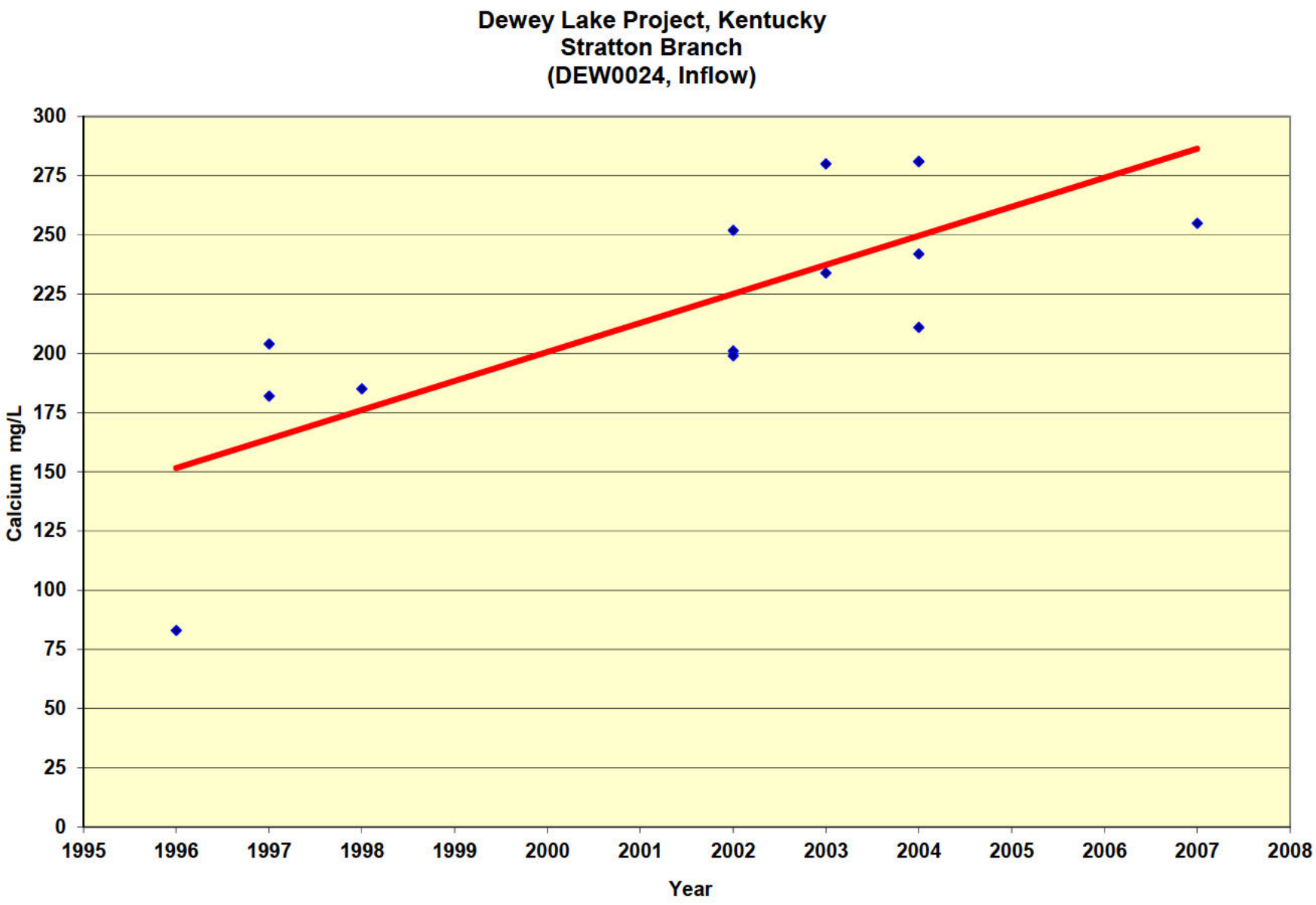
Ronald Landy | Greg, Would you please send the email with... | 11/10/2010 03:05:48 PM

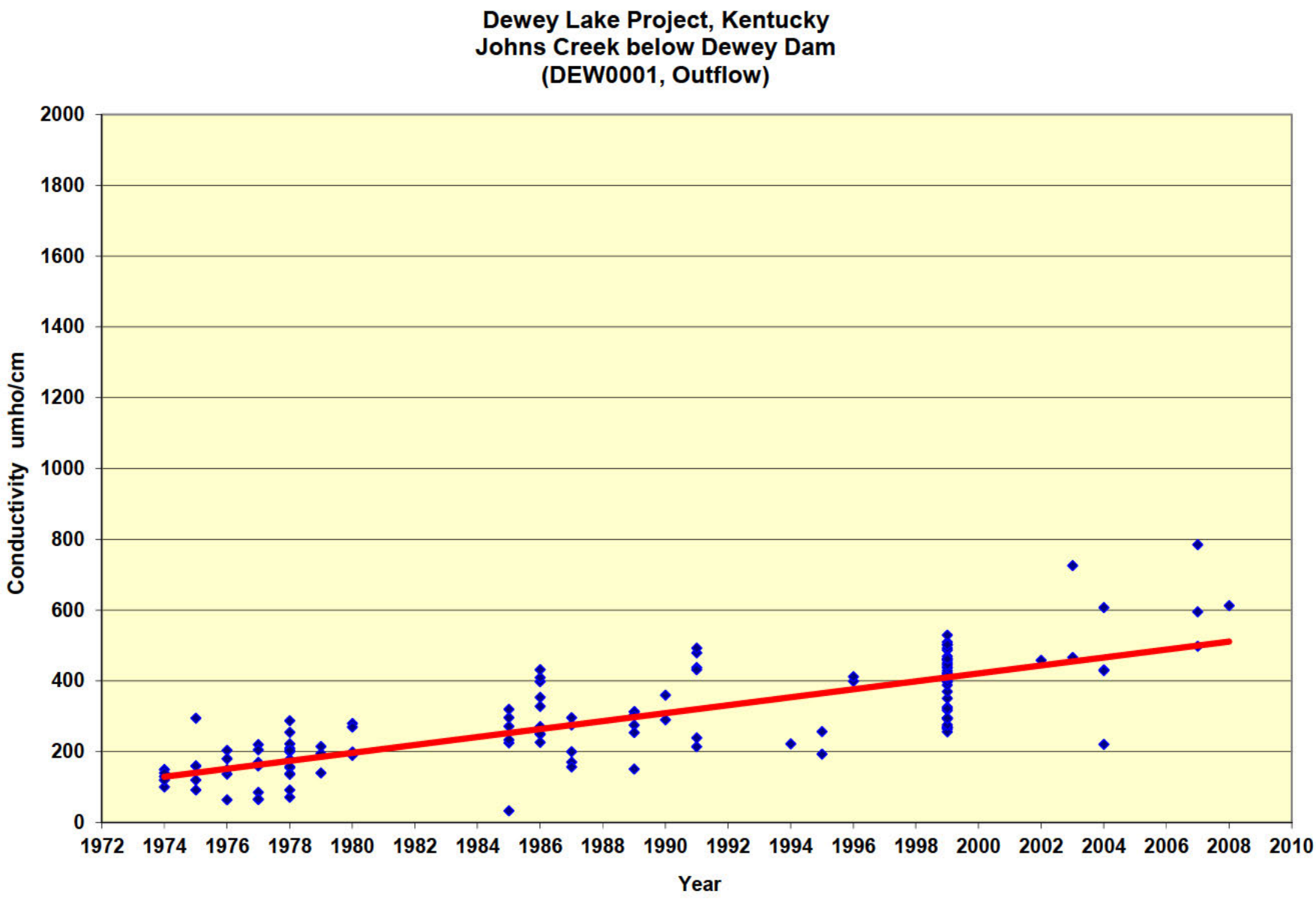
From: Ronald Landy/ESC/R3/USEPA/US
To: Greg Pond/R3/USEPA/US@EPA
Date: 11/10/2010 03:05 PM
Subject: Dewey Email

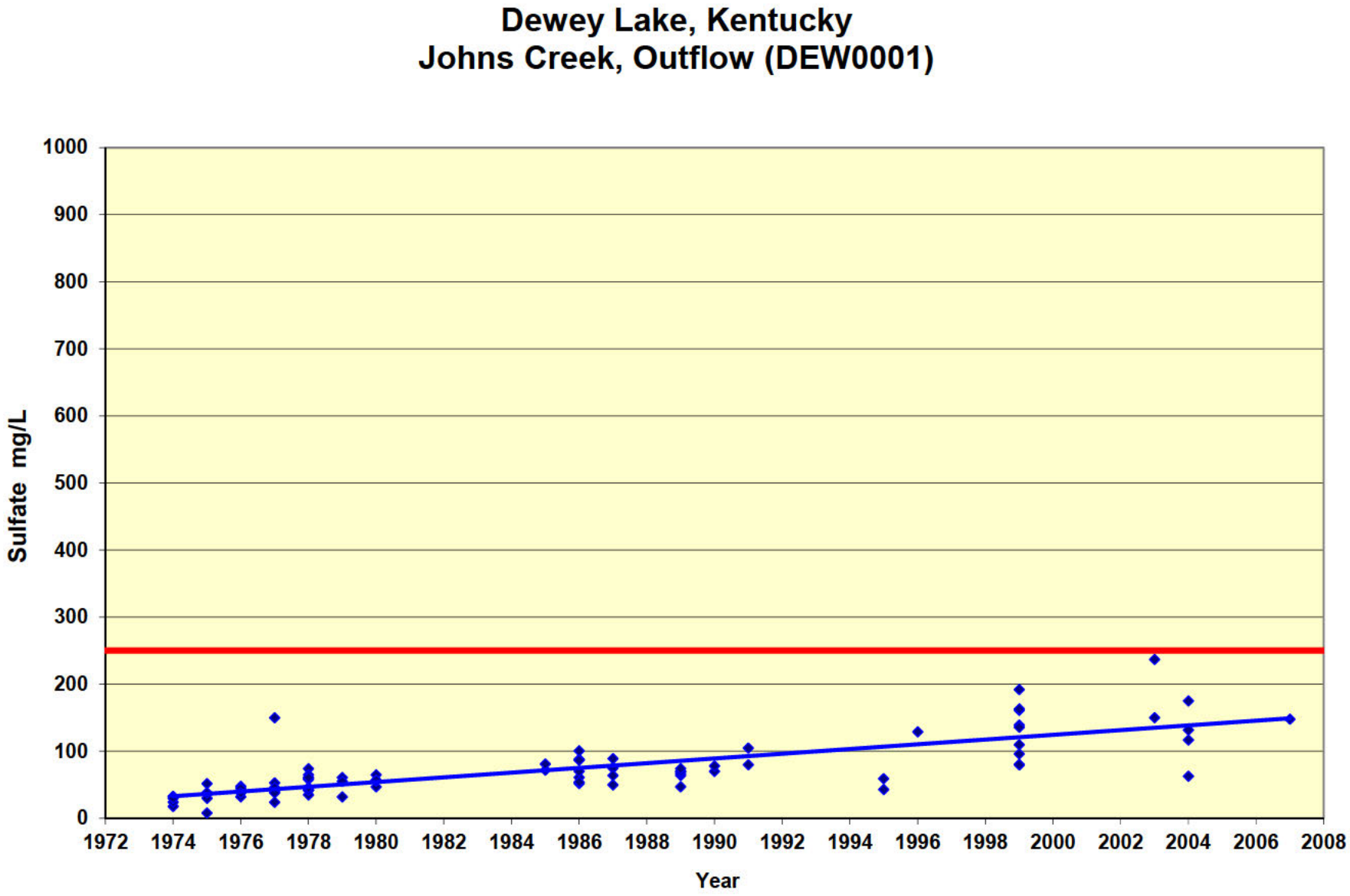
Greg,
Would you please send the email with all the data information, I had a problem with it, probably due to overload on my computer.

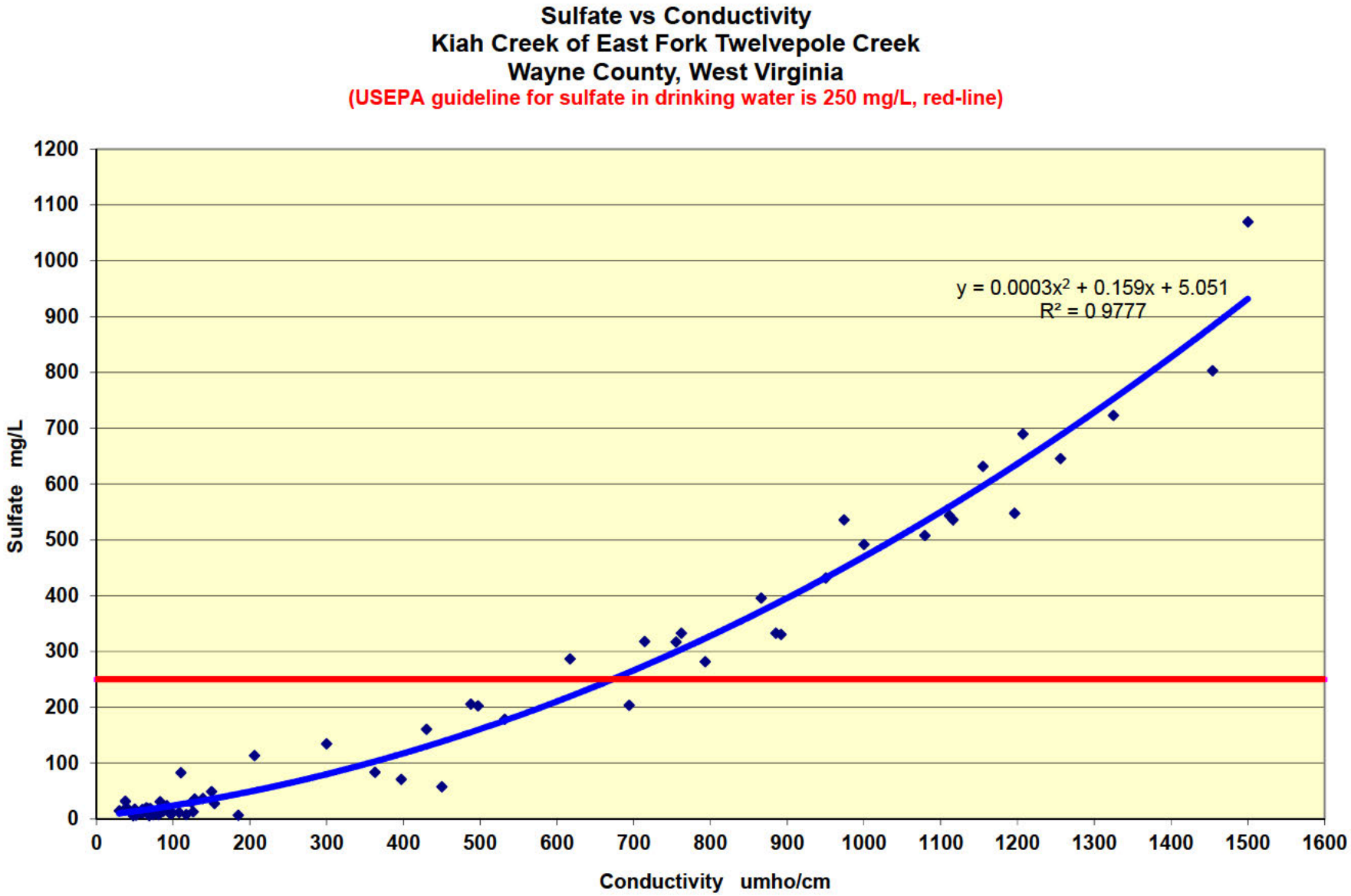
Thanks

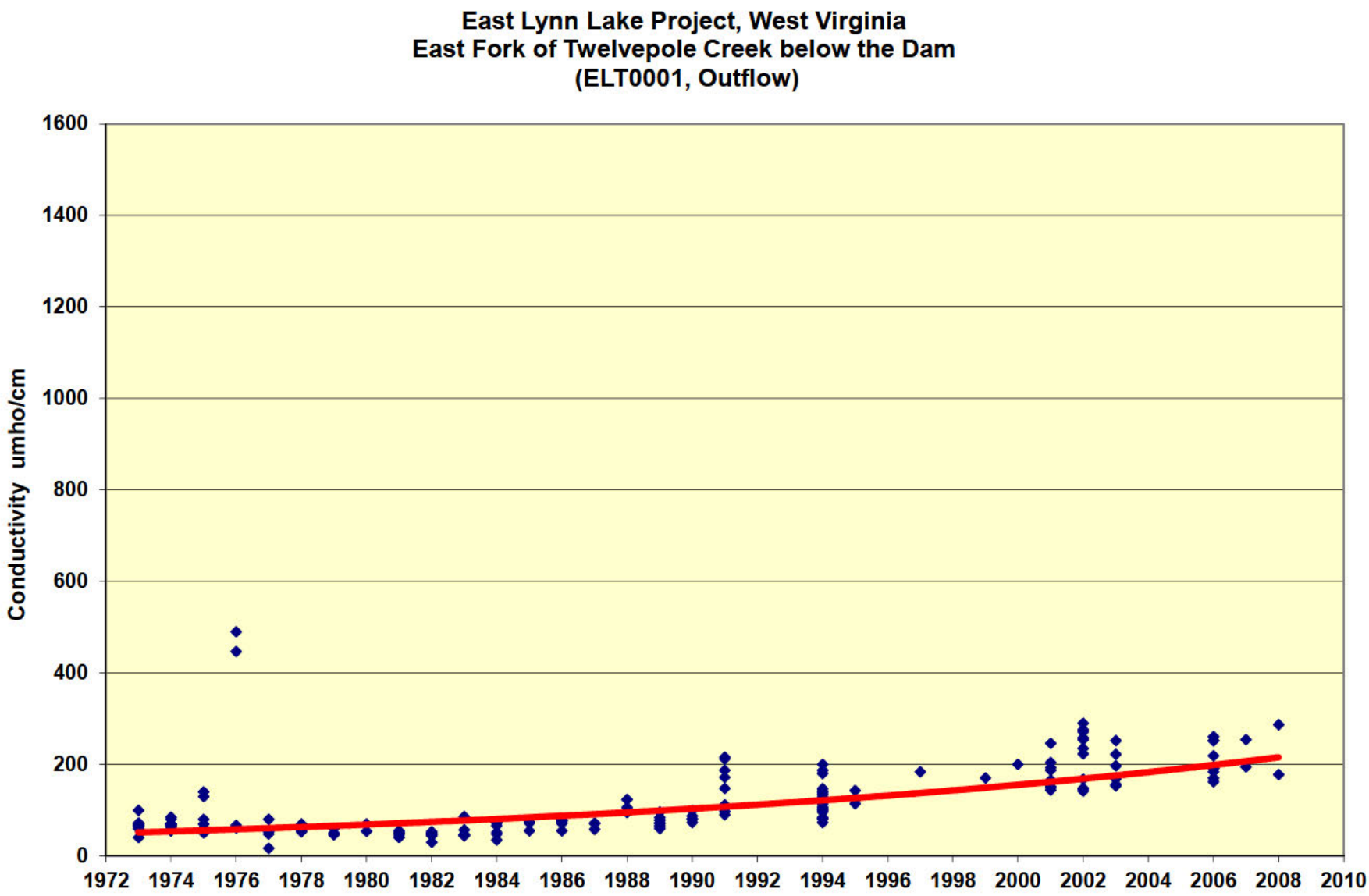
Ron

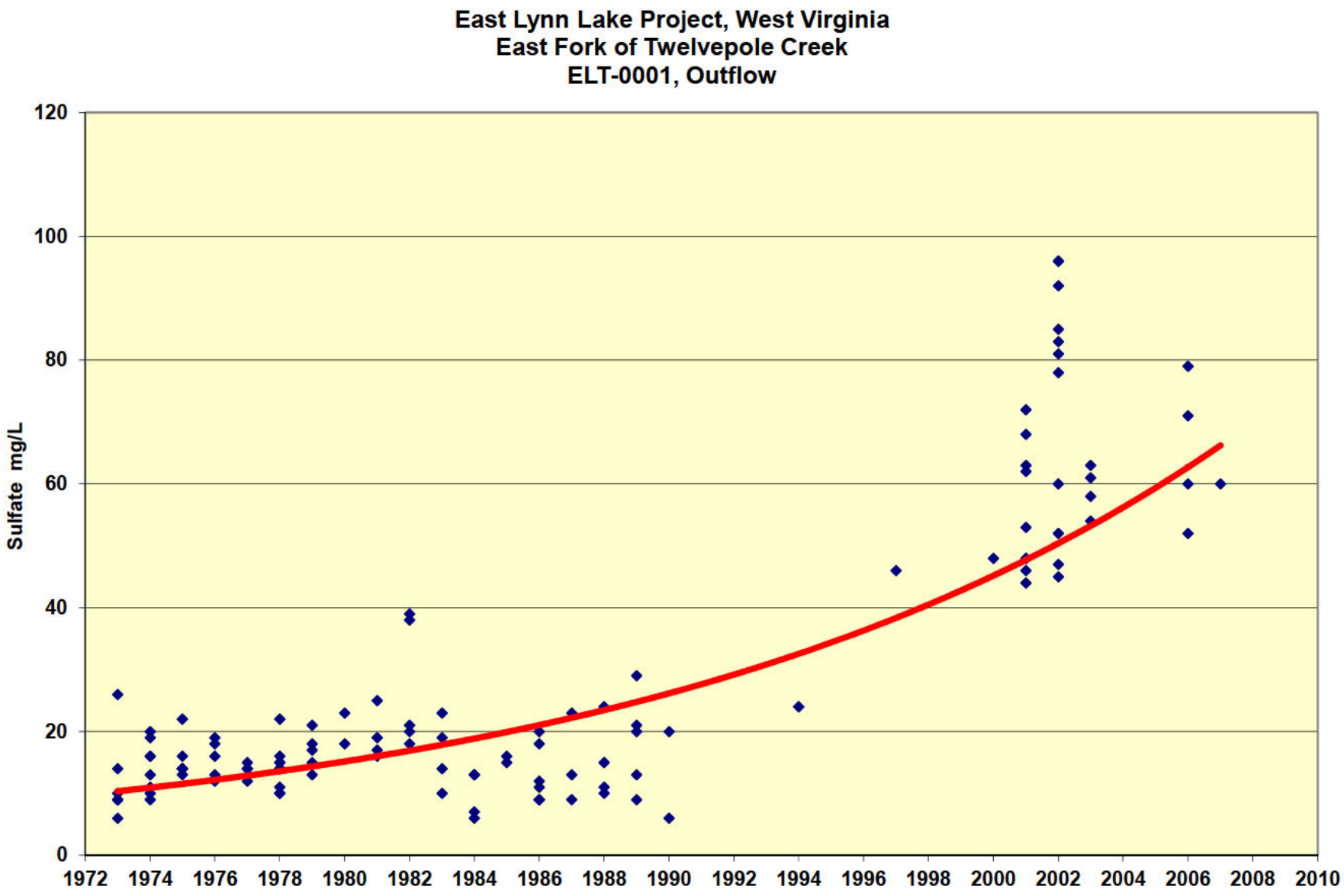

Dewey Lake Project, Kentucky
Stratton Branch
(DEW0024, Inflow)
Calcium mg/L
300
275
250
225
200
175
150
125
100
75
50
25
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year


Dewey Lake Project, Kentucky
Johns Creek below Dewey Dam
(DEW0001, Outflow)
Conductivity umho/cm
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year


Dewey Lake, Kentucky
Johns Creek, Outflow (DEW0001)
Sulfate mg/L
1000
900
800
700
600
500
400
300
200
100
0
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year


Sulfate vs Conductivity
Kiah Creek of East Fork Twelvepole Creek
Wayne County, West Virginia
(USEPA guideline for sulfate in drinking water is 250 mg/L, red-line)
y = 0.0003x² + 0.159x + 5.051
R² = 0.9777
Sulfate mg/L
Conductivity umho/cm
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600


East Lynn Lake Project, West Virginia
East Fork of Twelvepole Creek below the Dam
(ELT0001, Outflow)
Conductivity umho/cm
1600
1400
1200
1000
800
600
400
200
0
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010


East Lynn Lake Project, West Virginia
East Fork of Twelvepole Creek
ELT-0001, Outflow
Sulfate mg/L
0
20
40
60
80
100
120
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

Matthew Klasen/DC/USEPA/US
11/12/2010 09:21 AM

To Michael Slimak
cc
bcc
Subject Re: SAB progress on conductivity report (?)

Great -- thanks.

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
cell (202) 380-7229

Michael Slimak	Matt: I'll check with the SAB staff to see where t...	11/12/2010 09:20:08 AM

From: Michael Slimak/DC/USEPA/US
To: Matthew Klasen/DC/USEPA/US@EPA
Date: 11/12/2010 09:20 AM
Subject: Re: SAB progress on conductivity report (?)

Matt: I'll check with the SAB staff to see where they are.

Matthew Klasen	Hi Mike, Hope you enjoyed your holiday yesterd...	11/12/2010 09:00:28 AM

From: Matthew Klasen/DC/USEPA/US
To: Michael Slimak/DC/USEPA/US@EPA
Date: 11/12/2010 09:00 AM
Subject: SAB progress on conductivity report (?)

Hi Mike,

Hope you enjoyed your holiday yesterday. I had a question regarding the SAB review: Have you heard any updates from the SAB staff office on where the Panel is on revising their draft report on the conductivity report? From the last call, my understanding was that they would be getting out an updated draft of their report very soon -- within a couple weeks of receiving comments from panelists by 10/29 -- and that they'd reserved time on the 22nd in case they needed to discuss but that it didn't seem likely to be needed.

Just wanted to make sure we're aware over here in case a new draft comes out (especially given OPA's interest last time).

Thanks,
Matt

Matt Klasen
U.S. Environmental Protection Agency
Office of Water (IO)
202-566-0780
cell (202) 380-7229

Richard Paiste/R3/USEPA/US

11/16/2010 02:53 PM

To Daniel Holliman, AshleyL Williams, Christopher Hunter

cc Bill Jenkins

bcc

Subject Lit Matrix and other MTM/health docs Part 1

2 attachments

1)) Literature matrix for mountain top mining health effects .xls MTM Lit Review Summary.docx

Attached:
1) Literature Review Matrix
2) MTM Lit Review Summary

Richard Paiste
EPA Region 3
215 814 57239
cell: 267 738 3995

HEALTH EFFECTS FROM MINING IN APPALACHIA

	Title	Authors	Journal	Date	Purpose	Study Area	Data Type	Subjects	Stressors	Health Ouctomes	Results	Conclusions	Limitations
1	Higher coronary heart disease and heart attack morbidity in Appalachian coal mining regions	Hendryx, M. & Zullig, K.J.	Preventive Medicine	2009	Test if self-reported CVD rates are higher in Appalachian coal mining counties than others	Appalachia	Secondary; Retrospective	2006 BRFSS respondents from 150 Appalachian counties, 60 Appalachian counties with mining	arsenic, cadmium, other methals, non-specific PM, polycyclic aromatic hydrocarbons (PAHs)	cardiovascular disease (including stroke, heart attack, angina or coronary heart disease)	People in mining areas have higher risk of CVD (OR=1.22, 95% CI 1.14-1.30), angina or CHD (OR=1.29, 95% CI=1.19-1.39), and heart attack (OR=1.19, 95% CI = 1.10-1.30) *adjusted for smoking, alcohol, gender, education, race, income, physician supply, and metropolitan status	CVD linked to air and water contamination consistent with toxicants found in col and coal processing. Future research should be done, new monitoring stations, and comprehenisve assessment of water qualtiy; need for environmental assessments to confirm if resutls are from mining industry pollution	Lack of direct environmental qualty data, cross-sectional design, self-reported BRFSS data, if people in Appalachia more likely to die from heart attack or stroke, won't self-report and could be underestimated
2	Lung cancer mortality is elevated in coal-mining areas of Appalachia	Hendryx, M., O'Donnell, K., & Horn, K.	Lung Cancer	2008	Test if residence in coal-mining area contributes to increased lung cancer incidence and mortality	Appalachia	Secondary; Retrospective	2000-2004 CDC lung cancer mortality rates, age-adjusted to 2000 U.S. Census standard	zinc, cadmium, nickel, arsenic, PM	lung cancer	Lung cancer mortality highest in heavy coal-mining areas, followed by all other areas of Applachia and the nation p<.001; *covariates for gender, education, poverty, race, urbanicity, smoking, Southern state, and Appalachian county	Lung cancer mortality is higher due to smoking, poverty, and low education, but living in heavy coal-mining areas is an additional risk factor. The results of this study may be linked to growing body of evidence demonstrating increased health risks associated with residence in Appalachian coal-mining areas	Reliance on secondary county-level data and limited measures of coal-mining exposure; causes of individual lung cancer cases cannot be identified, precise pathway between residence in coal-mining areas and lung cancer is unknown; smoking rates imprecisely meeasured; demographic/cultural variables may not be captured through covariates
3	Mortality from heart, respiratory, and kidney disease in coal ming areas of Applachia	Hendryx, M.	International Archives of Occupational and Environmental Health	2009	Test whether population mortality rates from heart, respiratory, and kindey disease were higher as a function of levels of Appalachian coal mining	Appalachia	Secondary; Retrospective	CDC mortality data, age-adjusted 2000 US Census standard	zinc, dadmium, lead, mercury, arsenic, PM, aluminum, iron, manganese	heart disease, respiratory disease, kidney disease	Rate Ratios (RR) for Appalachian mining >4 million; up to 4 million; Non-Appalachian mining: Males (total) - Heart RR (1.07; 1.01, 1.01); Respiratory RR(1.03; 0.97; 1.05); Kidney RR (1.19; 1.10; 1,02) Females (total) - Heart RR (1.06; 1.0; 1.03); Respiratory RR (1.03; 0.94; 1.05); Kidney RR (1.13; 1.14; 1.08) *covariates gender, education, poverty, race, insurance, physician supply, urbanicity, smoking, Southern state	Total chronic heart, respiratory, and kidney disease, and kidney disease mortality rates significantly higher in coal mining areas of Appalachia than non-mining areas. Diferent patterns of results in mining areas outside Appalachia may be due to demographics, mining practices, topography, population density, variation in medical diagnostic practices, etc. Future research should be done using multi-level modeling of aggregate ecologic impacts on individual outcomes, collecting direct air and water samples, and collect direct measures of smoking, occupational exposure, druation of environmental exposure, and individual-level health and disease measures, identify exposure types, levels, and mechanisms of action that can account for higher mortality	Reliace on secondary county-level data; precise pathway between residence in coal mining areas and mortality is unknown; risk of ecological fallacy, use of smoking rates that were imprecisely measured; not all risk factors could be measured
4	Hospitalization patterns associated with Appalachian coal mining	Hendryx, M., Ahern, M.M., & Nurkiewicz, T.R.	Journal of Toxicology and Environmental Health	2007	Test whether volume of coal mining is related to population hospitalization rate for diseases sensitive/insensitve to coal mining by-products	Appalachia	Secondary; Retrospective	2001 hospitalization patient data for WV, KY, PA	residential proximity to coal mining site and amount of coal mined	hospitalization for diseases	Volume of coal mining significantly related to hospitalization risk for hyptertension (odds increased 1% for each 1462 tons of coal) and COPD (odds increased 1% for each 1873 tons of coal)*controlled for age, gender, insurance, comorbidities, hospital teaching status, county poverty, county social capital	The health risks from residential proximity to mining present and additional negative consequence that results from reliaance on this energy source; Inhalation of PM 2.5 is associted with hypertension and COPD among miners and residents; Individuals with hypertension showed increased association between inflammation and ambient PM2.5	County identified location of the hospital, not necessarily where patient resided, hospitalziation data is influence by other factors, teaching status of hospital may affect admission patterns; Need more refined methods to isolate nature and magnitude of PM2.5 effect - employ primary data collection efforts in targeted communitites distal and proximal to coal mining activitites; also stucies to clearly identify specific processes and pollutants that exert pathoglogic effects on populations Need more refined methods to isolate nature and magnitude of PM2.5 effect - employ primary data collection efforts in targeted communitites distal and proximal to coal mining activitites; also stucies to clearly identify specific processes and pollutants that exert pathoglogic effects on populations

5	Ecological integrity of streams related to human cancer mortality rates	Hitt, N.P. & Hendryx, M.	EcoHealth	2010	Test whether ecological integrity is related to cancer and coal mining in Appalachia	West Virginia	Secondary; Retrospective	1975-2005 county-level, age-adjusted cancer mortality rates from CDC	coal production, coal mining index (coal processing, coal slurry, etc.), inter-county effects (mine drainiage, etc.)	cancer mortality rates	Ecological integrity was inverslty related to age-adjusted cancer mortality rates (toal p<.01; digestive, breast, and respiratory p<.01; urinary p<.05) *controlled for poverty, access to health care provders, urbanization, education, smoking; high cancer cluster found in SW portion of state (Boone, Lincoln, Logan, and Mingo counties); Ecological integrity was significantly related to mining and cancer mortality and mining was significantly related to total calncer mortality	Results suggest, but cannot prove a causal link between coal mining and cancer mortality. Smoking, poverty, and urbanization were important predictors of cancer mortality, but did not account for significant association between ecological integrity and health. Metal contamination may be a concern for human communities downstream.	Need to evaluate waterborne exposures directly and need to explore other possible exposure pathways (i.e. dust); limited by spatial and temporal resolution of available dta, data aggregation dimished dose-response signals; need individual-based studies to quantify per-capita cancer risks; analyses of macroinverebrate genera and species to understand links; spatial analyses of human health and ecological integrity across larger geographic extents
6													
7	Relations between health indicators and residential proximity to coal mining in West Virginia	Hendryx, M., Ahern, M.M.	American Journal of Public Health	2008	To investigate the relations between health indicators and residential proximity to coal mining.	West Virginia	Primary (self reported)	16,493 West Virginians & 2000 U.S. Census data	tonnage of coal mined	cardiopulmonary disease, lung disease, cardiovascular disease, diabetes, kidney disease, chronic obstructive pulmonary disease (COPD), black lung disease, and hypertension	OR (95% CI) <3.9million tons; >4million tons: Cardiopulmonary disease: 1.006 (0.910, 1.113);1.119 (1.002, 1.249), Lung disease:1.085 (0.904, 1.303);1.297 (1.048, 1.605), COPD: 0.909 (0.582, 1.419);1.637 (1.061, 2.526), Black Lung:2.254 (1.255, 4.047);2.655 (1.602, 4.402), Cardiovascular disease:0.994 (0.890, 1.110);1.106 (0.990, 1.236), Hypertension:0.956 (0.820, 1.116);1.299 (1.130, 1.493), Kidney disease:0.764 (0.397, 1.470);1.698 (1.016, 2.837), Diabetes:0.898 (0.773, 1.042);1.008 (0.864, 1.176), Arthritis/osteoperosis:0.994 (0.844, 1.170);1.097 (0.901, 1.335)*controlled for age, income, education, insurance, poverty, smoking, obesity, social capital	Among West Virginia adults, residential proximity to heavy coal production was associated with poorer health status and with higher risk for cardiopulmonary disease, chronic lung disease, hypertension, and kidney disease, after controlled for covariates	ecological design, the possibility that unmeasured variables confounded with coal mining (i.e. individual smoking behavior or occupational exposure) contributed to poorer health, the survey response ratewas imperfect, potentially limiting generalizability,county of residence provides an imperfect estimate of people's proximity to mining sites, the format of the chronic disease questions likely resulted in an underreporting of disease, the nonspecific cancer measure may have been too crude to detect effects, if they existed. The third through fifth limitations may have resulted in underestimating coal-mining effects
8	Mountaintop mining consequences	Palmer, M.A., Bernhardt, E.S., Schlesinger, W.H., Eshleman, K.N., Foufoula-Georgiou, E., Hendryx, M.S., et al.	Science	2010	To conduct analyses of current peer-reviewed studies and of new water-quality data from WV streams and serious environmental impacts that mitigation practices cannot successfully address	central Appalachia	Secondary (literature review and analysis)				greater storm runoff and increased frequency and magnitude of downstream flooding;below valley fills, streams are characterized by increases in pH, electrical conductivity, and total dissolved solids due to elevated concentrations of sulfate (SO4), calcium, magnesium, and bicarbonate ions;n some freshwater food webs, Se has bioaccumulated to four times the toxic level; groundwater samples from domestic supply wells have higher levels of mine-derived chemical constituents than well water from unmined areas; Health problems are for women and men, so effects are not simply a result of direct occupational exposure of predominantly male coal miners		
9	Cancer incidence in Kentucky Pennsylvania and West Virginia: disparities in Appalachia	Lengerich, E., Tucker, T., Powell, R., Colsher, P., Lehman, E., Ward, A.	Journal of Rural Health	2005		Appalachia							

10	A geographical information system-based analysis of cancer mortality and population exposure to coal mining activities in West Virginia, United States of America	Hendryx, M., Fedorko, E., & Anesetti-Rothermel, A.	Geospatial Health	2010	To use GIS to develop and test a refined measure (a distance-weighted population exposure score) of population exposure to components of the mining industry in WV (compared to measure used in previous studies) by relating the comparative exposure measures to cancer mortality	West Virginia	Primary	age-adjusted 2000 U.S. Census data, CDC cancer mortality rates	arsenic, cadmium, chromium, nickel, beryllium, other carcinogens, contaminated water from processing and extraction, particulate matter	digestive, genital, urinary, breast, oral, respiratory, digestive, lymphatic, leukemia, lymphoma, and combined cancers	Univariate global spatial autocorrelation (GSAC) of age-adjusted combined cancer mortality rates: Morgan's I=0.405; E[I]=0.11; mean =-.008; SD=0.66. Univatirate GSAC test of total tonnage of coal producction: Morgans I=0.354; E[I]=-.011; mean=-.011; SD=.061. Bivariate GSAC between tonnage and combined cacner mortlity: Morgan's I=.218; E[I]=-.011; mean=-.001; SD=.049l; all 3 tests yeilded P<.001. Total cancer mortality rate distance-weighted exposure had significant effects (P<.05) for breast, respiratory, and "other" cancer. Even more significant (P<.01) for respiratory and "other cancer"	Distance-weighted, at-risk population coal mining exposure measure was significantly correlated to cancer moretaliy in WV. For total cancer and 3 subgroups, exposure was correlated after controlling for smoking rates. The variables had positive spatial autocorrelation and were spatially dependent. All components of mining (injection, preparation plants, impoundment ponds, and mines) were related to 1 or more cancer types	imprecision in temporal relationships between exposure and cancer mortality; cancer mortalty was collapsed across years to produce sufficient cases; assumption that current mining reflects past mining; limitations with simple distance proximity equations (more specific would need more detailed data than was gathered); may need models that account for spatial autocorrelation.
11	Arsenic in coal	Kolker, A., Palmer, C.A., Bragg, L.J.,	USGS Fact Sheet 2005-3152	2005									
12	Air pollution and risk of stroke:underestimation of effect due to misclassification of time of event onset	Lokken, R.P., Wellenius, G.A., Coull, B.A., et al.	Epidemiology	2009									
13	Long-term exposure to air pollutiona and incidence of cardiovascular events in women	Miller, K.A., Siscovick, D.S., Sheppard, L., et al.	New England Journal of Medicine	2007									
14	Ambient air pollution and daily emergency department visits for ischemic stroke in Edmonton, Canada	Szyszkowicz, M.	International Journal of Medical Environmental Health	2008									
15	Particulate air pollution and hospital admissions for congestive heart failure in seven United States cities	Wellenius, G.A., Schwartz, J., & Mittleman, M.A.	American Journal Cardiol	2006									
16	Lung cancer in never smokers: a review	Subramian, J. & Govindan, R.	Journal of Clinical Oncology	2007									
17	Lung cancer and air pollution: a 27 year follow up of 16,209 Norwegian men	Nafstad, P., Haheim, L.L, Oftedal, G. Gram, F., Holme, I., Hjermann, I., et al.	Thorax	2003									
18	Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particualte air polution	Pope, C.A., Burnett, R.T., Thun, M.J., Calle, E.E., Drewski, D., Ito, K., et al.	Journal of the American Medical Association	2002									

19	An ecological study of the association of metal polluatants with lung cancer incidence in Texas	Coyle, Y.M., Minahjuddin, A.T., Hynan, L.S., Minna, J.D.	Journal of Thoractic Oncology	2006		Texas						
20	Cell type specificity of lung cancer associated with arsenic ingestion	Guo, H.R., Wang, N.S., Hu, H., Monson, R.R.	Cancier Epidemiological Biomarkers Prevention	2004								
	Lung cancer and arsenic concentrations in drinking water in Chile	Ferreccio, C., Gonzalez, C., Milosavjlevic, V., Marshall, G., Sancha, A.M., & Smith, A.H.	Epidemiology	2000		Chile						
	Generation and quantification of hazardous dusts from coal mining in the Indian context	Ghose, M.K.	Environmental Monitoring Assessment	2007								
	Well water quality in the vicinity of a coal slurry impoundment near Williamson West Virginia	Stout, B.M., Papillo, J.	Wheeling Jesuit University	2004		West Virginia						
	Arsenic in domestic well water and health in central Appalachia USA	Shiber, J.G.	Water Air Soil Pollution	2005		Appalachia						
	Diesel exhaust and coal mine dust: lung cancer risk in occupational settings	Hoffmann, B., Jockel, K.H.	Annals of the New York Academy of Sciences	2006								
	Household air pollution from coal and biomass fuels in China: measurements, health impacts, and interventions	Zhang, J., Smith K.R.	Environmental Health Perspectives	2007		China						
	Coal mining and chronic obstructive pulmonary disease: a review of the evidence	Coggon, D. Taylor, A.N.	Thorax	1998								
	Coronary disease in mining communities in Marion County, West Virginia	Higgins, I.TT., Higgins, M.W., Lockshin, M.D., Canale, N.	Journal of Chronic Diseases	1969		West Virginia		men aged 20–69 living in three mining towns in Marion County, West Virginia.				

Ground-water quality in unmined areas and near reclaimed surface coal mines in the northern and central Appalachian coal regions, Pennsylvania and West Virginia	McAuley, S.D., Kozr, M.D.	USGS Scientific Investigations Reprot	2006		Appalachia							
Respiratory morbidity in Meyerside schoolchildren exposed to coal dust and air pollution	Brabin, B., Smith, M., Milligan, P., Benjamin, C., Dunne, E., & Pearson, M.	Archives of Disease in Childhood	1994									
Arsenic exposure and cardivascular disease: a systematic review of the epidemiological evidence	Navas-Acien, A., Sharrett, A.R., Silbergeld, E., Schwartz, B.S., Nachman, K.E., Burke, T.A., & Guallar, E.	Circulation	2004									
Causes of death and renal tubular dysfuntion in residents exposed to cadmium in the environment	Nishijo, M., Morikawa, Y., Nakagawa, N., Tawara, K., Miura, K., Kido, T., Kobayashi, E., & Nogawa, K.	Occupational and Environmental Medicine	2006									
Effects of exposure to low levels of environmental cadmium on renal biomarkers	Noonan, C.W., Sarasua, S.M., Campagna, D., Kathman, SlJ., Lybarger, J.A., & Mueller, P.W.	Environmental Health Perspectives	2002									
PM10 levels in communities close to and away from opencast coal miing sites in Northeast England	Pless-Mulloli, T., King, A., Howel, D., Stone, I., Merefield, J.	Atmospheric Environment	2000		England							
Living near opencast coal mining sites and children's respiratory health	Pless-Mulloli, T., King, A., Howel, D., Stone, I., Merefield, J., Bessell, J., & Darnell, R.	Occupational and Environmental Medicine	2000									
Relationships among exceedences of metals criteria, the results of ambient bioassays, and community metrics in mining-impacted streams	Griffith, M.B., Lazorchak, J.M., Herlihy, A.T.	Environmental Toxicology and Chemistry	2004									

Charachteristics of hazardous airborne dust around an Indian surface coal mining area	Ghose, M.K. & Majee, S.R.	Environmental Monitoring Assessment	2007									

MTM Lit Review Summary

Appalachia is characterized by social inequalities and health disparities (Hendryx, 2008). Coal mining inequalities and disparities have increasingly become a focus of public health agencies such as the U.S. Environmental Protection Agency (http://www.epa.gov/region03/mtntop/index.htm). A review of existing literature on health impacts from MTM was conducted to establish the baseline scientific understanding of MTM community health risks. The studies reviewed are primarily ecological, conducted using secondary data and investigations into whether associations between MTM and health exist. They do not provide direct assessments of environmental air and water quality in mining areas in relation to individual exposures and health outcomes. This more comprehensive research, including environmental chemical analyses and bio-monitoring, would require significantly greater funding. However, the results of these associational studies are sufficient to identify significant correlations between MTM activity and a variety of health disparities. Study findings indicate that health disparities are elevated in Appalachian coal mining regions for a number of common diseases including cardiovascular disease (CVD) and lung cancer. Risks for these diseases are affected by many factors including lifestyles, health-related behaviors and the cultural influences, genetic predispositions, environmental exposures, and lower socioeconomic status (SES). Coal mining areas are typically of lower SES relative to non-mining areas and more generally coal mining states such as West Virginia have overall lower SES than the U.S. average (Hendryx, 2008).

The Appalachian region has long been a region of severe socioeconomic disadvantages and consequently is inherently and area of environmental justice concern (http://www.epa.gov/environmentaljustice/). Lower socioeconomic status has long been correlated with higher disease incidence, prevalence and poorer health outcomes across the spectrum of diseases particularly chronic conditions, such as diabetes, heart disease, and cancer and recent studies have suggested that in Appalachia environmental pollution from the mining industry is a contributing factor (Hendryx & Ahern, 2009). For example, Hendryx and Ahern (2009) have found that age-adjusted mortality rates were higher every year from 1979 through 2005 in Appalachian coal mining areas that in other areas of Appalachia or the U.S. and the highest mortality rates were associated with areas having the highest levels of mining activity.

Another factor that may contribute to the higher mortality levels is elevated stress caused by economic disadvantage and environmental degradation. Adjusted mortality rates were found for both males and females which eliminates occupational exposure as the key explanatory factor (Hendryx and Ahern, 2009). Low socioeconomic status is a significant factor in morbidity and premature mortality and the higher unemployment and poverty rates in coal mining regions of Appalachia is likely a contributing factor to the region's poor health (Hendryx and Ahern, 2009). The heaviest coal mining areas of Appalachia had the poorest socioeconomic conditions. Before adjusting for covariates, the number of excess annual age-adjusted deaths in coal mining areas ranged from 3,975 to 10,923, depending on years studied and comparison group (Hendryx & Ahern, 2009). Areas with heavy mining have the highest unemployment rates in the region and coal mining counties in West Virginia experienced a mean net loss of 639 people to migration between 1995 and 2000, compared with a mean net migration gain of 422 people in non-mining counties (Hendryx and Ahern, 2009).

A number of environmental contaminants associated with coal extraction and processing are known to contribute to CVD including toxic metals such as arsenic and cadmium, particulate matter (PM) and polycyclic aromatic hydrocarbons (Hendryx & Zullig, 2009). Among West Virginia adults, residential proximity to heavy coal production was associated with poorer health status and with higher risk for cardiopulmonary disease, chronic lung disease, hypertension, and kidney disease, after controlling for covariates (Hendryx & Ahern, 2008).

Hendryx and Zullig (2009) conducted a study in to compare CVD rates for men and women residents of Appalachian coal mining counties before and after controlling for covariates. This study used national Behavioral Risk Factor Surveillance System (BRFSS) data to assess CVD risk in coal mining areas and incorporated important CVD covariates such as alcohol consumption, diabetes, obesity, and smoking. The results were that people in mining areas have higher risk of cardiovascular disease (CVD) (OR=1.22, 95% CI 1.14-1.30), angina or coronary heart disease (CHD) (OR=1.29, 95% CI=1.19-1.39), and heart attack (MI) (OR=1.19, 95% CI = 1.10-1.30) after adjusting for smoking, alcohol, gender, education, race, income, physician supply, and metropolitan status (Hendryx & Zullig, 2009).

Hendryx (2009) related county-level, age-adjusted mortality rates for the years 2000–2004 for heart, respiratory and kidney disease to tons of coal mined and found that total chronic heart, respiratory, and kidney disease, and kidney disease mortality rates were significantly higher in coal mining areas of Appalachia than non-coal mining areas for males and females. The study used Poisson regression models and included covariates of percent male population, college and high school education rates, poverty rates, race/ethnicity rates, primary care physician supply, rural-urban status, and smoking rates.

Cancer mortality is high relative to the U.S. in West Virginia and parts of Appalachia and has been linked with behavioral risk factors, such as smoking, associated with poor socioeconomic conditions (Hendryx, Fedorko, & Anesetti-Rothermel, 2010). Here again, coal mining activities potentially contribute to the elevated cancer rates. As noted by Hendryx (2008) and Hendryx and Ahern (2009) persons living in coal mining counties of Appalachia have elevated rates of total mortality and lung cancer mortality, after controlling for socio-economic status, availability of health care and other behaviors. Mining processes have contaminated trillions of gallons of water and released tons of particulate matter into the air in mining communities and it is known that coal contains many established carcinogens such as arsenic, cadmium, chromium, nickel, and beryllium (Hendryx, Fedorko, & Anesetti-Rothermel, 2010). Distance-weighted, at-risk population coal mining exposure measure was significantly correlated to cancer mortality in WV for total cancer and 3 subgroups after controlling for smoking rates and this held for all components of mining processes (injection, preparation plants, impoundments, and mining sites) (Hendryx, Fedorko, & Anesetti-Rothermel, 2010).

As noted previously incidence and mortality of cancer and other diseases in Appalachia is generally thought to result from higher smoking rates and associated low socioeconomic conditions and behaviors. Elevated arsenic levels in drinking water sources in coal mining areas have been found in areas of central Appalachia. And elevated lung cancer mortality rates largely attributed to smoking and socioeconomic factors may also be cause by exposure to environmental contaminants associated with mining processes. Hendryx, O'Donnell & Horn (2008) investigated whether elevated lung cancer mortality in Appalachia is attributable to strictly smoking and socioeconomic factors or whether an additional effect linked associated with proximity to heavy coal-mining areas is a contributor. The Hendryx, O'Donnell & Horn

(2008) study did indeed find that lung cancer mortality is higher in heavy coal-mining areas, followed by all other areas of Appalachia and the nation ($p<.001$) after accounting for covariates of gender, education, poverty, race, urban status, smoking, southern states, and Appalachian country. Additional studies have found that volume of coal mining is significantly related to hospitalization risk for hyptertension (odds increased 1% for each 1462 tons of coal) and chronic obstructive pulmonary disease (odds increased 1% for each 1873 tons of coal) controlled for age, gender, insurance, co-morbidities, county poverty, county and social capital (Hendryx, Ahern & Nurkiewicz, 2007) and that living in proximity to mining areas increases the odds of low birth weight, specifically, in mining areas, odds of low birth weight are increased by 14 to 16% depending on the amount of mining as compared to areas with no coal mining (Ahern, Mullett, MacKay, & Hamilton, 2010). A final study showed that ecological integrity was inversely related to age-adjusted cancer mortality rates (total $p<.01$; digestive, breast, and respiratory $p<.01$; urinary $p<.05$), controlled for poverty, access to health care providers, urbanization, education, smoking and that mining was significantly related to total cancer mortality (Hitt & Hendryx, 2010).

These studies by their nature could not and do not establish any causal linkage between MTM and these elevated rates of adverse health effects, but because they point to significant associations between MTM and elevated rates of adverse health impacts, the results warrant more research using rigorous epidemiological methods. The existing body of literature suggests that various negative health outcomes are not the result of a single exposure, but may reflect chronic exposures to multiple environmental pollutants, both air and/or water, which will vary for each individual. Though there is a growing body of research on mountain top mining, this research is not able to address the many confounders that are involved in assessing health effects

and strength of associations to MTM. Given the high level of concern about overall environmental and human health effects from mountain top mining (MTM) and the increasing focus of federal agency decisions to review and either approve or disapprove mining permits the existing literature base is inadequate. Rigorous primary research needs to be conducted in order to develop the level of relative certainty decision makers will need to disapprove permits or require pollution reduction measures to protect health.

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Christopher Hunter/DC/USEPA/US
11/16/2010 06:36 PM

To AshleyL Williams
cc
bcc
Subject More documents

Here is the recommended determination in the Spruce 404c action I told you about. The discussion on environmental justice and human health impacts begins on page 73

Spruce RD 092410.doc

And here is the Environmental Justice Executive Order

exec_order_12898.pdf

I'll be out on Wednesday this week, but we'll catch up next week if you're in.

Chris

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February 11, 1994

EXECUTIVE ORDER

FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1-1. **IMPLEMENTATION**.

1-101. *Agency Responsibilities*. To the greatest extent practicable and permitted by law, and consistent with the principles set forth In the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Marian islands.

1-102. *Creation of an Interagency Working Group on Environmental Justice* (a) Within 3 months of the date of this order, the Administrator of the Environmental Protection Agency ("Administrator") or the Administrator's designee shall convene an Interagency Federal Working Group on Environmental Justice ("Working- Group"). The Working Group shall comprise the heads of the following executive agencies and offices, or their designees: (a)Department of Defense; (b) Department of Health and Human Services; (c)Department of Housing and Urban Development; (d) Department of Labor; (e) Department of Agriculture; (f) Department of Transportation; (g) Department of Justice; (h) Department of the Interior; (i) Department of Commerce; (j) Department of Energy; (k) Environmental Protection Agency; (1) Office of Management and Budget; (m) Office of Science and Technology Policy; (n) Office of the Deputy Assistant to the President for Environmental Policy; (o) Office of the Assistant to the President for Domestic Policy; (p) National Economic Council; (q) Council of Economic Advisers; and (r) such other Government officials as the President may designate. The Working Group shall report to the President through the Deputy Assistant to the President for Environmental Policy and the Assistant to the President for Domestic Policy.

(b)The Working Group shall: (1) provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority populations and low-income populations;

(2)coordinate with, provide guidance to, and serve as a clearinghouse for, each Federal agency as it develops an environmental justice strategy as required by section 1-103 of this

order, in order to ensure that the administration, interpretation and enforcement of programs, activities and policies are undertaken in a consistent manner;

(3) assist in coordinating research by, and stimulating cooperation among, the Environmental Protection Agency, the Department of Health and Human Services, the Department of Housing and Urban Development, and other agencies conducting research or other activities in accordance with section 3-3 of this order;

(4) assist in coordinating data collection, required by this order;

(5) examine existing data and studies on environmental justice;

(6) hold public meetings at required in section 5-502(d) of this order; and

(7) develop interagency model projects on environmental justice that evidence cooperation among Federal agencies.

1-103. *Development of Agency Strategies*. (a) Except as provided in section 6-605 of this order, each Federal agency shall develop an agency-wide environmental justice strategy, as set forth in subsections (b) - (e) of this section that identifies and addresses disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. The environmental justice strategy shall list programs, policies, planning and public participation processes, enforcement, and/or rulemakings related to human health or the environment that should be revised to, at a minimum: (1) promote enforcement of all health and environmental statutes in areas with minority populations and low-income populations: (2) ensure greater public participation; (3) improve research and data collection relating to the health of and environment of minority populations and low-income populations; and (4) identify differential patterns of consumption of natural resources among minority populations and low-income populations. In addition, the environmental justice strategy shall include, where appropriate, a timetable for undertaking identified revisions and consideration of economic and social implications of the revisions.

(b) Within 4 months of the date of this order, each Federal agency shall identify an internal administrative process for developing its environmental justice strategy, and shall inform the Working Group of the process.

(c) Within 6 months of the date of this order, each Federal agency shall provide the Working Group with an outline of its proposed environmental justice strategy.

(d) Within 10 months of the date of this order, each Federal agency shall provide the Working Group with its proposed environmental justice strategy.

(e) Within 12 months of the date of this order, each Federal agency shall finalize its environmental justice strategy and provide a copy and written description of its strategy to the Working Group. During the 12 month period from the date of this order, each Federal agency, as part of its environmental justice strategy, shell identify several specific projects that can be

promptly undertaken to address particular concerns identified during the development of the proposed environmental justice strategy, and a schedule for implementing those projects.

(f) Within 24 months of the date of this order, each Federal agency shall report to the Working Group on its progress in implementing its agency-wide environmental justice strategy.

(g) Federal agencies shall provide additional periodic reports to the Working Group as requested by the Working Group.

1-104. *Reports to The President*. Within 14 months of the date of this order, the Working Group shall submit to the President, through the Office of the Deputy Assistant to the President for Environmental Policy and the Office of the Assistant to the President for Domestic Policy, a report that describes the implementation of this order, and includes the final environmental justice strategies described in section 1-103(e) of this order.

Sec. 2-2. **Federal Agency Responsibilities For Federal Programs**. Each Federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment, in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under, such, programs, policies, and activities, because of their race, Color, or national origin.

Sec. 3 -3. **Research, Data Collection, and Analysis**

3-301. *Human Health and Environmental Research and Analysis*. (a) Environmental human health research, whenever practicable and appropriate, shall include diverse segments of the population in epidemiological and clinical studies, including segments at high risk from environmental hazards, such as minority populations, low-income populations and workers who may be exposed to, substantial environmental hazards.

(b) Environmental human health analyses, whenever practicable and appropriate, shall identify multiple and cumulative exposures.

(c) Federal agencies shall provide minority populations and low-income populations the opportunity to comment on the development and design of research strategies undertaken pursuant to this order.

3-302. *Human Health and Environmental Data Collection and Analysis* To the extent permitted by existing law, including the Privacy Act, as amended (5 U.S.C. section 552a): (a) each federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information assessing and comparing environmental and human health risks borne by populations identified by race, national origin, or income. To the extent practical and appropriate, Federal agencies shall use this information to determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations;

(b) In connection with the development and implementation of agency strategies in section 1-103 of this order, each Federal agency, whenever practicable and appropriate, shall collect, maintain and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative or judicial action. Such information shall be made available to the public unless prohibited by law; and

(c) Each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding Federal facilities that are: (1) subject to the reporting requirements under the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. section 11001-11050 as mandated in Executive Order No. 12856; and (2) expected to have a substantial environmental, human health, or economic effect on surrounding populations. Such information shall be made available to the public unless prohibited by law.

(d) In carrying out the responsibilities in this section, each Federal agency, whenever practicable and appropriate, shall share information and eliminate unnecessary duplication of efforts through the use of existing data systems and cooperative agreements among Federal agencies and with State, local, and tribal governments.

Sec. 4-4. **Subsistence Consumption Of Fish And Wildlife**.

4-401. *Consumption Patterns*. Inorder to assist in identifying the need for ensuring protection of populations with differential patterns of subsistence consumption of fish and wildlife, Federal agencies, whenever practicable and appropriate, shall collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence. Federal agencies shall communicate to the public the risks of those consumption patterns.

4-402. *Guidance*. Federal agencies, whenever practicable and appropriate, shall work in a coordinated manner to publish guidance reflecting the latest scientific information available concerning methods for evaluating the human health risks associated with the consumption of pollutant-bearing fish or wildlife. Agencies shall consider such guidance in developing their policies and rules.

Sec. 5-5. **Public Participation and Access to Information** (a) The public may submit recommendations to Federal agencies relating to the incorporation of environmental justice principles into Federal agency programs or policies. Each Federal agency shall convey such recommendations to the Working Group.

(b) Each Federal agency may, whenever practicable and appropriate, translate crucial public documents, notices, and hearings relating to human health or the environment for limited English speaking populations.

(c) Each Federal agency shall work to ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public.

(d) The Working Group shall hold public meetings, as appropriate, for the purpose of fact-finding, receiving public comments, and conducting inquiries concerning environmental justice. The Working Group shall prepare for public review a summary of the comments and recommendations discussed at the public meetings.

Sec. 6-6. **General Provisions**.

6-601. *Responsibility for Agency Implementation*. The head of each Federal agency shall be responsible for ensuring compliance with this order. Each Federal agency shall conduct internal reviews and take such other steps as may be necessary to monitor compliance with this order.

6-602. *Executive Order No. 12250.* This Executive order is intended to supplement but not supersede Executive Order No. 12250, which requires consistent and effective implementation of various laws prohibiting discriminatory practices in programs receiving Federal financial assistance. Nothing herein shall limit the effect or mandate of Executive Order No. 12250.

6-6O3. *Executive Order No. 12875.* This Executive order is not intended to limit the effect or mandate of Executive Order No. 12875.

6-604. *Scope*. For purposes of this order, Federal agency means any agency on the Working Group, and such other agencies as may be designated by the President, that conducts any Federal program or activity that substantially affects human health or the environment. Independent agencies are requested to comply with the provisions of this order.

6-605. *Petitions far Exemptions*. The head of a Federal agency may petition the President for an exemption from the requirements of this order on the grounds that all or some of the petitioning agency's programs or activities should not be subject to the requirements of this order.

6-606. *Native American Programs*. Each Federal agency responsibility set forth under this order shall apply equally to Native American programs. In addition the Department of the Interior, in coordination with the Working Group, and, after consultation with tribal leaders, shall coordinate steps to be taken pursuant to this order that address Federally- recognized Indian Tribes.

6-607. *Costs*. Unless otherwise provided by law, Federal agencies shall assume the financial costs of complying with this order.

6-608. *General.* Federal agencies shall implement this order consistent with, and to the extent permitted by, existing law.

6-609. *Judicial Review*. This order is intended only to improve the internal management of the executive branch and is not intended to, nor does it create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, its officers, or any person. This order shall not be construed to create any right to judicial review involving the compliance or noncompliance of the United States, its agencies, its officers, or any other person with this order.

William J. Clinton

THE WHITE HOUSE,
February 11, 1994.

Recommended Determination of the U.S. Environmental Protection Agency Region III Pursuant to Section 404(c) of the Clean Water Act Concerning the Spruce No. 1 Mine, Logan County, West Virginia

U.S. Environmental Protection Agency
Region III

September 24, 2010

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I. Executive Summary

The Spruce No. 1 Mine as currently authorized Department of the Army (DA) Permit No. 199800436-3 (Section 10: Coal River), is one of the largest mountaintop mining projects ever authorized in West Virginia. If it is fully constructed, it will disturb approximately 2,278 acres and bury approximately 7.48 miles of streams.

As the phrase suggests, "mountaintop mining" involves removing the top of a mountain in order to recover coal seams contained within the mountain. Explosives are used to break apart the mountain's bedrock, and earth-moving equipment is used to remove the excess rock, soil, and debris (called "spoil") that formerly had composed the portions of the mountain above and immediately below the coal seams. The fractured material is larger in volume than when it was intact, fused bedrock within the mountain. The amount of spoil that may be placed on the mined area is also limited due to stability concerns. Hence mountaintop mining generates large quantities of "excess spoil" (i.e., volumes of rock, soil, and debris that cannot be placed back in the mined area) that are deposited in valleys, thereby burying streams that flow through those valleys. In this case, if the Spruce No. 1 Mine is constructed as currently authorized, it will bury headwater stream ecosystems under 110 million cubic yards of excess spoil.

The Spruce No. 1 Mine has a lengthy and complex history. The DA Permit No. 199800436-3 (Section 10: Coal River) (DA Permit) was issued by the US Army Corps of Engineers, Huntington District (Corps) in January 2007 authorizing the Mingo Logan Coal Company to construct six valley fills, associated sedimentation structures, and other discharges of fill material to the Right Fork of Seng Camp Creek, Pigeonroost Branch, Oldhouse Branch, and their tributaries. Due to litigation and an agreement with environmental groups, operations have been limited to the Seng Camp Creek watershed and as part of that agreement one valley fill is partially constructed.

Throughout review of the project, the U.S. Environmental Protection Agency has raised concerns regarding adverse impacts to the environment. Additionally, data and information have become available since permit issuance, which have confirmed EPA's earlier concerns regarding the potential for adverse water quality impacts, the potential for cumulative impacts, the availability of further avoidance and minimization measures and problems with the proposed mitigation measures.

On April 2, 2010, the U.S. Environmental Protection Agency Region III (EPA Region III or Region III) published in the Federal Register a Proposed Determination to prohibit, restrict or deny the specification or the use for specification (including withdrawal of specification) of certain waters at the project site as disposal sites for the discharge of dredged and/or fill material for the construction of the Spruce No. 1 Mine. Region III took this step because it believed, despite the regulatory review intended to protect the environment, that discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) could destroy wildlife habitat and cause significant degradation of downstream aquatic ecosystems and therefore could have unacceptable adverse effects on wildlife.

A public hearing was conducted on May 18, 2010. Region III received over 100 oral comments and over 50,000 written comments both supporting and opposing its Proposed Determination. Region III has carefully considered the comments received and conducted additional analysis, which will be described herein, before rendering this Recommended Determination.

Based on the foregoing analysis and upon consideration of the public comments received in response to Region III's proposed determination, Region III believes that discharges of dredged and/or fill material to Pigeonroost Branch and Oldhouse Branch for the purpose of constructing the Spruce No. 1 Surface Mine as currently authorized by DA Permit would likely have unacceptable adverse effects on wildlife. For this reason, it is the recommendation of the Regional Administrator that the specification embodied in DA Permit No. 199800436-3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material for construction of the Spruce No. 1 Surface Mine be withdrawn.

The goal of protecting water quality, plant and animal habitat, navigable waters, and other downstream resources requires as its first step the protection of headwater streams. Headwater streams perform services similar to those performed by capillaries in the human circulatory system. They are the largest network of waterbodies within our ecosystem and provide the most basic and fundamental building blocks to the remainder of the aquatic and human environment. As set forth herein, Pigeonroost Branch and Oldhouse Branch represent some of the very few remaining streams within the Spruce Fork sub-watershed and the Coal River sub-basin that represent “least degraded” conditions. They support diverse and healthy biological communities. As such, they are valuable in and of themselves and within the context of the Spruce Fork sub-watershed and Coal River sub-basin.

As currently authorized by DA Permit discharges of excess spoil to Pigeonroost Branch and Oldhouse Branch would bury those streams and their tributaries and the wildlife that live within them. Other wildlife would lose important headwater stream habitat on which they depend for all or part of their lifecycles.

In addition, the construction of valley fills, sedimentation ponds and other discharges into Pigeonroost Branch and Oldhouse Branch authorized by the DA Permit would likely have adverse impacts on downstream waters and wildlife living outside the footprint of the fill. These adverse impacts would be caused by the removal of functions performed by the buried resources and by transformation of the buried areas into sources that contribute contaminants to downstream waters. In addition, discharges to Pigeonroost Branch and Oldhouse Branch as currently authorized would likely contribute to conditions that would support blooms of golden algae that release toxins that kill fish and other aquatic life.

Based on these impacts, Region III has determined that discharges to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal

River) would likely have unacceptable adverse effects on wildlife. Particularly in light of the high quality of the impacted resources, it is unlikely that the compensatory mitigation plan (CMP) for the project would offset these impacts. The proposed on-site created streams would be unlikely to replace the physical, chemical, and especially biological functions of Pigeonroost Branch and Oldhouse Branch.

There are other impacts that, while not forming the basis of the Recommended Determination, are of concern to the Region. To the extent that discharge of excess spoil outside jurisdictional waters, deforestation, and other activities associated with the project depend upon specification of Pigeonroost Branch and Oldhouse Branch as disposal sites, there are likely to be other adverse impacts from those dependent activities. In addition, impacts from the project will contribute to cumulative impacts from multiple surface mining activities in the Coal River sub-basin. There are also concerns regarding environmental justice.

II. Introduction

This document explains the basis for the EPA Region III recommendation to withdraw the specification of Pigeonroost Branch, Oldhouse Branch and their tributaries (all of which are waters of the United States) within Logan County, West Virginia as a disposal site for dredged or fill material in connection with construction of the Spruce No. 1 Surface Mine (Spruce No. 1 Mine or the project) as currently authorized by DA Permit No. 199800436-3 (Section 10: Coal River)(DA Permit or permit) (See Figure 3). While the DA Permit also authorizes construction of valley fills and other discharges to the Right Fork of Seng Camp Creek and its tributaries, Region III is not recommending withdrawal of specification of those waters in part because some of those discharges have already occurred.

EPA Region III is recommending that action be taken under section 404(c) of the Clean Water Act (CWA) because the Region believes that the discharges to Pigeonroost Branch and Oldhouse Branch and their tributaries for the purpose of constructing Spruce No. 1 Mine as currently authorized by the DA Permit would likely have unacceptable adverse effects on wildlife. Pigeonroost Branch and Oldhouse Branch and their tributaries are some of the last remaining streams within the Spruce Fork sub-watershed and the larger Coal River sub-basin that represent "least degraded" conditions. As such, they perform important hydrologic and biological functions, support diverse and productive biological communities, contribute to prevention of further degradation of downstream waters, and play an important role within the context of the overall Spruce Fork sub-watershed and Coal River sub-basin. The Spruce No. 1 Mine as currently authorized would bury virtually all of Oldhouse Branch and its tributaries and much of Pigeonroost Branch and its tributaries under excess spoil generated by mountaintop removal surface coal mining operations. Region III does not believe that the anticipated effects of the burial of all of Oldhouse Branch and much of Pigeonroost Branch will be offset by the proposed mitigation because it will not replace the chemical, physical and biological functions of the lost aquatic resources.

In addition, this recommendation considers the adverse impacts from mining-related activities, such as deforestation, that are associated with the discharge of excess spoil to areas outside the jurisdictional waters to the extent that these activities necessarily depend upon specification of Pigeonroost Branch and Oldhouse Branch for the construction of valley fills and sedimentation ponds. Moreover, the discharges associated with the Spruce No. 1 Mine will contribute to a cumulative adverse impact to the Spruce Fork sub-watershed, the Little Coal River watershed and the Coal River sub-basin. Finally, the Region continues to be concerned that potential issues related to disproportionate and high impact on the local population from construction of the Spruce No. 1 Mine have not been fully considered.

The next Section provides an overview of the Section 404(c) procedures, describes the Spruce No. 1 Mine as authorized, and summarizes the history of the project. Section IV describes the environmental characteristics of the project area, specifically Pigeonroost Branch and Oldhouse Branch, and the overall Coal River sub-basin. Section V examines the anticipated impacts from the Spruce No. 1 Mine as currently authorized. Consistent with Section 404(c), this discussion will focus on impacts to wildlife. Section VI will discuss other considerations, including impacts from activities associated with the Spruce No. 1 Mine that do not include direct discharges of dredged and/or fill material to jurisdictional waters but which may depend upon authorization of such discharges, and that are likely to cause direct and cumulative impacts to the environment and to local communities. Section VII describes EPA Region III's conclusions and recommendations.

III. Background

A. Section 404(c) Procedures

The CWA, 33 U.S.C. §§ 1251 et seq., prohibits the discharge of pollutants, including dredged or fill material, into waters of the United States (including wetlands) except in compliance with, among other provisions, Section 404 of the CWA, 33 U.S.C. § 1344. Section 404 authorizes the Secretary of the Army (Secretary), acting through the Chief of Engineers, to authorize the discharge of dredged or fill material at specified disposal sites. This authorization is conducted, in part, through the application of environmental guidelines developed by EPA, in conjunction with the Secretary, under section 404(b) of the CWA, 33 U.S.C. § 1344(b) (Section 404(b)(1) Guidelines). Section 404(c) of the CWA, 33 U.S.C. § 1344(c), authorizes the EPA to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site. EPA is authorized to restrict or deny the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever it determines, after notice and opportunity for public hearing, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas.

The procedures for implementation of Section 404(c) are set forth in 40 CFR Part 231. Under those procedures, if the Regional Administrator has reason to believe that use of a site for the discharge of dredged or fill material may have an unacceptable adverse effect

on one or more of the aforementioned resources, he may initiate the section 404(c) process by notifying the U.S. Army Corps of Engineers (Corps) and the applicant (and/or project proponent) that he intends to issue a Proposed Determination. Each of those parties then has fifteen days to demonstrate to the satisfaction of the Regional Administrator that no unacceptable adverse effects will occur, or that corrective action to prevent an unacceptable adverse effect will be taken. If no such information is provided to the Regional Administrator, or if the Regional Administrator is not satisfied that no unacceptable adverse effect will occur, the Regional Administrator will publish a notice in the Federal Register of his Proposed Determination, soliciting public comment and offering an opportunity for a public hearing.

Following the public hearing and the close of the comment period, the Regional Administrator will decide whether to withdraw the Proposed Determination or prepare a Recommended Determination. A decision to withdraw may be reviewed at the discretion of the Assistant Administrator for Water at EPA Headquarters. If the Regional Administrator prepares a Recommended Determination, he then forwards it and the administrative record compiled in the Regional Office to the Assistant Administrator for Water at EPA Headquarters. The Assistant Administrator makes the Final Determination affirming, modifying, or rescinding the Recommended Determination.

This document represents the third step in the process and explains the basis for EPA Region III's Recommended Determination.

B. Project Description

The Spruce No. 1 Mine as currently authorized by DA Permit No. 199800436-3 (Section 10: Coal River), is one of the largest mountaintop mining projects ever authorized in West Virginia. As currently authorized, it will disturb approximately 2,278 acres (about 3.5 square miles) and bury approximately 7.48 miles of streams. By way of comparison, the project area would take up a sizeable portion of the downtown area of Pittsburgh, PA (Figure 1).

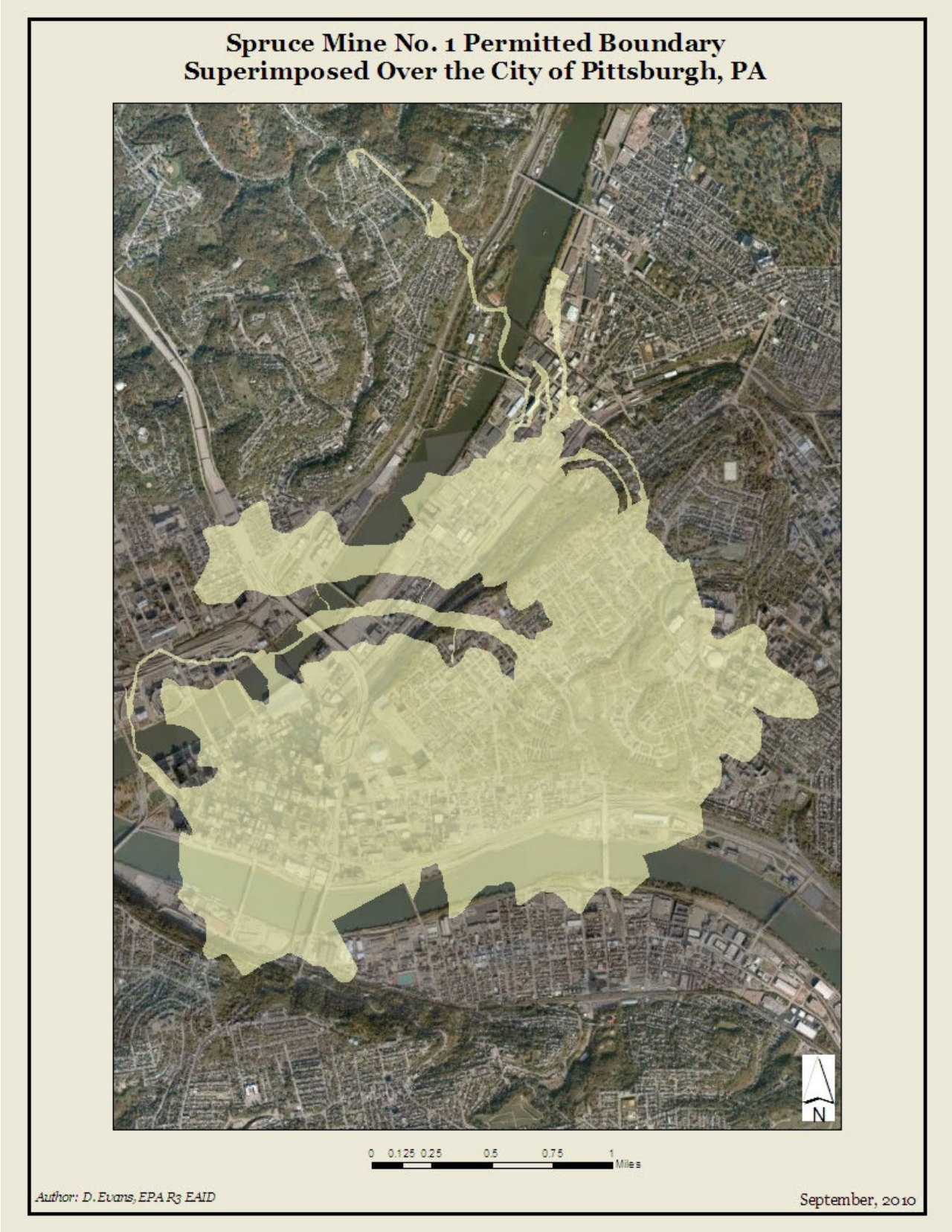

Figure 1 Spruce No. 1 Mine compared to downtown Pittsburgh, PA.

The project as authorized is located in the East District of Logan County, West Virginia at Latitude 38°52'39" and Longitude 81°47'52" depicted on the United States Geological Survey 7.5-minute Clothier and Amherstdale Quadrangles (Figure 2). The mine site is located approximately two miles northeast of Blair, in Logan County, West Virginia in the Central Appalachian ecoregion (Bryce, S.A., J.M. Omernik, and D.P. Larsen. 1999). http://www.epa.gov/wed/pages/ecoregions.htm

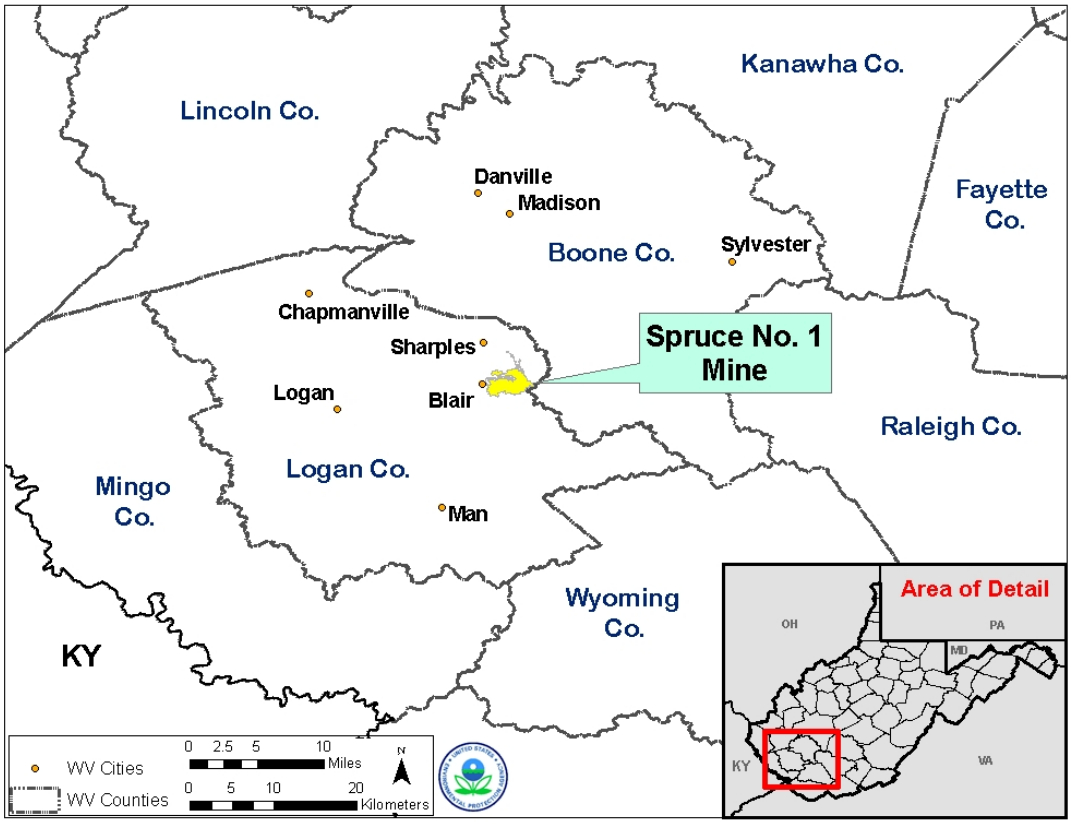

Figure 2: Spruce No. 1 mine location

According to the Environmental Impact Statement (EIS) prepared by the Corps in 2006 (Spruce No. 1 EIS) for the project, the Spruce No. 1 project is a mountaintop mining project targeting bituminous coal seams overlying and including the Middle Coalburg coal seam in the western portion of the project area. In the eastern portion of the project area, mountaintop mining would be limited to those seams including and overlying the Upper Stockton seam, with contour mining in conjunction with auger and/or highwall/thin-seam mining utilized to recover the Middle Coalburg seam.

As the phrase suggests, "mountaintop mining" involves removing the top of a mountain to recover coal seams contained within the mountain. Explosives are used to break apart the mountain's bedrock and earth-moving equipment is used to remove the excess rock, soil and debris (called “spoil”) that formerly had composed the portions of the mountain above and immediately below the coal seam. The fractured material is larger in volume

than when it was intact, fused bedrock within the mountain. The amount of spoil that may be placed back on the mined area is also limited due to stability concerns. Hence mountaintop mining generates large quantities of "excess spoil" that cannot be placed back in the mined area. The “spoil” is then deposited in valleys, thereby burying streams that flow through those valleys.

The Spruce No. 1 EIS describes the project impacts as a disturbance of a total of 2,278 acres to recover seventy-five percent (75%) of the coal reserve targeted for extraction within the project area during fifteen (15) phases. The mining process would remove 400 to 450 vertical feet from the height of the mountain, about 501 million cubic yards of overburden material. Nearly 391 million cubic yards of spoil would be placed within the mined area (i.e., back on the mountain) and the remaining 110 million cubic yards of excess spoil would be placed in six valley fills, burying all or portions of the Right Fork of Seng Camp Creek, Pigeonroost Branch, and Oldhouse Branch and their tributaries (hereafter, references to Seng Camp Creek, Pigeonroost Branch, and Oldhouse Branch also include all tributaries to those waters that would be impacted by the project as authorized). Specifically, the DA Permit authorizes construction of Valley Fills 1A and 1B in Seng Camp Creek; Valley Fills 2A, 2B, and 3 in Pigeonroost Branch; and Valley Fill 4 in Oldhouse Branch, and numerous sedimentation ponds, mined-through areas and other fills in waters of the U.S (Figure 3). A detailed discussion of Spruce No. 1 project can be found in the Spruce No. 1 EIS on pages 2-35 through 2-61.

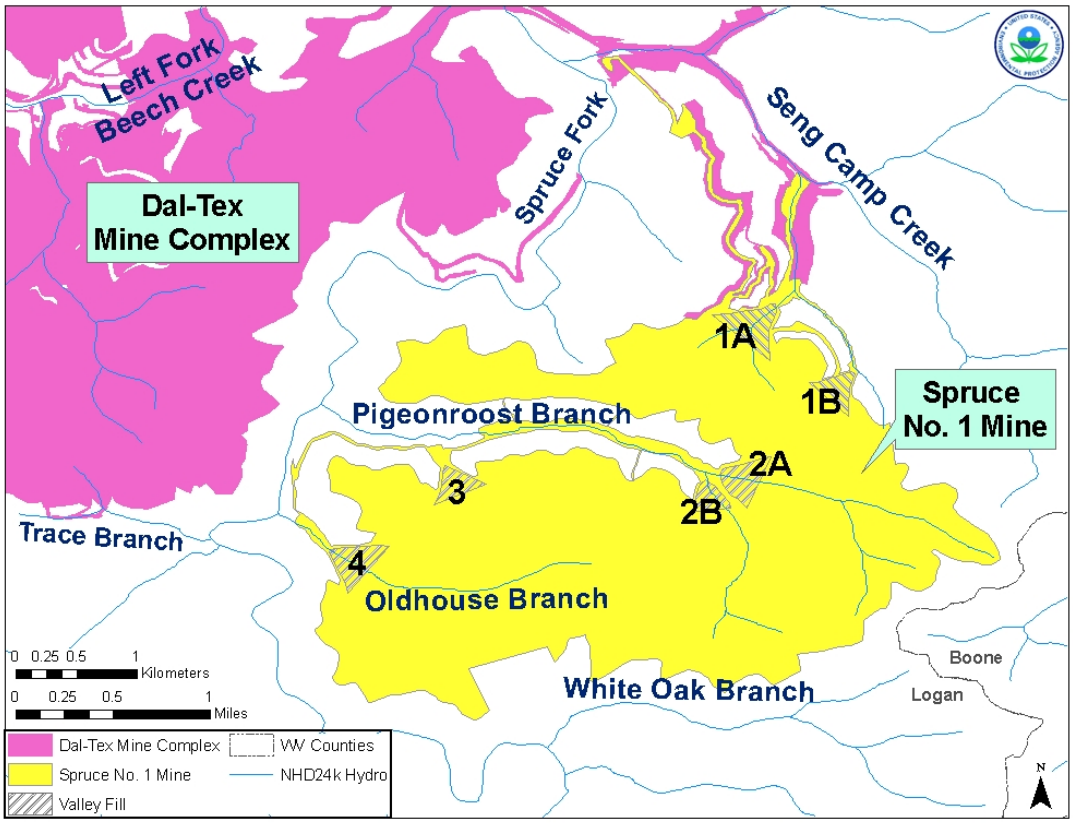

Figure 3. Spruce No. 1 Mine and associated valleyfills.

The Spruce No.1 Mine Surface Mining Control and Reclamation Act (SMCRA) Permit S-5013-97, Incidental Boundary Revision (IBR4, Modification 11) describes impacts from the project as including placement of dredged and fill material into approximately:

- 0.12 acre of emergent wetlands
- 10,630 linear feet (1.83 acres) of ephemeral stream channels (all permanent),
- 28,698 linear feet (6.12 acres) of intermittent stream channels
    - (26,184 linear feet [5.77 acres] permanent
    - 2,514 linear feet [0.35 acre] temporary)
- 165 linear feet (0.034 acre) of perennial stream channel (all temporary),

While Region III is providing the foregoing summary from the SMCRA Permit S-5013-97 IBR for descriptive purposes, as set forth in more detail in Section V.C.2. below, Region III believes that the description provided in the Spruce No. 1 SMCRA Permit and in the Spruce No. 1 EIS incorrectly characterizes stream resources that will be impacted, as described further below.

The project as authorized also includes compensatory mitigation to offset adverse project impacts. EPA's concerns with the November 2006 compensatory mitigation plan (CMP) submitted by the permittee will be described in Section V.C.

C. Project History

This project has a lengthy and complex regulatory history. The Spruce No. 1 Mine was originally advertised as operated by Hobet Mining Inc., a subsidiary of Arch Coal, Inc.[1] The project as originally proposed in 1998, was larger than the currently authorized project and would have directly impacted a total footprint area of 3,113 acres and 57,755 linear feet (more than ten miles) of stream (not including indirect impacts to remaining downstream waters). At that time, the Corps tendered and ultimately withdrew a nationwide permit for the project, and the permittee, Mingo Logan, advised the Corps it would submit an individual permit application. An Environmental Impact Statement was prepared for the Spruce No. 1 project by the Army Corps of Engineers Huntington District pursuant to the National Environmental Policy Act, 42 U.S.C. 4332(C). The original project application also launched events that led to the Interagency Mountaintop Mining/Valley Fills in Appalachia Programmatic Environmental Impact Statement which was finalized in October 2005 (PEIS). The PEIS is available at www.epa.gov/Region3/mtntop/eis2005.htm.

An initial 2002 Spruce No. 1 Draft Environmental Impact Statement (EIS) considered a proposed project that was similar in scope and size to the original project described above. Region III's review of the 2002 Draft Environmental Impact Statement found gaps in the analyses of the mine and related adverse environmental impacts. Region III was particularly concerned by the lack of information regarding the nature and extent of impacts to the high quality streams that would be buried under valley fills, and recommended additional evaluation to support the analysis of less environmentally damaging alternatives. EPA Region III, in a letter dated August 12, 2002, indicated the EIS contained inadequate information for public review and for decision-makers.

In 2006, a revised Spruce No. 1 Draft EIS was prepared. At that time, the project was reconfigured to reduce impacts. The Mingo Logan, revised the mine plan to eliminate construction of a valley fill in White Oak Branch, a high quality stream (see Section IV.A. below) and the project area was reduced from 3,113 to 2,278 acres with direct stream impacts reduced to 7.48 miles.

In our June 16, 2006, comment letter on the 2006 Draft EIS, EPA Region III recognized that impacts from the mine had been reduced and the quality of EIS information had improved. However, the letter also noted that EPA had remaining environmental concerns associated with the Spruce No. 1 Mine, including potential adverse impacts to water quality (specifically, the potential to discharge selenium and the known correlation between similar mining operations and degradation of downstream aquatic communities), uncertainties regarding the proposed mitigation, need for additional analysis of potential environmental justice issues, and lack of study related to the cumulative impact of multiple mining operations within the Little Coal River watershed. EPA continued to

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[1] Effective December 31, 2005, Arch Coal, Inc. transferred Spruce No. 1 Mine holdings and responsibilities to its Mingo Logan Coal Company (Mingo Logan) subsidiary.

stress its belief that corrective measures should be required to reduce environmental impacts and that other identified information, data, and analyses should be included in the final EIS.

Concerns regarding the Spruce No. 1 project were also raised by the U.S. Fish and Wildlife Service (USFWS), Ecological Services West Virginia Field Office in a letter dated May 30, 2006 from the Department of Interior, Philadelphia to the Huntington District Army Corps of Engineers. In that letter, the USFWS expressed concerns over the permittee's compensatory mitigation plan. The USFWS stated there was inadequate compensatory mitigation for the project because the assessment methodology used by the permittee to evaluate stream impacts considered only the physical characteristics of the impacted streams, without considering the equally important biological or chemical characteristics. The USFWS expressed concern the project would impact healthy, biologically functional streams and the mitigation included erosion control structures designed to convey water that would not replace the streams' lost ecological services.

The Corps issued the Spruce No. 1 Final EIS on September 22, 2006. On October 23, 2006, EPA commented on the Final EIS, noting that many of EPA's comments had not been adequately addressed. In a letter dated November 30, 2006, EPA offered its assistance to the Corps in developing a stream functional assessment protocol and willingness to work with Mingo Logan through EPA's Conflict Prevention and Resolution Center to develop a cumulative impact assessment and watershed restoration plan for the Little Coal River watershed.

Despite EPA and USFWS concerns on January 22, 2007, the Corps issued a Clean Water Act § 404 Permit (DA Permit No. 199800436-3 (Section 10: Coal River)) to Mingo Logan for the Spruce No. 1 Mine. That permit specified the Right Fork of Seng Camp Creek, Pigeonroost Branch and its tributaries, and Oldhouse Branch and its tributaries as disposal sites for the discharge of dredged and/or fill material from the Spruce No. 1 Mine.

On January 30, 2007, a number of environmental groups filed a complaint against the Corps in federal district court challenging its decision to issue the permit. That litigation was stayed for a period of time pending the U.S. Court of Appeals for the Fourth Circuit's decision in *Ohio Valley Environmental Coalition v. Aracoma Coal Co.,* 556 F. 3d 177 (4th Cir. 2009). Following that decision, the litigation related to the Spruce No. 1 permit was reactivated. The litigation was then stayed again until October 22, 2010 following Region III's publication of its Proposed Determination on April 2, 2010.

In early 2007, Mingo Logan commenced limited operations at Spruce No. 1 pursuant to their DA Permit No. 199800436-3 (Section 10: Coal River) subject to an agreement with the environmental groups who are plaintiffs in the litigation. Pursuant to that agreement, Mingo Logan has been operating in a portion of the project in the Seng Camp Creek drainage area, including construction of one valley fill (valley fill 1A). Under the agreement, Mingo Logan must give plaintiffs 20 days notice before expanding operations

beyond the area subject to the agreement, and has done so once without objection from the plaintiffs. Mingo Logan's operations in the Seng Camp Creek watershed have generated data related to impacts from the project as constructed, including discharge monitoring reports submitted to the West Virginia Department of Environmental Protection (WVDEP). These data have been reviewed by Region III.

While the litigation was pending, the scientific literature beagn to reflect a growing scientific consensus of the importance of headwater streams, a growing concern about the adverse effects of mountaintop removal mining, and concern that impacted streams cannot easily be replaced. Many of these studies are cited in this Recommended Determination. On June 11, 2009, EPA , the Department of the Army, and the Department of the Interior entered into a *Memorandum of Understanding Implementing the Interagency Action Plan on Appalachian Surface Coal Mining,* in which the agencies agreed to take steps to reduce the harmful environmental consequences of Appalachian surface coal mining. On April 1, 2010, the U.S. Environmental Protection Agency's Office of Research and Development made available for public comment two reports titled: *The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields* and *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams.* On the same day, EPA also published interim guidance titled: *Guidance on Improving EPA Review of Appalachian Surface Coal Mining Operations under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order.*[2]

On September 3, 2009, Region III requested the Corps suspend, modify or revoke DA Permit No. 199800436-3 (Section 10: Coal River) for discharges associated with the Spruce No. 1 Mine. On September 30, 2009, the Corps of Engineers stated that it would not reconsider the permit authorization. As a result, Region III initiated the Clean Water Act Section 404(c) process on October 16, 2009. Region III communicated with representatives of Mingo Logan and the Corps both in person and by telephone and electronic mail on several occasions to determine whether corrective action would be taken to address Region III's concerns. On April 2, 2010, Region III published in the Federal Register a Proposed Determination to withdraw specification of Pigeonroost Branch and Oldhouse Branch pursuant to CWA section 404(c). Region III solicited public comments on the Proposed Determination and held a public hearing in Charleston, West Virginia on May 18, 2010. Region III received over 50,000 comments on the Proposed Determination. Of these approximately 70% of comment letters submitted to the docket generally supported EPA's Proposed Determination while 65% of public hearing participants generally opposed EPA's Proposed Determination.

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[2] Issuance of this guidance document is mentioned here solely for purposes of describing recent events related to EPA's understanding of impacts from Appalachian surface coal mine activities. The guidance provides a framework for EPA review of certain proposed surface coal mining applications. This Recommended Determination is based upon Region III's review of scientific and other information regarding the likely effects from the discharges to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River). Region III did not rely upon the April 1 Guidance in making its Recommended Determination.

In addition to its DA Permit No. 199800436-3 (Section 10: Coal River), the project received authorizations from the WVDEP, including authorization pursuant to the State's surface mining program approved under the Surface Mining Control and Reclamation Act of 1977 (SMCRA), 30 U.S.C. 1201-1328 (SMCRA permit), and a National Pollutant Discharge Elimination System (NPDES) permit for discharges of pollutants pursuant to Section 402 of the Clean Water Act, 33 U.S.C. 1342. WVDEP also issued a Clean Water Act Section 401 water quality certification.

IV. Characteristics and Functions of the Impacted Resources[3]

The resources that will be impacted by the Spruce No. 1 Mine include Central Appalachian headwater stream ecosystems in Pigeonroost Branch and Oldhouse Branch. Those waters have surface connection and flow to Spruce Fork, which in turn flows to the Little Coal River, and the Coal River. Because of the connectivity between headwater systems and downstream waters, Spruce Fork, the Little Coal River and the Coal River also would be likely to be impacted by discharges to Pigeonroost Branch and Oldhouse Branch. Accordingly, the characteristics and functions of the resources that will be impacted by discharges of fill material associated with the Spruce No. 1 Mine are best viewed from the perspective of the ecologic functions performed by Appalachian headwater stream ecosystems and within the context of the larger Spruce Fork sub-watershed and Coal River sub-basin.

Headwater streams play an important role in the ecosystem far beyond the mere transport of water from one point to another. In many ways, headwater streams are like the capillaries within the human circulatory system. Headwater streams form the largest network of waterbodies within the ecosystem and, as the early stages of the river continuum, provide the most basic and fundamental building blocks to the remainder of the aquatic and human environment. Appalachian headwaters provide habitat for wildlife. They also are a locus of significant interface between the river system and the terrestrial environment. Appalachian headwater streams and their wildlife inhabitants convert organic matter from the surrounding landscape (such as leaf litter) and transform it into nutrients and energy that can be transported and consumed by downstream

[3] Region III derives its understanding of the potentially impacted resources and the predicted impacts of the project from several sources. The Draft (June 2003) and Final (October 2005) Interagency Mountaintop Mining/Valley Fills in Appalachia Programmatic EIS (PEIS) represent an important inter-agency effort designed to inform more environmentally sound decision-making for future permitting of mountaintop mining/valley fills. It had a geographic focus of 12 million acres encompassing most of eastern Kentucky, southern West Virginia, western Virginia, and scattered areas of eastern Tennessee, and included the Spruce No. 1 project area and the Coal River subbasin. EPA also consulted information gathered by the WVDEP, including an assessment of the Coal River sub-basin conducted in 1997, data collected to support the 2006 Coal River sub-basin total maximum daily load (TMDL), and WVDEP and nationally available GIS data. EPA also reviewed the 2006 Spruce No.1 EIS, and other sources of data including studies conducted by EPA scientists and discharge monitoring reports generated by Mingo Logan. In addition, EPA consulted a wide range of peer reviewed studies and literature. EPA Region III also communicated with the US Fish and Wildlife Service Elkins Field Office on impacts to fish and wildlife resources in the project area. Appendices to this Recommended Determination (RD) contain more detailed specific data, analysis and an index of references.

ecosystems. They also play an important role in storing, retaining and transporting nutrients, organic matter, and sediment. In addition they perform hydrologic functions related to downstream flow regimes, moderating flow rate and temperature. "Value of Headwater Streams: Results of a Workshop" from PEIS on MTM/VF (EPA 2003; http://www.epa.gov/region03/mtntop/pdf/appendices/d/value-of-headwater-streams/headwater.pdf); Fischenich, J.C. (2006), *Functional objectives for stream restoration.* EMRRP Technical Notes Collection (ERDC TN-eMRRP-SR-52 Vicksburg).

As authorized, the Spruce No. 1 Mine would bury under valley fills or impact through construction of sedimentation ponds substantially all of Oldhouse Branch and its tributaries and a substantial portion of Pigeonroost Branch and its tributaries. Oldhouse Branch and Pigeonroost Branch support ecosystems and conditions consistent with "least degraded" conditions in the Coal River sub-basin. As such, they are valuable in and of themselves and for the functions they perform within the context of the Spruce Fork sub-watershed and the Coal River sub-basin.

A. Watershed and Stream Conditions

1. Pigeonroost Branch and Oldhouse Branch

The stream systems that are the subject of this Recommended Determination, Pigeonroost Branch and Oldhouse Branch, are healthy stream systems supporting diverse aquatic communities as measured by their benthic macroinvertebrate populations.

In a body of water, benthic macroinvertebrates are the bottom-dwelling (benthic) organisms that are large enough to be seen without the aid of microscopes (macro) and do not have backbones (invertebrate). Freshwater macroinvertebrates, such as mayflies and stoneflies, serve as indicators of ecosystem health, and play a vital role in food webs and in the transfer of energy in river systems. These organisms convert plant material into fats and proteins, food sources critical for maintaining healthy fish and amphibian populations, as well as for foraging terrestrial vertebrates such as birds, bats, reptiles, and small mammals. In this ecological niche, macroinvertebrates deliver energy and nutrients along the stream continuum. They also clean excess living and nonliving organic material from freshwater systems, a service that contributes to the overall quality of the watershed. Because of these functions, macroinvertebrates are essential organisms within the food web, supporting the health of the entire aquatic ecosystem.

Macroinvertebrates are also good indicators of watershed health and are used by West Virginia and other states in the Mid-Atlantic region and across the U.S. to assess the quality of their waters. They are good indicators because they live in the water for all or most of their life cycle. Macroinvertebrates can be found in all streams, are relatively stationary and cannot escape pollution. They also differ in their tolerance to the amount and types of pollution. Macroinvertebrate communities integrate the effects of stressors over time and some taxa (i.e., taxonomic category or group such as phylum, class, family, genus, or species) are considered pollution-tolerant and will survive in degraded conditions. Other taxa are pollutant-intolerant and will die when exposed to certain levels

of pollution. Thus, the composition of tolerant and intolerant (i.e., sensitive) communities informs scientists about the quality of the water.

In a healthy stream, one would expect to find a high diversity of benthic macroinvertebrate taxa and a large number of different taxa including taxa that are more sensitive to stressors. Using the mayfly (Insecta: Ephemeroptera) as an example, some genera of mayfly are more sensitive than others. The presence of a large number of individuals from the more sensitive mayfly genera indicates good water quality conditions. Mayflies in particular have long been recognized as important indicators of stream ecosystem health. Mayflies are a very important part of the native organisms in Appalachian headwater streams and they routinely make up between 30%-50% of the insect assemblages in certain seasons. Numerous studies demonstrate that mayfly community structure reflects the chemical and physical environment of watercourses (e.g., Barber-James et al. 2008; Bauernfeind & Moog 2000). See Appendix 1 for more detail on macroinvertebrates as indicators of water quality.

According to Morse et al. (1997) , the Central Appalachian ecoregion has many endemic and rare species of benthic macroinvertebrates in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).[4] This diversity and unique assemblage has been attributed to the unique geological, climatic, and hydrological characteristics of this region. The Spruce No. 1 Mine project area has been found to be very rich in macroinvertebrates species. Data from the PEIS, the Spruce No. 1 EIS and from the WVDEP monitoring database indicate that high macroinvertebrate diversity exists in Pigeonroost Branch and Oldhouse Branch. Data from EPA, WVDEP, and the applicant's consultants (Sturm Env. Services, BMI, Inc.) reveal that collectively, Pigeonroost Branch, Seng Camp Creek, and Oldhouse Branch contain a high number of mayfly taxa and individuals. A total of 21 genera (Table 2) have been identified from these three headwater streams indicating these systems offer high water quality and optimal habitat.

Macroinvertebrate data collected in Oldhouse Branch indicates that the quality of the macroinvertebrate community in Oldhouse Branch is in the top 5% of all streams in the Central Appalachia ecoregion. In 1999-2000, EPA collected eighty-five (85) macroinvertebrate genera in riffle complexes[5] of Pigeonroost Branch and Oldhouse Branch.

With respect to mayfly taxa, as many as nine genera have been collected in Oldhouse Branch in any one season-specific sample, with an average of seven genera across multiple samples. This observation ranks in the 95th percentile of all samples taken in the Central Appalachian ecoregion (937 samples) by WVDEP. Out of more than 4000

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[4] The orders Ephemeroptera, Plecoptera and Trichoptera (EPT taxa) contain pollution sensitive groups and are used by natural resource agencies such as West Virginia Department of Environmental Protection to assess watershed health.

[5] Riffle and pool complexes are considered special aquatic sites under 40 CFR 230.1(d) and as such the degradation or destruction of these sites is considered to be among the most severe environmental impacts covered by the 404(b)(1) Guidelines.

samples collected statewide in West Virginia, Oldhouse Branch ranks in the 90th percentile. Pigeonroost Branch contained eight mayfly genera in a season-specific sample, ranking it among the 90th percentile in the Central Appalachians and 83rd percentile statewide from among more than 4000 single-sample observations.

The data are similar for stoneflies. Data compiled from EPA, WVDEP, and the applicant's consulting firms show that Oldhouse, Pigeonroost, and Seng Camp collectively yielded 16 genera of stoneflies (Table 3). Oldhouse and Pigeonroost both had 11 genera. A single collection in Oldhouse by EPA (Spring 2000) had 9 genera of stoneflies which ranks greater than the 98th percentile of all Central Appalachian streams sampled by WVDEP (937 samples). This means that only 2% of stream samples in this ecoregion had more stonefly taxa than Oldhouse within a single sampling event. Pigeonroost Branch had as many as six stonefly genera in any one season-specific sample, ranking it at the 83rd percentile among 937 Central Appalachian streams, and 72nd percentile statewide.

Water chemistry data for Pigeonroost Branch and Oldhouse Branch also reflect healthy streams with little human disturbance. Data from WVDEP indicate that average conductivity values for the unmined streams on the Spruce No. 1 project area are very low. Based on the WVDEP dataset (2002-2003), Oldhouse Branch had an average conductivity level of 90 µS/cm, which is below that of White Oak Branch, a nearby reference-quality stream, which had an average conductivity level of 118 µS/cm. Conductivity levels described above in Oldhouse Branch and White Oak Branch indicate excellent water quality, comparable to reference quality streams for this ecoregion. Sulfate concentrations in these streams are also low (28 mg/l in Oldhouse and 24 mg/l in White Oak Branch). Pigeonroost Branch had a conductivity level of 199 µS/cm and sulfate level of 99 mg/l. The slightly elevated average conductivity and sulfate values reflect the relatively small amount of historical mining landuse in the Pigeonroost watershed.

During the December 2008 to March 2010 time frame, discharge monitoring reports submitted by the permittee indicate 15 of the 16 selenium measurements at both Pigeonroost Branch and Oldhouse Branch were below the detection limit of 0.6 µg/L. The single detection of selenium on Oldhouse Branch was 0.9 µg/L during July 2009. The single detection of selenium on Pigeonroost Branch was 1.9 µg/L during August 2009. These readings are far below West Virginia's numeric chronic water quality criterion for selenium of 5 µg/L. These levels are also significantly lower than levels demonstrated immediately downstream of adjacent mining operations, as described below.

2. The Spruce Fork Sub-watershed and the Coal River Sub-basin

The Spruce No. 1 mine is located within the larger Spruce Fork sub-watershed (12-digit hydrologic unit code (HUC) and the Coal River sub-basin (8-digit HUC) (Figure 4). Pigeonroost Branch and Oldhouse Branch flow to Spruce Fork, which in turn flows into the Little Coal River and then into the Coal River. Oldhouse Branch and Pigeonroost

Branch are important within the context of the larger Coal River sub-basin and Spruce Fork sub-watershed because they represent some of the few stream systems supporting least-degraded conditions within those watersheds.

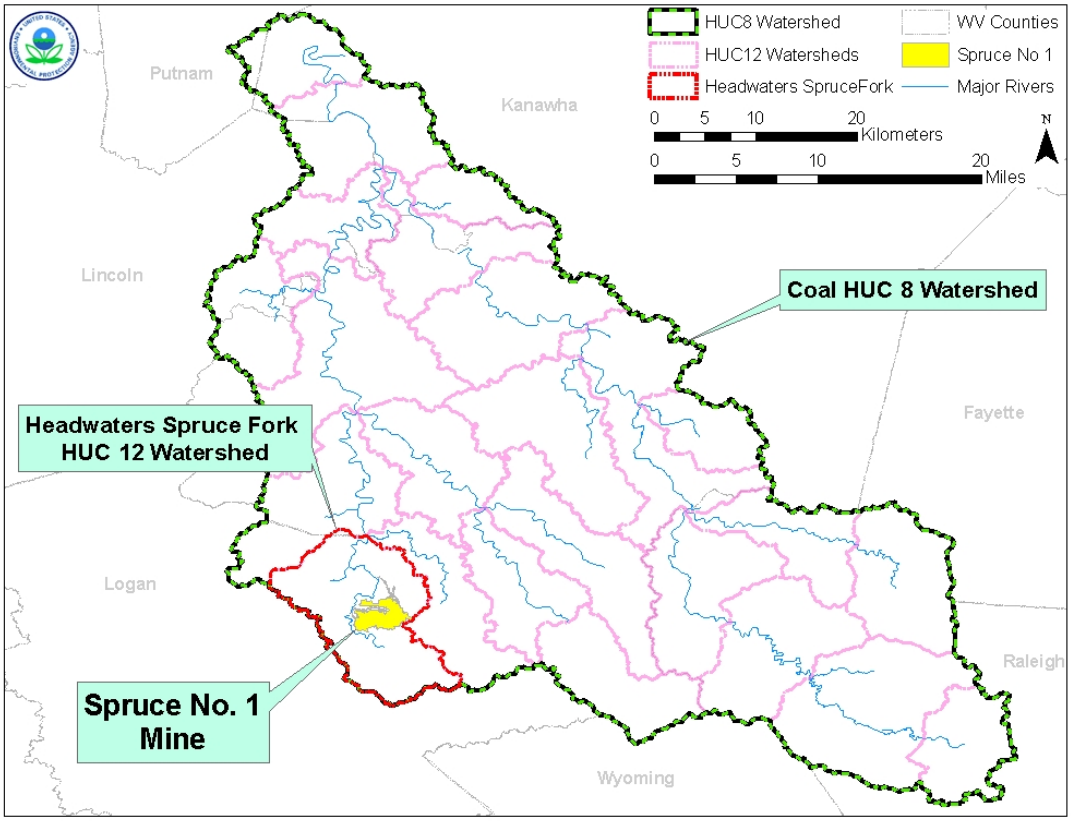

Figure 4 Spruce Fork sub-watershed (12-digit hydrologic unit code (HUC)) and the Coal River sub-basin (8-digit HUC)

The Coal River sub-basin encompasses nearly 891 square miles within West Virginia. Major tributaries within the Coal River sub-basin include Marsh Fork, Clear Fork, Pond Fork, Spruce Fork, and Little Coal River. Marsh Fork and Clear Fork join at Whitesville, WV to form the Big Coal River. Pond Fork and Spruce Fork join at Madison, WV to form the Little Coal River. Little Coal and Big Coal Rivers join to form the Coal River at Forks of the Coal, WV. The Coal River sub-basin has been impacted by past and present surface mining. Based upon the National Land Cover Database (NLCD) change product for 1992-2001 and WVDEP's Geographic Information System (GIS) mining files, more than 257 past and present surface mining permits have been issued in the Coal River sub-basin, which collectively occupy more than 13% of the land area. Some sub-watersheds in the Coal River sub-basin have more than 55% of the land occupied by surface mine permits.

The Spruce Fork sub-watershed, where the project is located, is a fourth order tributary that combines with Pond Fork to form the Little Coal River, which in turn flows into the Coal River. Spruce Fork is located in the southwestern portion of the Coal River watershed and drains approximately 126.4 square miles. The dominant landuse in the

Spruce Fork watershed is forest. Other important landuse types include urban/residential and barren/mining land. The Spruce Fork sub-watershed has been impacted by past and present surface mining activity. According to WVDEP Division of Mining and Reclamation permit maps, within the Headwaters Spruce Fork sub-watershed, where Spruce No. 1 is to be located, there are more than 34 past and present surface mine permits issued which collectively occupy more than 33% of the land area. Assuming full constructions of these projects in addition to known future surface mining permits, more than 40% of the land area of the sub-watershed will be affected.

In 1997, the WVDEP performed its first comprehensive ecological assessment of the Coal River sub-basin[6]. WVDEP assessed three major aspects of watershed health: water quality, habitat condition, and benthic macroinvertebrate community status. The subsequent report, An Ecological Assessment of the Coal River Watershed (1997), indicated that sediments, coal mining and inadequate sewage treatment were the major stressors on streams in this watershed. As a part of that assessment WVDEP stated:

> High quality streams with minimal human disturbances provide significant and even irreplaceable wildlife habitat. They also provide a tremendous recreational resource. No sites in the Coal River Watershed met the minimum criteria for reference site status. This is the first of 32 watersheds studied in West Virginia that produced no potential reference sites. Researchers conducting the EPA study on mountaintop mining, alluded to previously, have found a few small streams within the watershed that may meet the reference site criteria. The Program has since adopted one stream, White Oak Branch, (KC-10-T-22), as a reference site. Since reference sites reflect least-degraded conditions, it is vital that the WVDEP do its part in fulfilling the mission of preserving the high quality of these rare and important streams. It is also important that the agency make a concerted effort to find the apparently few remaining streams within the watershed that have not been significantly impacted by human disturbances.

White Oak Branch, referenced above in WVDEP's 1997 study, flows to Spruce Fork immediately upstream of Oldhouse Branch and Pigeonroost Branch. As noted above, WVDEP has adopted White Oak Branch as a reference site. WVDEP defines reference conditions as those conditions that "describe the characteristics of waterbody segments least impaired by human activities and are used to define attainable biological and habitat conditions. Final selection of reference sites depends on a determination of minimal disturbance, which is derived from physico-chemical and habitat data collected during the assessment of the stream sites." Reference sites are used to determine the score that represents the threshold between impaired and non-impaired sites.

Based on a comparison of their macroinvertebrate communities, Oldhouse Branch and Pigeonroost Branch are of comparable quality to White Oak Branch. Accordingly, Oldhouse Branch and Pigeonroost Branch reflect least–degraded conditions and represent

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[6] Report can be found at http://www.dep.wv.gov/WWE/watershed/wqmonitoring/Documents/EcologicalAssessments/EcoAssess_Coal_1997.pdf

some of the few remaining streams within the Coal River sub-basin that have not been significantly adversely impacted by human disturbances.

Oldhouse Branch flows into Spruce Fork immediately downstream of White Oak Branch and exhibits similar healthy biological diversity and water quality (EPA data). Using the West Virginia Stream Condition Index (WVSCI), an assessment method developed for use in West Virginia to help evaluate the health of benthic macroinvertebrate communities at the family level in wadeable streams,[7] both Oldhouse Branch and White Oak Branch scored comparably well, meaning that both were of similar quality and supporting similar aquatic communities.

Oldhouse Branch and White Oak Branch also score comparably well when the benthic macroinvertebrate community is considered at the more sensitive genus (as opposed to family) level. For instance, Oldhouse Branch shared 55 total genera (many of them pollution intolerant) with White Oak Branch (EPA data) indicating a diverse and healthy aquatic community in Oldhouse Branch similar to the high quality communities of White Oak Branch.

Pigeonroost Branch also shares many macroinvertebrate genera (many of them pollution intolerant) in common with the high quality community in White Oak Branch, indicating that the health of Pigeonroost Branch's aquatic community is similar. The WVSCI assessment of Pigeonroost indicates water quality is relatively good despite the presence of localized historic mining in the watershed. See Section IV.B.1. and Appendix 1 for more detail on macroinvertebrates at the Spruce No. 1 mine project site.

The relatively high quality of Oldhouse Branch and Pigeonroost Branch also can be demonstrated by comparison to other streams in the Spruce Fork sub-watershed that have been impacted by mining operations similar to the Spruce No. 1 Mine. Four such streams are directly northwest of the Spruce No. 1 project, on the west side of Spruce Fork, and in part, are impacted by the Mingo Logan Dal-Tex Mining Operation. Section V.B.2.a below compares the health of the relatively unimpacted macroinvertebrate communities in Pigeonroost Branch and Oldhouse Branch with the macroinvertebrate communities in streams elsewhere within the Spruce Fork sub-watershed that have been impacted by mining activity. By way of summary here, Oldhouse Branch and Pigeonroost Branch support a much healthier and more diverse assemblage of benthic macroinvertebrates than do the four comparison streams that are impacted by the Dal-Tex operation.

B. Wildlife

The ecoregion where the Spruce No. 1 project is be located (Figure 5) has some of the greatest aquatic animal diversity of any area in North America, especially for species of amphibians, fishes, mollusks, aquatic insects, and crayfishes. Salamanders in particular reach their highest North American diversity in the Central Appalachian ecoregion.

[7] For a more detailed discussion of WVSCI, see Section V.B.2.a.iii.

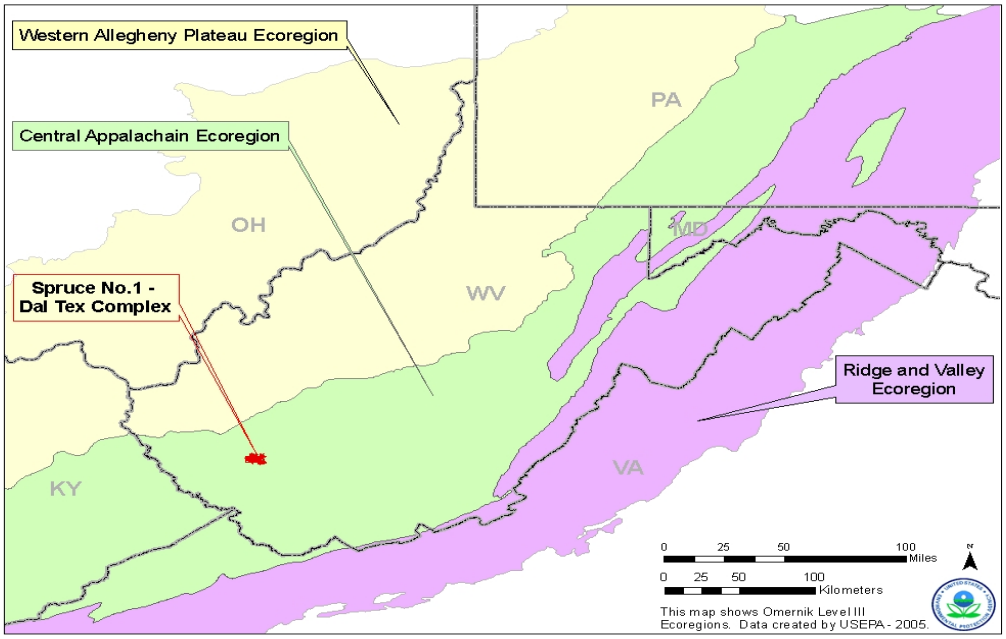

Figure 5 Central Appalachian Ecoregion

The ecoregion where the Spruce No. 1 project is located includes one of the most prominent biodiversity hot spots of rarity and richness identified by The Nature Conservancy (TNC) (Figure 6).

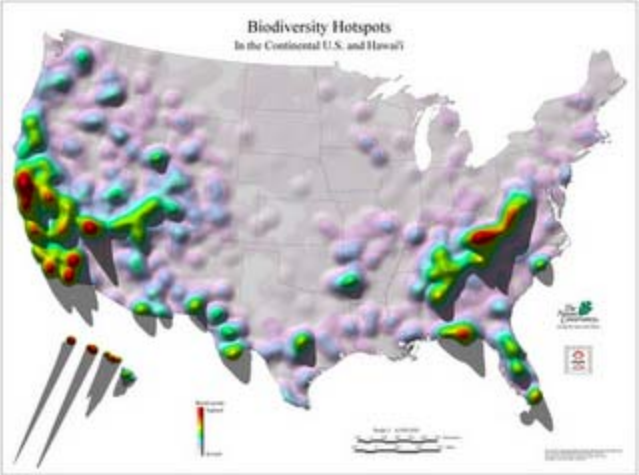

Figure 6: TNC Biodiversity Hotspots

Map adapted from Precious Heritage:
The Status of Biodiversity in the United States.
Data from State Natural Heritage Programs and their cooperators.
Map produced by TNC Eastern Conservation Science GIS, 5/19/00.
© The Nature Conservancy
http://www.nature.org/wherewework/northamerica/states/westvirginia/science/

Individual watersheds and peaks in the Appalachian chain, isolated for millions of years with benign environmental conditions, provided a perfect setting for the evolution of unique species of plants, invertebrates, salamanders, crayfishes, freshwater mussels, and fishes. These forests represent the center of the earth's salamander diversity. Not only are there numerous species, but salamanders also are incredibly abundant here, often accounting for the most vertebrate biomass in a given patch of forest (Stein et al, 2000). It has been documented that other specialized wildlife such as some neotropical migrant birds and forest amphibians rely on the natural headwater stream condition and adjacent forest types exhibited by Pigeonroost Branch and Oldhouse Branch for maintenance of their populations (Stein et al, 2000).

1. Invertebrates

As set forth above in Section IV.B.1. above, Pigeonroost Branch and Oldhouse Branch support diverse and healthy communities of benthic macroinvertebrates. In terms of its mayfly community, Oldhouse Branch ranks in the top 5% in the eco-region and the top 10% in the State. Oldhouse Branch's stonefly community ranks in the top 2% of the ecoregion. Pigeonroost Branch's mayfly community ranks among the top 10% in the co-region and the top 17 % in the State. Pigeonroost's stonefly community ranks in the top 17% in the eco-region and the top 28% third of the State.

As described above, benthic macroinvertebrates are the bottom-dwelling (benthic) organisms that are large enough to be seen without the aid of microscopes (macro), and are not equipped with backbones (invertebrate). Put simply, they are aquatic insects. In addition to serving as indicators of ecosystem health, freshwater macroinvertebrates, including mayflies and stoneflies, play a vital role in food webs and in the transfer of energy in river systems. These organisms essentially convert plant material into food sources (fats and proteins) essential for the maintenance of healthy fish and amphibian populations, and for foraging terrestrial vertebrates such as birds, bats, reptiles, and small mammals; serving as critical foodchain organisms, vital to the sustenance of healthy ecosystems. Because of their productivity and secondary position in the aquatic food chain, macroinvertebrates play a critical role in the delivery of energy and nutrients along the stream continuum. They also are instrumental in cleaning excess living and nonliving organic material from freshwater systems, a service that contributes to the overall quality of the watershed.

Macroinvertebrates are indigenous to central Appalachian streams and their naturally occurring communities are important components of stream ecosystems. Macroinvertebrates are recognized as wildlife by several organizations, including the US Fish and Wildlife Service (USFWS), USDA Forest Service, The Nature Conservancy, State Natural Heritage programs, and the West Virginia Department for Natural Resources (WVDNR). Currently, within the U.S., the USFWS lists 50 species of insects as endangered under the Endangered Species Act (ESA), and another 10 species as threatened under the ESA. Insects represent 10.4 percent of all currently-listed animals in the U.S. and 4.4 percent of all listed species, including plants (http://ecos.fws.gov/tess_public/pub/boxScore.jsp). Several dozen other insects are candidates for listing under the ESA, including the Sequatchie caddisfly (*Glyphopsyche sequatchie*), a trichopteran found in Tennessee.

The State of West Virginia also considers insects to be wildlife, and includes insects on its list of rare, threatened and endangered species. Many aquatic insects are listed, including: 12 species of stoneflies, two species of mayflies, and 73 species of dragonflies and damselflies (West Virginia Natural Heritage Program 2007). Scientists and environmental consultants who collect benthic macroinvertebrates in West Virginia must obtain a wildlife collection permit from WVDNR.

Mayflies are most popularly known among fly-fishermen, where anglers rely on the seasonal hatches of mayflies that coincide with catching trout and other game fish species. Not only do trout rely on mayflies and stoneflies, but a group of colorful benthic fishes known as Darters (Percidae) feed primarily on mayflies. A dietary study of small stream fishes in the Appalachian coalfields of Kentucky (Lotrich 1973) showed that gut contents of several darters contained mostly mayflies. Darters are an important part of the fish assemblage and many are hosts for mussel larvae. Several darter species inhabit Spruce Fork in the immediate vicinity of the project area. Table 1 identifies the mayfly genera that have been identified in the Spruce No. 1 mine permit area.

Table 1. Presence/absence of mayfly genera in the permit area.

Order	Family	Genus	Oldhouse	Pigeonroost	Seng Camp
Ephemeroptera	Ameletidae	*Ameletus*	X	X	
Ephemeroptera	Baetidae	*Acentrella*	X	X	
Ephemeroptera	Baetidae	*Baetis*	X	X	X
Ephemeroptera	Baetidae	*Diphetor*		X	
Ephemeroptera	Baetiscidae	*Baetisca*		X	X
Ephemeroptera	Caenidae	*Caenis*			X
Ephemeroptera	Ephemerellidae	*Attanella*		X	X
Ephemeroptera	Ephemerellidae	*Dannella*		X	X
Ephemeroptera	Ephemerellidae	*Drunella*	X	X	
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	X	
Ephemeroptera	Ephemerellidae	*Eurylophella*	X	X	X
Ephemeroptera	Ephemeridae	*Ephemera*	X	X	X
Ephemeroptera	Heptageniidae	*Cinygmula*	X	X	
Ephemeroptera	Heptageniidae	*Epeorus*	X	X	
Ephemeroptera	Heptageniidae	*Heptagenia*		X	
Ephemeroptera	Heptageniidae	*Maccaffertium*	X	X	X
Ephemeroptera	Heptageniidae	*Stenacron*	X		X
Ephemeroptera	Isonychiidae	*Isonychia*		X	X
Ephemeroptera	Leptophlebiidae	*Choroterpes*	X		
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	X		X

Note: Siphlonurus and Pseudocloeon reported by Sturm Env. are likely erroneous identifications. These genera have been excluded from this list.

Stoneflies (Plecoptera) also represent an important group of aquatic insects in the structure and functioning of stream ecosystems. Stoneflies also fill important trophic roles in stream ecosystems, as displayed by their detritivory (consumption of dead or decaying organic matter) and predatory functional feeding group designations. As with mayflies, stoneflies are valued and imitated by fly-fishermen and serve as an abundant food source for many salamanders and fishes. Stoneflies are primarily stenothermic, meaning they inhabit cool to cold waters which provide the higher dissolved oxygen concentrations required for their survival. Table 2 presents the stonefly genera identified in the Spruce No. 1 Mine area.

Table 2. Presence/absence of stonefly genera in the permit area.

Order	Family	Genus	Oldhouse	Pigeonroost	Seng Camp
Plecoptera	Capniidae	*Allocapnia*	X	X	X
Plecoptera	Chloroperlidae	*Alloperla*		X	
Plecoptera	Chloroperlidae	*Haploperla*	X		
Plecoptera	Chloroperlidae	*Sweltsa*	X		
Plecoptera	Leuctridae	*Leuctra*	X	X	X
Plecoptera	Nemouridae	*Amphinemura*	X	X	
Plecoptera	Nemouridae	*Ostrocerca*	X	X	
Plecoptera	Nemouridae	*Paranemoura*		X	
Plecoptera	Peltoperlidae	*Peltoperla*	X		X
Plecoptera	Perlidae	*Acroneuria*	X	X	X
Plecoptera	Perlodidae	*Isoperla*	X		X
Plecoptera	Perlodidae	*Remenus*		X	
Plecoptera	Perlodidae	*Yugus*	X		
Plecoptera	Pteronarcyidae	*Pteronarcys*	X	X	X
Plecoptera	Taeniopterygidae	*Taenionema*		X	
Plecoptera	Taeniopterygidae	*Taeniopteryx*		X	X

Note: Podmosta, Paraleuctra, Megaleuctra,and Beloneuria reported by Sturm Env. are likely erroneous identifications. These genera been excluded from this list.

2. Salamanders

The ecoregion where the Spruce No. 1 project is located contains one of the richest salamander fauna in the world (Petranka 1998, Stein et al., 2000). Nearly ten percent of global salamander diversity is found within streams in the ecoregion (Green and Pauley, 1987). Salamanders are a diverse and unique form of Appalachian wildlife that depend on forested headwater habitat and decline or disappear from surface mined areas. Many species of salamanders are aquatic or semi-aquatic and utilize headwater streams at some point in their life histories. Most of the species found in the project area are water-dependent and belong to the family Plethodontidae, the lungless salamanders, which require high moisture retaining leaf-litter, dense shade, and cool flowing streams to survive and reproduce. Typically, salamanders occupy small, high-gradient headwater streams while fish occur farther downstream.

Salamanders are an important ecological component in the mesic (medium precipitation) forests of the ecoregion and are often the most abundant group of vertebrates in both biomass and number (Burton and Lykens, 1975; Hairston, 1987). Ecologically, salamanders are intimately associated with forest ecosystems acting as predators of small invertebrates and serving as prey to larger predators (Pough et al., 1987). Some species of salamanders split their lives between forests and headwaters and depend on a close connection to move between the two (Petranka, 1998).

Moler and Franz (1987) cite the work of Burton and Likens (1975) and Gosz et al. (1978) in New Hampshire who suggest an important role for amphibians in energy cycling. Burton and Likens (1975) found that the biomass of salamanders was about double that of birds during the peak birding season and about equal to the biomass of small mammals. Gosz et al. (1978) found that salamanders and shrews were the most important vertebrates preying on the invertebrates of the forest floor. They estimated that birds consumed 6.5 times, and shrews 4.7 times, the amount of food energy consumed by the salamander community. However, because the warm-blooded birds and shrews expended 98% of their energy intake on metabolic maintenance compared to only 40% for the salamanders, salamanders contribute 4.6 (shrews) and 6.3 (birds) times as much biomass to the available prey base, making them an important component of the foodweb.

With respect to the immediate project area, stream-dwelling salamanders have been surveyed in White Oak Branch (USFWS, unpublished data, 2004). White Oak Branch had good numbers of Northern Dusky (9 adult, 7 larvae), Appalachian Seal (15 adult, 12 larvae), and Two Lined salamanders (1 adult and 15 larvae). These numbers represent densities in a 12 square meter plot that includes dry and wetted portions of the stream channel. Because Oldhouse Branch and Pigeonroost Branch are very close geographically and have similar features as White Oak Branch, salamander populations in Pigeonroost and Oldhouse Branch can be expected to be similar to those in White Oak Branch. Williams (2003) found mean densities within reference reaches of Pigeonroost, Bend Branch (another tributary of Spruce Fork), and Ash Fork (a tributary of Gauley River) at more than six salamanders per square meter. In the Williams' study, the majority of the total catch of salamanders was found in Pigeonroost.[8] Using these numbers from White Oak Branch and Pigeonroost, EPA estimates aquatic salamanders are indeed abundant (~5-6 per square meter) along stream channels in Pigeonroost Branch and Oldhouse Branch.

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[8] Williams (2003) data from the WV MTM region also showed that while more individuals were found in the lower 1st-2nd order reaches, slightly more species (8 spp.) were actually found in the upper intermittent reaches.

3. Fish

Fish communities change with watershed size and respond to gradients of physical habitat and chemistry. The fish assemblages in Pigeonroost Branch and Oldhouse Branch are typical of headwater streams, containing only a few species. The fish assemblages in Spruce Fork are in relatively good condition. Spruce Fork is a locally important rock bass and smallmouth bass fishery. These fish assemblages are not representative of pristine conditions and it is likely that some of the more sensitive species may have been historically extirpated from past anthropogenic activities, including mining.

In an analysis of fish community data from Spruce Fork, Region III assessed the small streams immediately impacted by the Spruce No. 1 permit and three reaches of Spruce Fork: 1) Upstream of Seng Camp, 2) Seng Camp to Spruce Laurel, and 3) Downstream of Spruce Laurel. Other data analyzed included data collected for the Programmatic Environmental Impact Statement (PEIS) for Mountaintop Mining/Valley Fills. (see Stauffer and Ferreri, 2002 and Fulk et al. 2003); unpublished data included in the West Virginia Department of Natural Resources database (including USEPA, WVDNR, and consulting firm data); and data from Decota Consulting (consultants for Mingo Logan) supplied to the WVDNR collecting permit program. The data consisted of samples that were intended for community assessment and were judged to have sufficient numbers of individuals to render a fair assessment. Fish community data can be difficult to analyze and oftentimes the absence of species may be due to zoogeography (how they were distributed in response to past geological events) or due to stressors over time in the watershed. Some of these stressors may still be apparent and some may not.

The fish found in Pigeonroost Branch, Oldhouse Branch, and White Oak Branch are typical of small streams in the Coal River Basin. They do not indicate impairment, nor do they indicate reference conditions. EPA compared samples collected for the PEIS in 1999 and more recent data collected by Decota Consuting from 2008 and 2009. When sampled for the PEIS, Pigeonroost Branch had been affected by drought and only blacknose dace and creek chubs were present. These species are tolerant of disturbance and are headwater species adapted to drought. White Oak Branch also was sampled for the PEIS at the same time. It too was drought-affected and contained only blacknose dace at the time of the PEIS sampling in 1999. No samples were collected in Oldhouse Branch for the PEIS.

More recent data indicates that Pigeonroost Branch also has a population of mottled sculpin, and at times smallmouth bass and stonerollers. More recent data from White Oak Branch indicates that creek chubs are also present in good numbers and mottled sculpin are rare (only 1 individual captured). Data from Oldhouse Branch indicates that blacknose dace and creekchubs are the only species present.

For the PEIS, Fulk et al. (2003) used the Mid-Atlantic Highlands (MAHA) Index of Biotic Integrity (IBI - a multi-metric index used to assess biotic health), with some minor modification, to assess the impacts of MTM/VF to fish assemblages. Using this same

index, the assemblage upstream of Seng Camp Creek ranged from fair to excellent condition.

The fish assemblage in the mainstem of Spruce Fork is in relatively good condition. Spruce Fork is a locally important rock bass and smallmouth bass fishery. Rock Bass and Smallmouth Bass are moderately sensitive gamefish species. While sampling Spruce Fork in 2010, recreational fishing was observed in the lower reaches of the stream and there was evidence of fishing in the upper reaches as well. Species present in Spruce Fork upstream and downstream of Seng Camp Creek are typical of streams of this size within the Coal River Basin and have not changed appreciably over the last 60 years.

4. Birds[9]

Many terrestrial bird species depend on the headwater streams like those of the Spruce Fork for their survival. The ecotone (transition area) between terrestrial and aquatic habitats results in diverse flora and fauna. For example, unique avifauna assemblages can be found along the riparian zone of headwater streams.

Among the many migratory birds likely to breed in the project area, there are six species that the USFWS has designated as Birds of Conservation Concern (BCC) within the Appalachian Mountains Bird Conservation Region (AMBCR). These include the cerulean, Kentucky, Swainson's and worm-eating warblers, the wood thrush, and the Louisiana waterthrush. The first five of these are also designated as BCC species within the USFWS's Northeast Region as a whole and nationally (USFWS 2008). The first four are also considered to be among the 100 most at-risk bird species in North America (Wells 2007).

The Louisiana waterthrush (*Seirus motacilla*), a neotropical migrant song bird, is considered an obligate headwater riparian songbird (an example of water-dependent wildlife) because its diet is comprised predominantly of immature and adult aquatic macroinvertebrates found in and alongside headwater streams and because it builds its nest in the stream banks. Breeding waterthrushes nest and forage primarily on the ground along medium- to high-gradient, first- to third-order, clear, perennial headwater streams flowing through closed-canopy forest. Good water quality is a key component of the species breeding habitat. Headwater streams like Pigeonroost Branch and Oldhouse Branch that support healthy macroinvertebrate communities are food sources for species such as the Louisiana waterthrush.

The Appalachian Mountain Bird Conservation Region (AMBCR), which extends from southeastern New York south to northern Alabama, is thought to support a substantial portion of the Louisiana waterthrush's breeding population, perhaps as much as 45 percent. West Virginia, the only state that lies entirely within the AMBCR, encompasses the largest contiguous area of high relative breeding abundance over the species' entire breeding range, based on North American Breeding Bird Survey (BBS) data from 1994-

[9] Much of the discussion related to avian and bat species is based upon communications with the U.S. Fish and Wildlife Service.

2003. The West Virginia population may serve as a source for populations elsewhere in the breeding range. The Louisiana waterthrush is also an area-sensitive species, requiring undisturbed forest tracts of 865 acres to sustain a population (Robbins, C.S., J.R. Sauer, RS. Greenburg**,** and S. Droege. 1989). The most effective management protocol for the Louisiana waterthrush would appear to be protection of forest tracts and water systems inhabited on both breeding and wintering areas particularly moderate- to high-gradient headwater streams, which compose 75-80% of stream length in a typical watershed.

Bird species that rely on mature forest habitats that are on the Audubon watch list as declining species and are listed as probable in the area include the Swainson warbler (*Limnothlypis swainsonii*), Kentucky warbler (*Oporornis formosus*), and Cerulean warbler (*Dendroica cerulean*).

The Cerulean warbler in particular is considered an area-sensitive species; it is thought to require large (greater than 30 sq miles) tracts of mature interior forest habitat to support stable breeding populations. This species is a canopy-foraging insectivorous neotropical migrant songbird that breeds in mature deciduous forests with broken, structurally-diverse canopies across much of the eastern United States and winters in middle elevations of the Andes Mountains of northern South America. Important among a number of breeding season constraints are the loss of mature deciduous forest, particularly along stream valleys, and fragmentation and increasing isolation of remaining mature deciduous forest. The cerulean warbler appears to be more sensitive than most other North American birds to landscape-level changes in habitat. The USFWS has designated the cerulean warbler a Species of Management Concern and a Species of Conservation Concern throughout its range. It has also been preliminarily designated by the Appalachian Mountains Joint Venture as a Species of Highest Conservation Priority within the Appalachian Mountains Bird Conservation Region, which encompasses West Virginia. The AMBCR is thought to support about 80 percent of the species' entire breeding population, and the AMBCR breeding population likely functions as a source for populations elsewhere in the breeding range.

The Acadian flycatcher (*Empidonax virescens*) is commonly encountered throughout the Central Appalachian Ecoregion, but despite the large expanse of existing forest habitat, it is primarily restricted to forested tracts with understory vegetation along small headwater streams, where it can feed on emergent aquatic insects. Spruce Fork and its tributaries meets these habitat requirements. Neotropical migrant songbirds are also often attracted to headwater streams for breeding areas because of the diversity of the habitat and the availability of emergent aquatic insects.

5. Bats

Thirteen species of bats are found in West Virginia. Most North American bats are insectivorous, which capture their prey by foraging in flight, catching flying insects from a perch, or collecting insects from plants.

Different species of bats often have distinct life history traits and behaviors. Some bats

are solitary and hang in tree foliage, attics, barns, and other protected places during the day. Other bats are colonial and cluster in caves and mine tunnels. Bats have one of the slowest reproductive rates for animals their size. Most bats in northeastern North America have only one or two pups a year and many females do not breed until their second year. This low reproductive rate is somewhat offset by a long life span, often over 20 years. The little brown bat, common in North America and in West Virginia, is the world's longest lived mammal for its size, with a maximum life-span over 32 years. During the winter, some bats migrate south in search of food, while others hibernate through the cold weather when insects are scarce. Bats that do migrate usually travel less than 200 miles, often following the same routes as migratory birds.

Species that have potential to be found in the area of south-Central West Virginia that encompasses the Spruce No. 1 Mine include the northern bat (*Myotis septentrionalis*), big brown bat (*Eptesicus fuscus*), red bat (*Lasiurus borealis*), eastern small-footed bat (*Myotis leibii*), Virginia big-eared bat (*Corynorhinus townsendii virginianus*), northern long-eared bats *(Myotis septentrionalis)* and the Indiana bat (*Myotis sodalis*).

Both the Indiana and Virginia big-eared bats are listed as endangered under the Endangered Species Act. The USFWS was also recently petitioned to list the eastern small-footed bats and the northern long-eared bats under the ESA. Five eastern small-footed bats and 16 northern long-eared bats were captured during mist net surveys conducted at the Spruce No. 1 project site in 2004, representing 7.6 and 24.2 percent, respectively, of all bats captured (U.S. Army Corps of Engineers Huntington District 2006, DEIS Spruce No. 1 Mine. Appendix M).

Indiana bats have been described as once one of the most common mammals in the Eastern United States. Between 1960 and 2004, biologists have documented a 56 percent population decline in Indiana bats. Indiana bats feed solely on emerged aquatic and terrestrial flying insects. They are habitat generalists and their selection of prey reflects the environment in which they forage. In a study in the Allegheny Mountains, activity in non-riparian upland forest and forests in which timber harvest had occurred was low relative to forested riparian areas. This evidence suggests that the forested riparian zones of the project area would be more suitable habitats for Indiana bat populations than active or restored mining sites.

Mist net surveys were conducted in the project area in 2000 and 2004, and no Federally-listed bats were captured. Although the capture of bats confirms their presence, failure to catch bats does not absolutely confirm their absence (U.S. Fish and Wildlife Service 2007, pg. 252). The project area occurs roughly half-way between known hibernacula in northeastern Kentucky and southeastern West Virginia. Since the most recent surveys at the Spruce No. 1 site, maternity roosts have been documented in central and north-central Boone County. Additionally, a juvenile Indiana bat was captured on August 9, 2010 in southwest Fayette County, indicating the presence of a maternity colony in that area.

C. Summary

Based on the foregoing, EPA Region III finds that Pigeonroost Branch and Oldhouse Branch contain important wildlife resources and habitat. The Region bases its conclusion on several factors including the similarity of Pigeonroost Branch and Oldhouse Branch to the reference quality White Oak Branch and therefore they support conditions representing some of the last remaining least degraded streams and riparian areas within the Spruce Fork sub-watershed and the Coal River sub-basin.

V. Basis for Recommended Determination

A. Section 404(c) Standards

Section 404(c) provides:

> The Administrator is authorized to prohibit the specification (including the withdrawal of specification) of any defined area as a disposal site, and he is authorized to deny or restrict the use of any defined area for specification (including the withdrawal of specification) as a disposal site, whenever he determines, after notice and opportunity for public hearings, that the discharge of such materials into such area will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. Before making such determination, the Administrator shall consult with the Secretary. The Administrator shall set forth in writing and make public his findings and his reasons for making any determination under this subsection.

While EPA strongly prefers to initiate the Section 404(c) process prior to issuance of a permit, Section 404(c) and EPA's implementing regulations authorize EPA to initiate the Section 404(c) process after a permit has been issued by withdrawing specification of a disposal site. See 40 CFR 231.1(a); see also definition of "withdraw specification," 40 CFR 231.2(a). In this case, consistent with Section 404, Pigeonroost Branch and Oldhouse Branch were specified as disposal sites in DA Permit No. 199800436-3.

Section 404(c) does not define the term "unacceptable adverse effect." EPA's regulations at 40 CFR 231.2(e) define "unacceptable adverse effect" as:

> Impact on an aquatic or wetland ecosystem which is likely to result in significant degradation of municipal water supplies or significant loss of or damage to fisheries, shellfishing, or wildlife habitat or recreation areas. In evaluating the unacceptability of such impacts, consideration should be given to the relevant portions of the Section 404(b)(1) Guidelines (40 CFR Part 230).

For purposes of the Spruce No. 1 mine, the relevant portions of the Section 404(b)(1) Guidelines that are particularly important for assessing the unacceptability of environmental impacts include:

- Less environmentally damaging practicable alternatives (230.10(a))

- Water quality impacts (230.10(b))
- Significant degradation of waters of the United States (230.10(c))
- Minimization of adverse impacts to aquatic ecosystems (230.10(d))
- Cumulative effects (230.11(g)); and
- Secondary effects (230.11(h))

The purpose of the Clean Water Act is to "restore and maintain the physical, chemical, and biological integrity of the Nation's waters." 33 U.S.C. 1251(a). Part of the concept of protecting the "biological integrity" of the Nation's waters is protection of the indigenous, naturally occurring community. This goes beyond protecting the function performed by various members of the aquatic community and extends to protection of the quality of the aquatic community itself. *See Alameda Water & Sanitation District v. EPA*, 930 F. Supp.486 (D. Colo. 1996).

B. Adverse impacts from specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material from the Spruce No. 1 Mine

The impacts from the specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material from the Spruce No. 1 Mine will occur through several different pathways.

First, direct impacts will occur as a result of the discharge of fill (excess spoil, minethrough, and construction of valley fills), which will bury much of Pigeonroost Branch and Oldhouse Branch and eliminate the buried ecosystems, including all wildlife living in those streams. Burial of Pigeonroost Branch and Oldhouse Branch also will eliminate habitat for wildlife that depend upon those streams. Loss of the buried portions of Pigeonroost Branch and Oldhouse Branch will impact wildlife that depend on those headwater streams for all or part of their lifecycles and adversely affect adults, juveniles, larvae, and/or eggs.

In addition, adverse impacts will occur to wildlife that live outside the footprint of the fills and sedimentation ponds. Discharges of fill material into Pigeonroost Branch and Oldhouse Branch will have the effect of removing those streams as sources of freshwater dilution and adversely affect the delivery of headwater stream ecosystem functions to downstream waters. Studies have shown a strong correlation between the construction of valley fills for surface coal mining in Applachia and significant adverse impact on downstream macroinvertebrate communities.

There is also a likelihood that the discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch will transform those areas into sources of contaminants (particularly conductivity and selenium) contributing to degradation of downstream waters. The project as authorized also has the potential to contribute to conditions that would support blooms of golden algae that release toxins that can kill fish and other aquatic life.

To evaluate the impacts of the Spruce No. 1 project, Region III has consulted the PEIS and available data and literature documenting impacts from similar projects. Region III also has examined impacts caused by the portion of the Spruce No. 1 Mine that has already been

constructed in the Seng Camp Creek watershed (specifically, Valley Fill 1A). In addition, Region III reviewed the nearby Mingo Logan Dal-Tex operation. Based on location and similarity of geology and minerals, impacts from the Mingo Logan Dal-Tex operation are likely to be a good predictor of impacts from the Spruce No. 1 Mine. This was acknowledged by the Huntington District Corps of Engineers in the Spruce No. 1 EIS, which stated: "The past and present impacts to topography, geology, and mineral resources of the previous mining along the western side of Spruce Fork are similar to the anticipated impacts of the Spruce No. 1 Mine, as mining is to occur in the same strata."

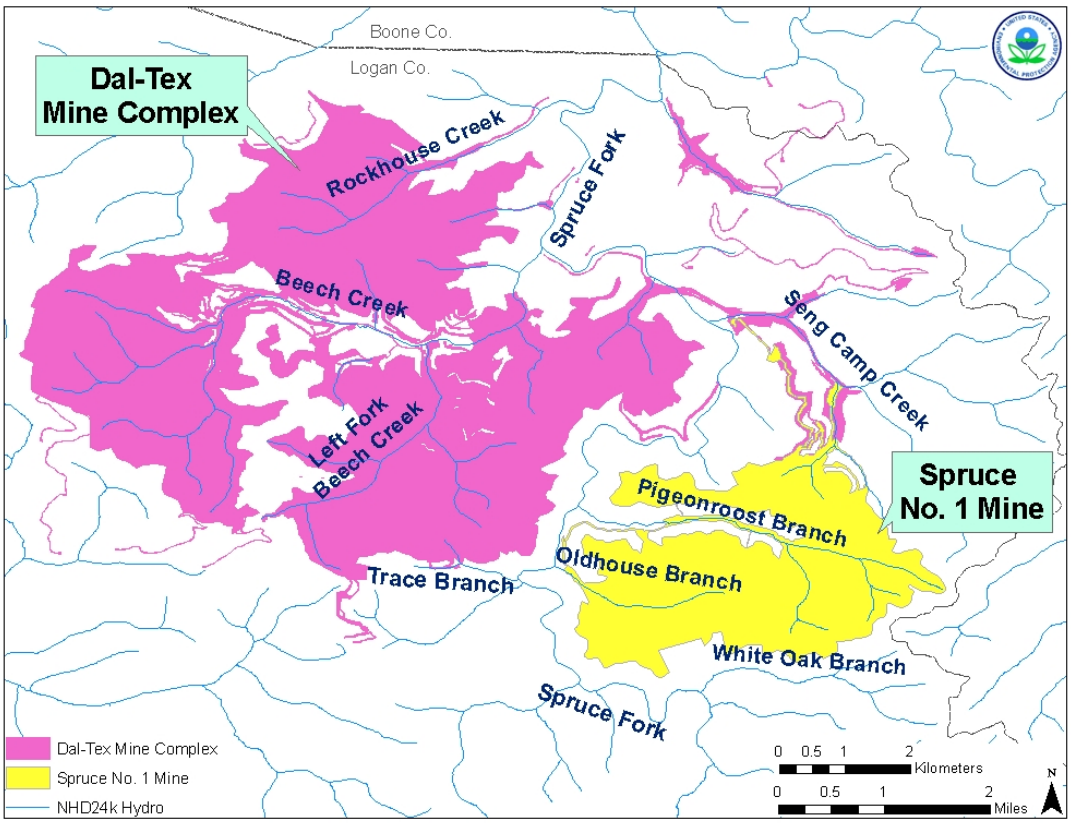


Figure 7 Spruce No. 1 Mine and the Dal-Tex Mine Operation

Region III completed a review of rock cores and corresponding cross sections for the Dal-Tex mines including the Gut Fork mine (immediately across Spruce Fork from Spruce No.1; Figure 7) and compared those to the Spruce No. 1 mine. This review, which is set forth in Appendix 4, indicates that, for the most part, the formations are repeated from the Dal-Tex mine complex to the Spruce No 1 mine location. Per the EIS, the same coal beds are to be developed for the Spruce No. 1 mine as for the Del-Tex mine. Also, these coal bed sequences are similar to those described in the literature for southern West Virginia coal bed sequences and the geologic column for the Spruce No 1 mine.

1. Effects on Water Chemistry

The Section 404(b)(1) Guidelines direct that no permit should issue if the discharge will cause or contribute to violations of applicable water quality standards or if the discharge will cause or contribute to significant degradation of the aquatic ecosystem, including but not limited to significant adverse effects on stages of aquatic life and other wildlife dependent upon aquatic ecosystems, including the transfer concentration, and spread of pollutants or their byproducts outside the disposal area. 40 C.F.R. §§230.10(b)(1) & 230.10(c). *See also* 40 C.F.R. §§ 230.31.

Adverse changes in water chemistry frequently have a corresponding impact on wildlife and fisheries that live in or depend upon the water. Potential impacts to water chemistry are considered because they may affect the native aquatic and water-dependent communities in the Spruce Fork watershed.

a. Selenium

Discharges from the Spruce No. 1 Mine Complex project are likely to increase selenium loading to the immediate receiving streams and downstream waters. The State of West Virginia has established a numeric chronic water quality criterion for selenium (5 µg/L) to protect instream aquatic life. Selenium is a naturally occurring chemical element that is an essential micronutrient, but excessive amounts of selenium can also have toxic effects. For aquatic animals, the concentration range between essential and toxic is very narrow, being only a few micrograms per liter in water. Selenium toxicity is primarily manifested as reproductive impairment and birth defects due to maternal transfer, resulting in embryotoxicity and teratogenicity in egglaying vertebrates (e.g., fish and ducks). The most sensitive toxicity endpoints in fish larvae are teratogenic deformities such as skeletal, craniofacial, and fin deformities, and various forms of edema. Embryo mortality and severe development abnormalities can result in impaired recruitment of individuals into populations (Chapman et al. 2009). A WV draft study indicates that elevated selenium concentrations in fish eggs, increased larval deformity rates and increased deformity rates in mature fish are occurring in the Mud River Reservoir, Boone County, WV due to mining activities. These adverse conditions were all associated with elevated water column selenium concentrations (WVDEP, 2009, draft).

In West Virginia, coals that contain the highest selenium concentrations are found in a region of south central West Virginia where the Allegheny and Upper Kanawha Formations of the Middle Pennsylvanian are mined (WVGES 2002). WVDEP reports that some of the highest coal selenium concentrations are found in the central portion of the Coal River watershed where significant active mining and selenium impaired streams are located, in the immediate vicinity of the Spruce No. 1 project. Selenium is discharged when surface mining activities expose selenium-bearing material that comes in contact with water and contaminated water drains from the mining area to surface waters. The sedimentation ponds that are the usual form of water treatment at mining sites generally are not effective at treating selenium before effluent is discharged from ponds to downstream waters.

To evaluate the impact of discharges into Pigeonroost Branch and Oldhouse Branch as authorized by the DA Permit, Region III has compared selenium levels in Pigeonroost Branch and Oldhouse Branch with selenium levels in waters that have been impacted by the nearby Dal-Tex operation.[10] In addition, Region III has reviewed data from discharge monitoring reports from mining outlets for the portion of the Spruce No. 1 Mine that has been constructed in the Seng Camp Creek watershed. Figure 8 shows mine outlet locations.

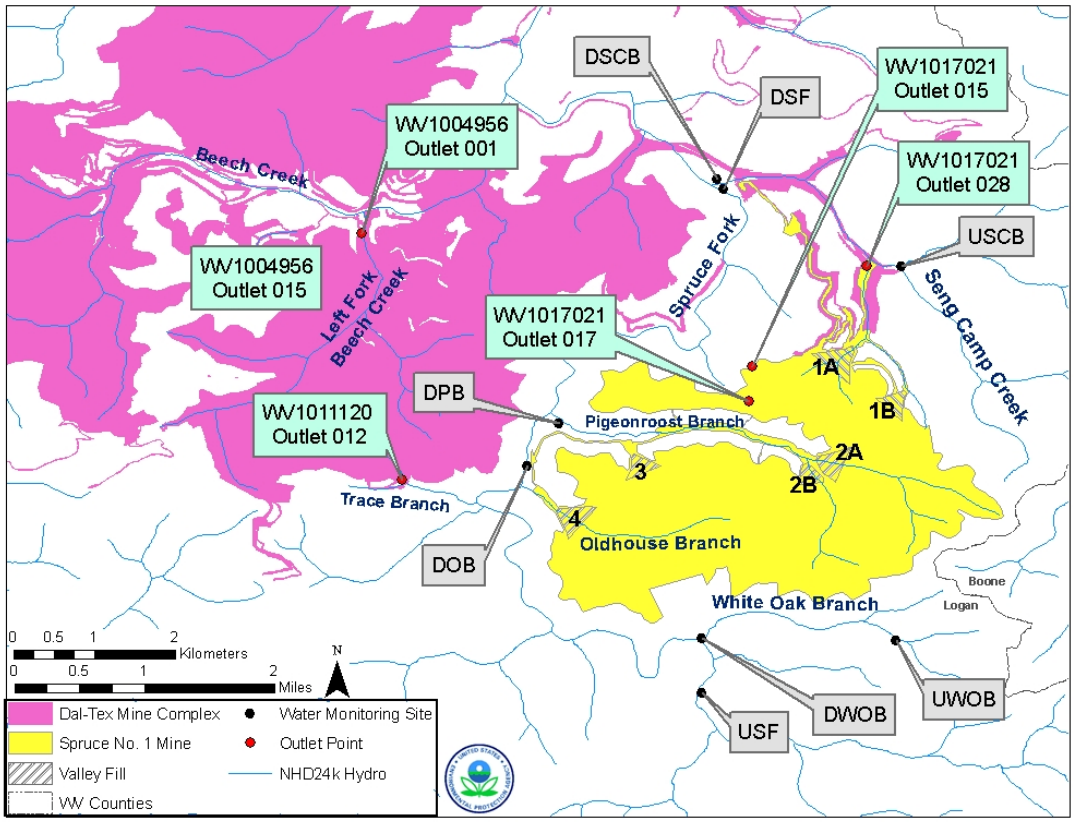


Figure 8: Dal-Tex and Spruce No. 1 Mine outlet locations.

[10] Levels of selenium in other nearby waters that have been impacted by surface coal mining activity and generally have similar geology also support a prediction that construction of the Spruce No. 1 Mine as currently authorized will result in elevated levels of selenium in downstream waters. Selenium concentrations have exceeded the Se criterion at least three times in six (6) other mined streams in the Coal River Sub-basin. These include White Oak Creek (a tributary to the Coal River), the left Fork of White Oak Creek, Seng Creek (another tributary to the Coal River); and Casey Creek, James Creek, and Beaver Pond Branch, all tributaries to Pond Fork. These elevated levels of selenium demonstrate that the geology in the area of the Spruce No. 1 mine is likely to release selenium during mining activities. See Appendix 2 for further details on selenium.

Table 3 provides a summary of selenium averages and ranges for Pigeonroost Branch and Oldhouse Branch and streams draining the nearby Dal-Tex operation (Left Fork Beech Creek, Beech Creek, and Trace Branch). The table also contains data for White Oak Branch (upstream of Spruce No. 1 as currently authorized) and Seng Camp Creek (receiving water for the portion of Spruce No. 1 that is under construction).

Summarizing the data in the following table, streams draining the nearby Dal-Tex operation have selenium concentrations exceeding the 5 ug/l chronic selenium numeric criterion. The data from the Dal-Tex mine complex do not indicate any decrease in selenium concentrations over the period of record. These data strongly suggest construction of valley fills and other discharges of fill material from the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch would likely result in discharges of elevated levels of selenium in the receiving waters and lead to significant degradation of water quality of the receiving waters and downstream waters. Such degraded water quality would be likely to impact downstream wildlife populations, including fish population

Table 3. Selenium Concentrations (ug/l) Near Spruce No. 1 Project Area

Stream Name	Subbasin	Source and time period of data					
		PEIS (2000-2001)		WVDEP (2002-2003)		WVDEP (2005-	
		Se (avg)	Se (range)	Se (avg)	Se (range)	Se (avg)	Se (ran
Average and Range of Se in Tribs to Spruce Fork that drain Spruce No. 1 project area							
White Oak Branch	Spruce Fork	<3 ND		<5 ND		NS	
Oldhouse Branch	Spruce Fork	<3 ND		<5 ND		NS	
Pigeonroost Branch	Spruce Fork	<3 ND		<5 ND		NS	
Seng Camp Creek	Spruce Fork	NS		<5 ND		NS	
Average and Range of Se in Tribs to Spruce Fork draining Dal-Tex Operation							
Beech Creek[11]	Spruce Fork	7.5	5.6-9.5	6	5.0-9.0	12.3	6.0
Left Fork of Beech Creek	Spruce Fork	22.7	15.3-31.1	22	5.0-53.0	NS	
Trace Branch	Spruce Fork	NS	NS	7	5.0-10.0	NS	
Rockhouse Branch	Spruce Fork	5.3	3.8-8.0	< 5 ND	< 5 ND	NS	

ND: Se not detected. Detection limit shown.
NS: Not sampled. Stream was not sampled for the study shown.

Graphical trends of selenium concentrations from Discharge Monitoring Report (DMR) records for January 2007 to June 2010 from three outfalls from the Dal-Tex Mine Operations are shown in the following Figures 9-11. These demonstrate that the discharges from those outfalls consistently exceed West Virginia's chronic numeric water quality criterion for selenium (5 µg/L).

[11] In the WVDEP study on selenium bioconcentration factors, selenium was also found in fish tissue in Beech Creek (average 7.55 mg/kg).

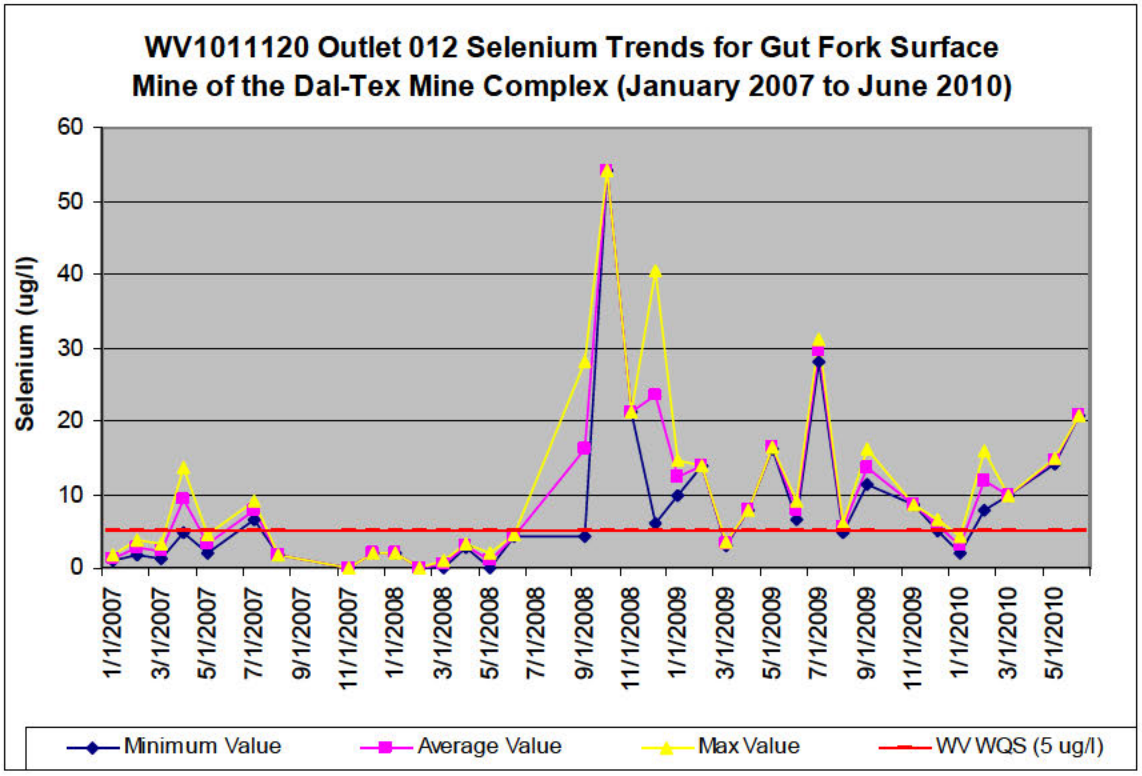


Figure 9: Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1011120 – Outlet 012 (Mingo Logan Coal Company's Gut Fork Surface Mine of the Dal-Tex Mine Complex)

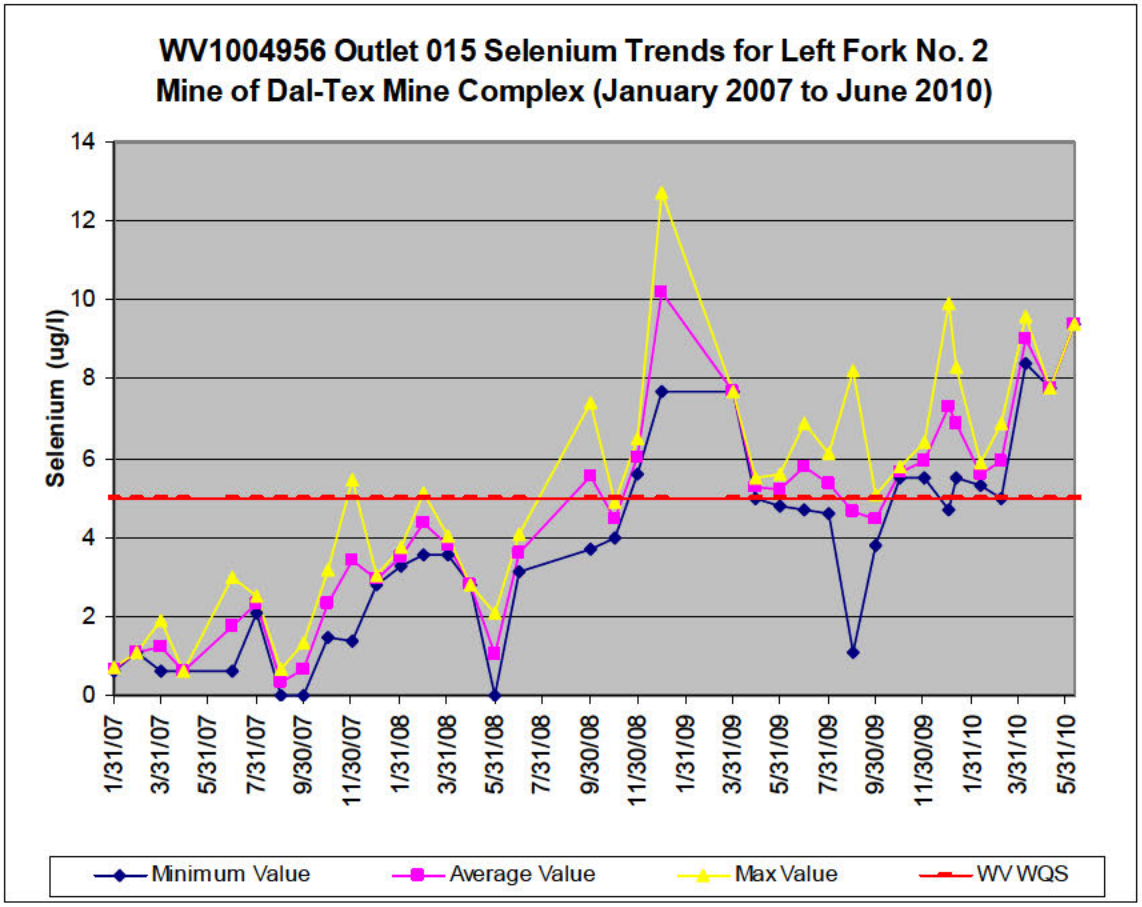


Figure 10: Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1004956 – Outlet 015 (Mingo Logan Coal Company's Left Fork No. 2 Mine of the Dal-Tex Mine Complex)

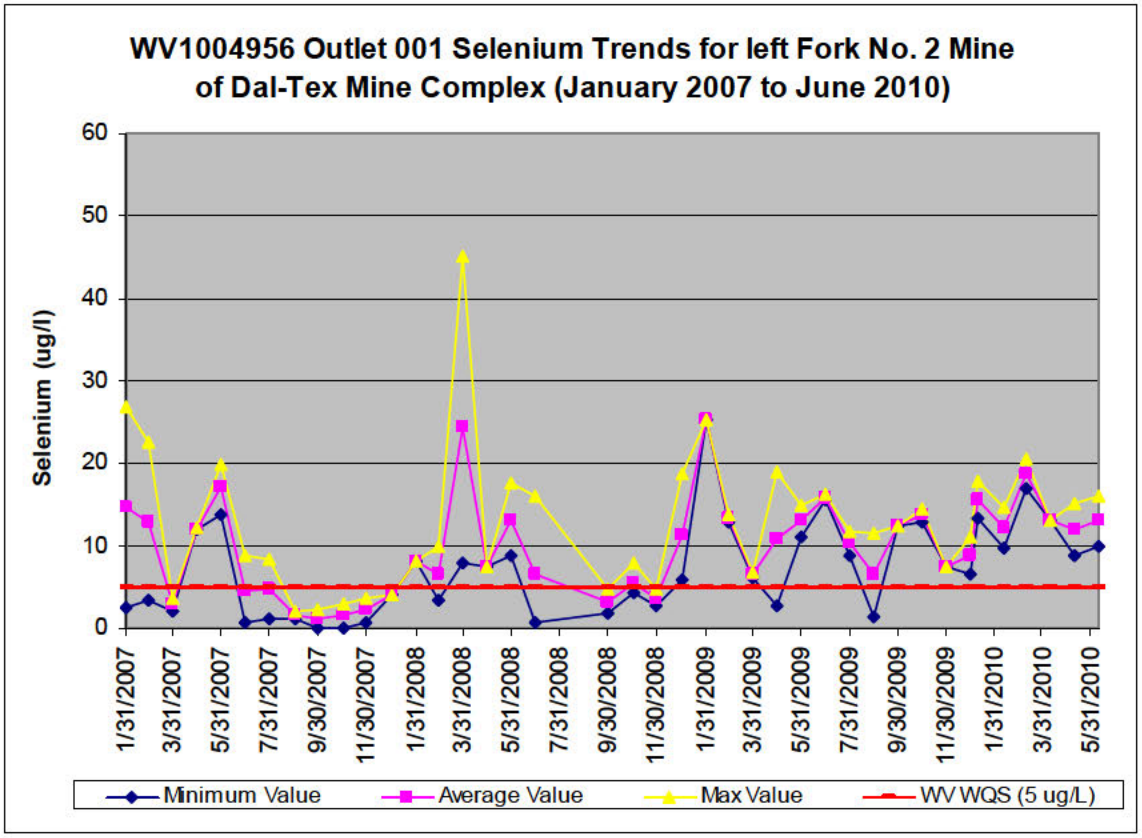


Figure 11: Selenium Trends (January 2007 to June 2010) for NPDES Permit WV1004956 – Outlet 001 (Mingo Logan Coal Company's Left Fork No. 2 Mine of the Dal-Tex Mine Complex)

Region III also reviewed data from the portion of the Spruce No. 1 Mine that is already constructed in Seng Camp Creek (Figure 12). These data also indicate that construction of valley fills in Pigeonroost Branch and Oldhouse Branch would likely result in discharges of elevated levels of selenium. The Spruce No. 1 project has active mining in the Right Fork of the Seng Camp Creek sub-watershed. Recent NPDES DMRs for a 16 month period (December 2008 to March 2010) show that the constructed portion of the Spruce No. 1 project (Outlet 028) is discharging selenium at concentrations that exceed West Virginia's chronic numeric water quality criterion (Table 4).[12] A technical review of the submitted 16 monthly DMR records for the Spruce No. 1 Outlet 028 document the maximum values exceeded the chronic selenium water quality criteria of 5 µg/L on six occasions (December 2008, January 2009, August 2009, September 2009, February 2010, and March 2010) representing a 37.5% exceedence rate. In addition, the average monthly measurements during this same time frame for Outlet 028 exceeded the chronic water quality criterion on 4 of the 16 monthly DMR reports (December 2008, January 2009, September 2009, and March 2010) representing a 25% exceedance rate of the WV

[12] The July 2009 DMR was not provided for review.

chronic water quality criterion for selenium. Selenium concentrations in excess of the chronic criterion were also reported from Outlet 017.[13]

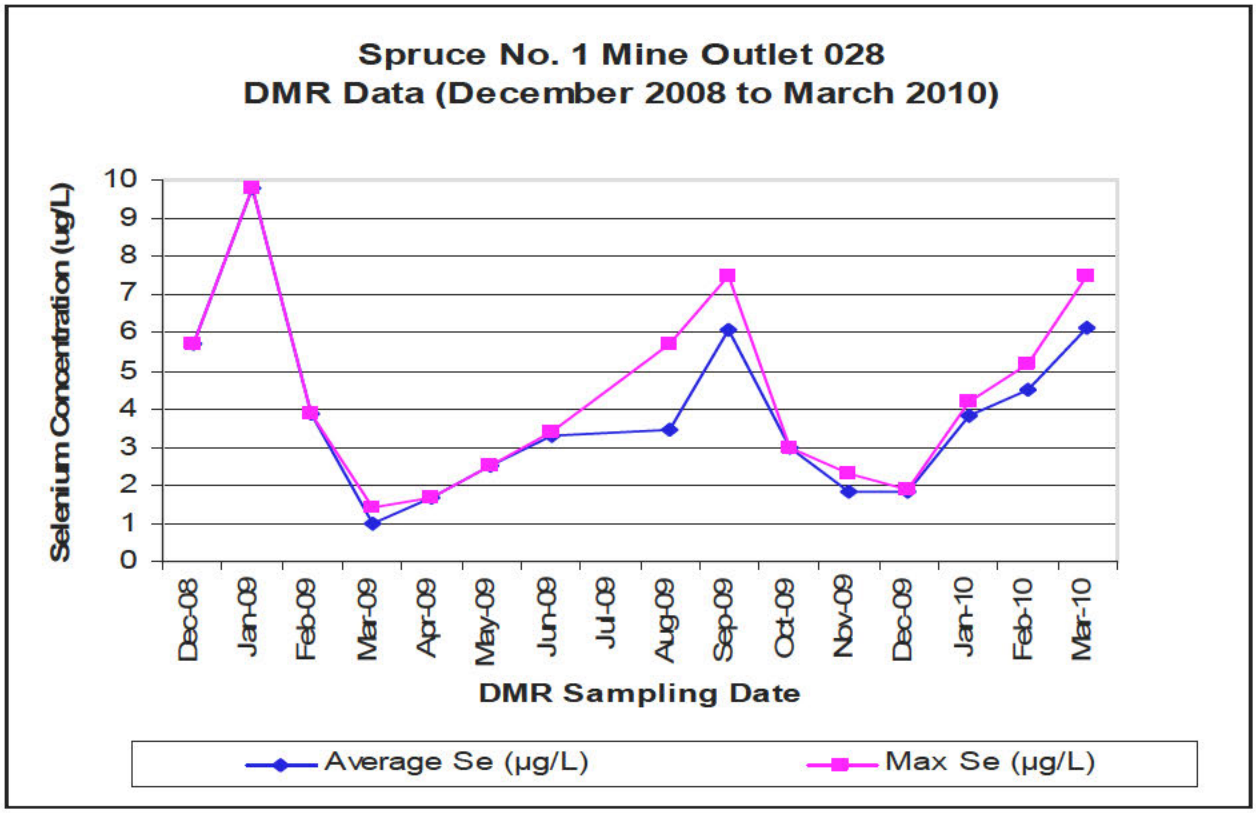


Figure 12: Selenium concentrations in discharge from outlet 028 on Spruce No. 1 Mine

[13] To the extent that commenters have stated that selenium discharges should be addressed only through the NPDES permit, the Section 404(b)(1) Guidelines provide an independent obligation to assure compliance with water quality standards (40 CFR 230.10(b)). Moreover, it is noted that the NPDES permit issued for the Spruce No. 1 project establishes effluent limitations for selenium in only three of the outfalls in the NPDES permit. The permit requires only monitoring at the remaining outfalls, including the outfalls in Seng Camp Creek discussed herein. To the extent the Company has commented that the impacts from the Dal-Tex operation are not a good predictor of selenium impacts from construction of Spruce No. 1 due to implementation of a materials handling plan at Spruce No. 1, it is noted that the materials plan as being implemented by Mingo Logan in the Seng Camp Creek watershed has not fully succeeded in preventing exceedance of the numeric water quality criterion for selenium at Outfalls 17 and 28. Moreover, the Arch corporate family, including Mingo Logan, has conceded that its efforts to control selenium at a number of its active surface coal mines in West Virginia have been unsuccessful. Arch's various subsidiaries recently have requested extensions of NPDES compliance schedules for selenium discharges at numerous facilities,further indicating challenges in meeting the WV chronic criterion.

Table 4. Total Recoverable Selenium (µg/L) for Outlets 015, 017 and 028 for NPDES Permit WV1017021, Mingo Logan Coal Company Spruce No. 1 Mine. Note: Shaded areas indicate exceedences of the selenium standard (5 µg/L).

Site Code	Site Location	Sample Date	Min Value	Ave. value	Max value
015	Outlet 015	12/31/2008	0.00	0.00	0.00
017	Outlet 017	12/31/2008	0.00	0.00	0.00
017	Outlet 017	9/30/2009	19.20	19.20	**19.20**
028	Outlet 028	12/31/2008	5.70	5.70	5.70
028	Outlet 028	1/31/2009	9.80	9.80	**9.80**
028	Outlet 028	2/28/2009	3.90	3.90	3.90
028	Outlet 028	3/31/2009	0.60	1.00	1.40
028	Outlet 028	4/30/2009	1.70	1.70	1.70
028	Outlet 028	5/31/2009	2.50	2.50	2.50
028	Outlet 028	6/30/2009	3.20	3.30	3.40
028	Outlet 028	8/31/2009	1.25	3.48	5.70
028	Outlet 028	9/30/2009	4.60	6.05	7.50
028	Outlet 028	10/31/2009	3.00	3.00	3.00
028	Outlet 028	11/30/2009	1.40	1.85	2.30
028	Outlet 028	12/31/2009	1.80	1.85	1.90
028	Outlet 028	1/31/2010	3.40	3.80	4.20
028	Outlet 028	2/28/2010	3.80	4.50	5.20
028	Outlet 028	3/31/2010	4.70	6.10	7.50

The Spruce Fork watershed upstream of Pigeonroost Branch and Oldhouse Branch has selenium concentrations elevated above the chronic water quality criterion based on the instream DMR data. See Appendix 2, Table 14. The downstream Spruce Fork (DSF) site does not have selenium concentrations above the water quality criterion. This suggests that Pigeonroost Branch and Oldhouse Branch provide clean dilution water to the mainstem of Spruce Fork (Appendix 2, Table 15). The proposed valley fills for Pigeonroost Branch and Oldhouse Branch will eliminate the freshwater dilution contributions from both of these tributaries. Based on the current during- and post-mining water quality conditions observed in Seng Camp Creek downstream of the Spruce No. 1 project, selenium values will likely also increase at both outlet points on Oldhouse and Pigeonroost Branch during and post-mining. The increased selenium concentrations combined with the elimination of the dilution from these two tributaries will likely cause the selenium concentrations in Spruce Fork to increase.

In summary, water quality from streams and discharges draining both the Dal-Tex Mine Complex and the current operational portions of the Spruce No. 1 Mine confirm EPA's concern that the Spruce No. 1 project would be likely to discharge levels of selenium exceeding the WV chronic water quality criterion for selenium (greater than 5 µg/l)

downstream of the filled streams and in Spruce Fork. [14] An important adverse impact of selenium residues in aquatic food chains is not just the direct toxicity to the organisms themselves, but rather the dietary source of selenium these organisms contribute to fish and wildlife species in the upper food web that feed on them.

b. Total Dissolved Solids/Conductivity

To understand the water quality impacts from increased total dissolved solids (TDS) and conductivity, it is helpful to understand the relationship between salinity, TDS, and specific conductivity, and the effect increases in conductivity have on native wildlife. For purposes of this action, when Region III discusses increased conductivity or TDS, we are referring to an increase in salinity in otherwise dilute freshwater, consistent with background levels in central Appalachian streams.

Salinity is the mass of salt in a given mass of water. While many of the elements that comprise mineral salts are essential nutrients, aquatic organisms are adapted to specific ranges of salinity and experience toxic effects from excess salinity.

Salinity reflects the amount of TDS in water. TDS is a measure of the combined content of all inorganic and organic substances contained in a solution in molecular, ionized or micro-granular (colloidal) suspended form and is normally reported in the units mg/l. The majority of TDS in many waters are simply salts.

Salinity is often expressed in terms of specific conductivity (hereafter referred to as conductivity). Conductivity is the ability of a solution to carry an electric current at a specific temperature (normally 25º C) and is normally reported in the units µS/cm (microsiemens per centimeter). Conductivity and TDS both increase as the concentration of ions in a solution increase and are very strongly correlated. Normally, conductivity is reported by state and federal monitoring agencies because it is an instantaneous measurement that can be collected in situ with a meter, that does not require a laboratory analysis, and that is precise and accurate. "Conductivity" refers to the measurement and resulting data; "salinity" refers to the environmental property that is being measured. Conductivity is an excellent indicator of the total concentration of all ions and is also a good predictor of aquatic life use impairment, especially in the ecoregion

[14] The concentrations of water column selenium observed at the Dal-Tex outlets and Seng Creek are significant in the fact that these concentrations have been associated with elevated fish tissue concentrations that are above the levels that cause teratogenic deformities in larval fish, leave fish with Se concentrations above the threshold for reproductive failure (4 ppm), and place birds at risk of reproductive failure through ingestion of fish with selenium concentrations greater than 7 ppm (Lemley 1997). According to the WVDEP's study on 'Selenium Bioaccumulation among select stream and lake fishes in West Virginia' (WVDEP 2009), Seng Camp had the highest average water column concentration (27.20 ppb) and a corresponding average fish tissue concentration of 8.16 ppm. While Beech Creek had a water concentration of 12.30 ppb with a corresponding average fish tissue concentration of 7.55 ppm. As outlined in the graphical trends of selenium concentrations from the DMR records for three permitted outlets for the Dal-Tex Mine Complex (WV1011120, WV1004956, WV1004956), these values are similar or greater than the Seng Camp and Beech Creek concentrations which supports our view that the corresponding fish tissue concentrations will be elevated to levels that cause fish and bird impairments.

69 in which the Spruce No. 1 project is located.

A recent study found that elevated conductivity greater than 500 µS/cm caused by alkaline mine effluents was strongly associated with high probability of degradation of native biota (Pond et al. 2008). In that study, 20 of 20 mined sites (100%) with conductivity levels greater than 500µS/cm reflected adverse impact to native macroinvertebrates using a genus-level multi-metric index, and 17 of those 20 sites (85%) reflected adverse impact to native macroinvertebrates using the family-level WVSCI index (using the less than 68 threshold). [15]

WVDEP ambient monitoring data confirm the high probability of adverse impact to aquatic life when conductivity levels are elevated to greater than 500µS/cm. WVDEP macroinvertebrate data from subecoregion 69d (the Cumberland Mountains of the Central Appalachians, the specific subecoregion where the project is located) were analyzed to determine the percentage of WVDEP sites that reflected adverse impact to aquatic life when the instream conductivity levels exceeded 500 µS/cm. This analysis indicates that a majority of the sites reflected adverse impact to aquatic life when conductivity levels were elevated above 500 µS/cm, even when accounting for the possible confounding effects of acidic pH and habitat degradation. For example, after removing low pH sites, only 100 sites out of 417 sites attained WVSCI scores greater than 68 when conductivity levels were greater than 500 µS/cm (76% of the sites reflected WVSCI scores less than 68). When the potential confounding effect of habitat degradation was completely removed (this subset includes only sites with Rapid Bioassessment Protocol habitat scores greater than 140, indicating reference quality habitat), 62% of the sites still had WVSCI scores less than 68. See Appendix 1 and 2 for further detail on macroinvertebrates and conductivity.

EPA's draft report, *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams* (USEPA 2010a). also recognizes stream aquatic life impacts associated with conductivity. This study, which is publicly available and is undergoing external peer review by the EPA's Science Advisory Board, applies EPA's standard methodology for deriving water quality criteria to field data and concludes that genus-level macroinvertebrate impacts to the biological community occur at conductivity levels as low as 300 µS/cm.

Pond et al. 2008 showed that mayfly richness is significantly reduced to a few or zero genera, and that several stonefly and caddisfly taxa were also extirpated or reduced in abundance, when conductivity exceeds 500 µS/cm downstream of mining operations similar to Spruce No. 1. This mining-induced pattern was also documented in the eastern Kentucky coalfields (Pond 2010). Many mayfly, stonefly and caddisfly genera are extirpated from streams downstream of headwater valley fills, and this extirpation is strongly correlated to water quality degradation caused by mining. This extirpation is in

[15] As noted elsewhere, in its 2008 Section 303(d) List, WVDEP identified a WVSCI score of 68 as the lowest score at which a waterbody was considered to "fully support" aquatic life. Less than 68 indicates degradation of the aquatic life use.

addition to direct burial of these macroinvertebrates and other wildlife, as previously described. See Appendix 1 macroinvertebrates for further detail.

After evaluating confounding effects as described above, scientific evidence points to the conclusion that the extirpation of macroinvertebrate taxa documented in these studies is caused by water quality degradation and not habitat degradation. Conductivity is an excellent predictor of native taxa loss from Appalachian streams while habitat variables provide little ability to predict taxa loss. Using the WV spring null model applied to genus-level data from Pond et al. (2008), Observed/Expected (O/E) scores strongly responded negatively (R^2=0.63) to increasing conductivity. See Section V.B.2.a.ii. below for a further explanation of the Observed/Expected Index. Water quality degradation caused by elevated conductivity explained more than twice the variance in O/E scores than did RBP habitat scores (R^2=0.28), confirming that conductivity is an excellent predictor of native taxa loss from Appalachian streams. Sediment deposition, substrate embeddedness, channel alteration, riparian zone width, pH, or temperature had no significant influence on O/E scores. From this analysis it is apparent that habitat degradation offered little explanatory value in O/E variation in this dataset.[16]

Data from WVDEP indicate that average conductivity values for Pigeonroost Branch and Oldhouse Branch are very low and are consistent with dilute background conditions in central Appalachian headwater streams (Table 5). Construction of valley fills and other discharges from the Spruce No. 1 Mine into Pigeonroost Branch and Oldhouse Branch would likely cause an increase in conductivity and TDS in receiving waters. This will have two effects: first, it will eliminate Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution to downstream waters, including Spruce Fork; and second, it will transform Pigeonroost Branch and Oldhouse Branch into sources of increased conductivity and TDS to downstream waters.

Construction of valley fills in the ecoregion in which the Spruce No. 1 Mine is located is strongly correlated with an increase in conductivity levels in downstream waters. Sedimentation ponds, which are the usual form of water treatment for surface coal mines, appear to be ineffective in removing TDS and decreasing conductivity. For example, average conductivity and sulfate levels are highly elevated in other tributaries to Spruce Fork where historical mining has occurred. Table 5 provides the following average conductivity and sulfate values for streams draining mined areas to the west of Spruce Fork in comparison with Pigeonroost Branch and Oldhouse Branch.

[16] Sites downstream of MTM in Pond et al. 2008 were located in relatively natural stream reaches in order to help control for obvious habitat effects

Table 5. Average conductivity and sulfate values for streams in project area		
Stream	**Conductivity Values**	**Sulfate Values**
Rockhouse Creek	1012 uS/cm conductivity	407 mg/l sulfate
Left Fork of Beech Creek	2426 uS/cm conductivity	1019 mg/l sulfate
Beech Creek	1432 uS/cm conductivity	557 mg/l sulfate
Trace Branch	971 uS/cm conductivity	569 mg/l sulfate
Oldhouse Branch	90 uS/cm conductivity	28 mg/l sulfate
Pigeonroost Branch	199 uS/cm conductivity	99 mg/l sulfate

Average conductivity and sulfate concentrations in the mainstem of Spruce Fork to which Pigeonroost Branch and Oldhouse Branch flow are also strongly elevated to as much as ten times above natural background levels in Oldhouse Branch. Average conductivity at almost every monitoring site on the mainstem Spruce Fork exceeded 500 µS/cm. Only one site had an average conductivity of less than 500 µS/cm, which was located upstream of the project area, upstream of Adkins Fork, and southeast of Blair, WV.

Pigeonroost Branch and Oldhouse Branch are providing freshwater dilution to Spruce Fork thereby preventing conductivity levels in Spruce Fork from becoming even more elevated. Construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch would remove sources of freshwater dilution to Spruce Fork and contribute to existing water quality degradation.

In addition to removing Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution for Spruce Fork, construction of valley fills and other discharges authorized by the permit into those waters also would likely transform Pigeonroost Branch and Oldhouse Branch into sources of elevated conductivity and TDS to downstream waters. As described in Section V.B.2.a. below, there is a strong correlation between elevated levels of conductivity and extirpation of macroinvertebrate taxa. Spruce Fork mainstem has little, if any, remaining assimilative capacity for conductivity.

Post-mining conductivity levels in Spruce Fork downstream of the project area were modeled using a watershed area weighted deterministic model with two post-mining average (500 and 1000 µS/cm) and maximum (1000 and 1500 µS/cm) conductivity values for Oldhouse Branch, Pigeonroost Branch and Seng Camp Creek. These values are conservative and likely underestimate the post-mining conductivity values. For example, when compared to Left Fork Beech Creek, which is completely mined and filled, the average and maximum conductivity values are 2425 and 3000 µS/cm. In Beech Creek, which is partially mined and filled, the average and maximum conductivity values are 1432 and 1776 µS/cm (average and maximum values based on 2002-2003 WVDEP data). In every case, since the measured average and maximum conductivity levels in Spruce Fork are currently greater than 500 µS/cm pre-mining, the modeled post-mining conductivity values are also greater than 500 µS/cm. Using the more conservative post-mining values (average 500 and 1000 µS/cm and maximum 1000 and

1500 µS/cm), we estimate that average conductivity in Spruce Fork downstream of Seng Camp Branch could increase from 555 pre-mining to 745 µS/cm post-mining and maximum conductivity could increase from 965 pre-mining to 1226 µS/cm post-mining. EPA expects that these additional conductivity increases would likely further extirpate native aquatic macroinvertebrates (wildlife) that are not tolerant to increased conductivity. See Appendix 2 for further detail on conductivity.

2. Impacts to Wildlife

a. Macroinvertebrates

As set forth in Sections IV A.1 and I.B.1 above, benthic macroinvertebrates are diverse and healthy in the Spruce No. 1 project area and represent an important component of the aquatic community in Pigeonroost Branch and Oldhouse Branch. Furthermore, because of their productivity and secondary position in the aquatic food chain, they also play a critical role in the delivery of energy and nutrients to downstream reaches (in aquatic life stages) as well as to upland terrestrial habitats (in winged adult life stages).

Construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will impact the native macroinvertebrate community in two ways. First, the macroinvertebrates that live in stream channels within the footprint of the valley fill will be destroyed. As set forth in Section V.C. below, it is not likely that the on-site stream creation proposed by the permittee as mitigation would support the quality of macroinvertebrate community that currently exists in Pigeonroost Branch and Oldhouse Branch. Second, construction of valley fills and other authorized discharges into Pigeonroost Branch and Oldhouse Branch would likely have an adverse impact on the macroinvertebrate communities in remaining downstream waters. Sensitive species of mayflies, stoneflies, and caddisflies currently inhabiting downstream waters will be impacted through increasing chemical loading of contaminants.

As set forth above, the 2006 Spruce No. 1 EIS states that impacts from the Spruce No. 1 Mine are expected to be similar to those from the Dal-Tex operation. Accordingly, conditions in streams impacted by the Dal-Tex operation will likely occur in the unfilled portions of the streams that will be impacted by the Spruce No. 1 Mine. To evaluate the impacts from the Spruce No. 1 Mine, Region III analyzed conditions in streams impacted by the Dal-Tex operation. Region III conducted three different analyses. First, Region III compared benthic macroinvertebrate collections from Pigeonroost Branch and Oldhouse Branch to benthic macroinvertebrate samples from streams that have been impacted by Mingo Logan's Dal-Tex operation. Second, Region III used an observed/expected approach. Third, Region III compared WVSCI scores in Pigeonroost Branch and Oldhouse Branch with streams impacted by the Dal-Tex operation. The following describes these three analyses.

i. Comparison of macroinvertebrate communities

To evaluate the impact of the project, EPA compared benthic collections from the Spruce No. 1 project area to Mingo Logan's Dal-Tex site (Table 1), using an equal number of

benthic samples collected at both locations. This analysis reveals that construction of valley fills and and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch would likely result in degraded macroinvertebrate communities downstream of these discharges.

Considering the number of genera collected, the relatively unimpacted Pigeonroost Branch and Oldhouse Branch contain a far greater number and diversity of macroinvertebrate genera. Collectively, 85 different genera were collected from Pigeonroost Branch and Oldhouse Branch between 1999-2000, while only 56 different genera were collected from both Beech Fork and Left Fork Beech Fork, streams that drain the inactive Dal-Tex operations.

Region III further refined its analysis to a comparison of the Ephemeroptera, Plecoptera and Trichoptera (EPT: mayflies, stoneflies and caddisflies) taxa collected. In Pigeonroost and Oldhouse combined, 42 EPT taxa were collected, while at Dal-Tex (Beech and Left Fork Beech), only 12 EPT were found. Narrowing further to mayflies and stoneflies, there were 14 mayfly genera and 12 stonefly genera in Oldhouse Branch and Pigeonroost Branch but only two relatively pollution-tolerant mayfly genera and three pollution-tolerant stonefly genera were collected in streams draining the Dal-Tex mine.. EPA also found that caddisflies were rich (14 total genera) in Pigeonroost and Oldhouse, but only seven total genera were found in Beech and Left Fork Beech downstream of the Dal-Tex mine.

As set forth above in Section IV.A., macroinvertebrates are good indicators of watershed health, and differ in their tolerance to the amount and types of pollution. Macroinvertebrate communities integrate the effects of stressors over time and some taxa (i.e., taxonomic category or group such as phylum, class, family, genus, or species) are considered pollution-tolerant and will survive in degraded conditions. Some taxa are pollutant-intolerant and will die when exposed to certain levels of pollution. Thus, the composition of tolerant and intolerant (i.e., sensitive) communities informs scientists about the quality of the water. The presence of a large number of individuals from the more sensitive genera indicates good water quality conditions, whereas the presence of a large number of tolerant genera may indicate degraded conditions.

The data described above indicates a substantial reduction in taxa diversity in the mine-impacted waters. In addition, several tolerant taxa were found in the streams draining the Dal-Tex mine that were not found in the Spruce project area further indicating degradation and adverse impact to wildlife habitat (Table 1). Some of these taxa are highly tolerant snails that typically do not occupy healthy headwater streams in the Appalachians (Lymnaeidae*, Physella, Helisoma*). Other tolerant beetles and fly larvae found at Dal-Tex but not Pigeonroost or Oldhouse also indicate biological impacts and altered environmental conditions (i.e., atypical of Appalachian headwater streams) that foster the invasion of these tolerant taxa. Table 6 compares the macroinvertebrate taxa identified in Oldhouse Branch and Pigeonroost Branch with that found in streams that have been impacted by the Dal-Tex Mine.

Table 6. List of macroinvertebrate taxa identified from Spruce project and Dal-Tex.

Order	Family	Genus	Oldhouse +Pigeonroost Spruce No. 1	Beech+Left Fork Beech Dal-Tex Mine
Oligochaeta	Oligochaeta	Oligochaeta	X	X
Nematoda	Nematoda	Nematoda		X
Proseriataoela	Plagiostomidae	*Hydrolimax*	X	
Tricladida	Planariidae	Planariidae	X	
Basommatophora	Lymnaeidae	Lymnaeidae		X
Basommatophora	Physidae	Physella		X
Basommatophora	Planorbidae	*Helisoma*		X
Coleoptera	Dryopidae	*Helichus*	X	
Coleoptera	Elmidae	*Dubiraphia*		X
Coleoptera	Elmidae	*Macronychus*		X
Coleoptera	Elmidae	*Microcylloepus*		X
Coleoptera	Elmidae	*Optioservus*	X	X
Coleoptera	Elmidae	*Oulimnius*	X	X
Coleoptera	Psephenidae	*Ectopria*	X	
Coleoptera	Psephenidae	*Psephenus*	X	X
Decapoda	Cambaridae	*Cambarus*	X	
Diptera	Ceratopogonidae	*Atrichopogon*		X
Diptera	Ceratopogonidae	*Bezzia/Palpomyia*	X	X
Diptera	Ceratopogonidae	*Dasyhelea*	X	X
Diptera	Chironomidae	*Acricotopus*		X
Diptera	Chironomidae	*Chaetocladius*	X	X
Diptera	Chironomidae	*Corynoneura*	X	X
Diptera	Chironomidae	*Cricotopus*	X	X
Diptera	Chironomidae	*Diamesa*	X	X
Diptera	Chironomidae	*Eukiefferiella*	X	X
Diptera	Chironomidae	*Metriocnemus*		X
Diptera	Chironomidae	*Micropsectra*	X	X
Diptera	Chironomidae	*Microtendipes*	X	
Diptera	Chironomidae	*Orthocladius*	X	X
Diptera	Chironomidae	*Parachaetocladius*	X	
Diptera	Chironomidae	*Parametriocnemus*	X	X
Diptera	Chironomidae	*Paraphaenocladius*		X
Diptera	Chironomidae	*Paratanytarsus*		X
Diptera	Chironomidae	*Polypedilum*	X	X
Diptera	Chironomidae	*Rheotanytarsus*	X	X
Diptera	Chironomidae	*Smittia*		X
Diptera	Chironomidae	*Stempellinella*	X	
Diptera	Chironomidae	*Stenochironomus*		X
Diptera	Chironomidae	*Stilocladius*	X	
Diptera	Chironomidae	*Sympotthastia*	X	
Diptera	Chironomidae	*Tanytarsus*	X	
Diptera	Chironomidae	*Thienemanniella*		X
Diptera	Chironomidae	*Thienemannimyia*	X	X
Diptera	Chironomidae	*Tvetenia*	X	X
Diptera	Chironomidae	*Zavrelimyia*	X	
Diptera	Empididae	*Chelifera/Metachela*	X	X
Diptera	Empididae	*Clinocera*	X	
Diptera	Empididae	*Hemerodromia*		X
Diptera	Simuliidae	*Prosimulium*	X	
Diptera	Simuliidae	*Simulium*	X	X
Diptera	Tabanidae	Tabanidae		X
Diptera	Tipulidae	*Antocha*		X
Diptera	Tipulidae	*Cryptolabis*	X	
Diptera	Tipulidae	*Dicranota*	X	
Diptera	Tipulidae	*Hexatoma*	X	

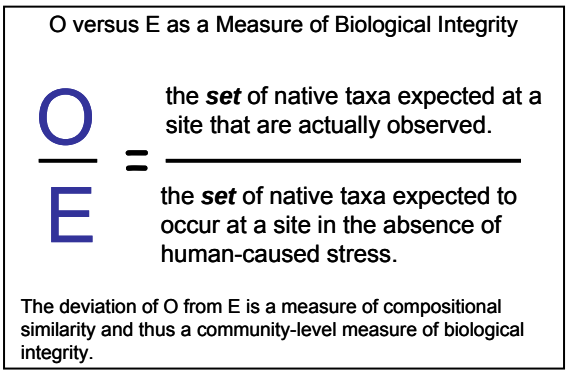
Table 6. Continued.

Continued			Oldhouse +Pigeonroost	Beech+Left Fork Beech
Order	Family	Genus	Spruce No. 1	Dal-Tex Mine
Diptera	Tipulidae	*Limnophila*	X	
Diptera	Tipulidae	*Limonia*	X	X
Diptera	Tipulidae	*Pseudolimnophila*	X	
Diptera	Tipulidae	*Tipula*	X	X
Ephemeroptera	Ameletidae	*Ameletus*	X	
Ephemeroptera	Baetidae	*Acentrella*	X	
Ephemeroptera	Baetidae	*Baetis*	X	X
Ephemeroptera	Baetiscidae	*Baetisca*	X	
Ephemeroptera	Ephemerellidae	*Drunella*	X	
Ephemeroptera	Ephemerellidae	*Ephemerella*	X	
Ephemeroptera	Ephemerellidae	*Eurylophella*	X	
Ephemeroptera	Ephemeridae	*Ephemera*	X	
Ephemeroptera	Heptageniidae	*Cinygmula*	X	
Ephemeroptera	Heptageniidae	*Epeorus*	X	
Ephemeroptera	Heptageniidae	*Stenacron*	X	
Ephemeroptera	Heptageniidae	*Maccaffertium/Stenonema*	X	
Ephemeroptera	Isonychiidae	*Isonychia*	X	X
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*	X	
Megaloptera	Corydalidae	*Corydalus*		X
Megaloptera	Corydalidae	*Nigronia*	X	X
Odonata	Aeshnidae	*Boyeria*		X
Odonata	Gomphidae	*Lanthus*	X	X
Plecoptera	Capniidae	Capniidae	X	
Plecoptera	Chloroperlidae	*Haploperla*	X	
Plecoptera	Leuctridae	*Leuctra*	X	
Plecoptera	Nemouridae	*Amphinemura*	X	X
Plecoptera	Nemouridae	*Ostrocerca*	X	
Plecoptera	Nemouridae	*Prostoia*		X
Plecoptera	Peltoperlidae	*Peltoperla*	X	
Plecoptera	Perlidae	*Acroneuria*	X	
Plecoptera	Perlodidae	*Isoperla*	X	
Plecoptera	Perlodidae	*Remenus*	X	
Plecoptera	Perlodidae	*Yugus*	X	
Plecoptera	Pteronarcyidae	*Pteronarcys*	X	
Plecoptera	Taeniopterygidae	*Taenionema*	X	
Plecoptera	Taeniopterygidae	*Taeniopteryx*	X	X
Trichoptera	Glossosomatidae	*Agapetus*	X	
Trichoptera	Glossosomatidae	*Glossosoma*	X	
Trichoptera	Goeridae	*Goera*	X	
Trichoptera	Hydropsychidae	*Ceratopsyche*	X	
Trichoptera	Hydropsychidae	*Cheumatopsyche*	X	X
Trichoptera	Hydropsychidae	*Diplectrona*	X	X
Trichoptera	Hydropsychidae	*Hydropsyche*	X	X
Trichoptera	Hydroptilidae	*Hydroptila*		X
Trichoptera	Limnephilidae	*Pycnopsyche/Hydatophylax*	X	
Trichoptera	Philopotamidae	*Chimarra*	X	X
Trichoptera	Philopotamidae	*Dolophilodes*	X	
Trichoptera	Polycentropodidae	*Polycentropus*	X	
Trichoptera	Psychomyiidae	*Psychomyia*	X	X
Trichoptera	Rhyacophilidae	*Rhyacophila*	X	X
Trichoptera	Uenoidae	*Neophylax*	X	
Tricladida	Planariidae	Planariidae	X	
		Total Distinct Taxa	85	56
		Total EPT Taxa	42	12

ii. Observed/Expected Index

In order to further predict and quantify the loss of taxa expected from construction of valley fills in Pigeonroost Branch and Oldhouse Branch as authorized, Region III applied a well-accepted and peer reviewed approach, called an Observed/Expected index (O/E) (Hawkins 2006, Van Sickle 2005) (Figure 13). O/E ratios basically represent the proportion of predicted taxa that were observed in a sample, compared to those expected in the sample, after predicting the probability that a sample site is a member of one or more fixed sets of reference site types.

Figure 13. Measure of biological integrity; O vs. E (C.P. Hawkins, Utah State Univ.).



Rather than using several reference site types, null models can be developed that assume only one set of comparable reference sites. Null models are appropriate when working in areas with relatively similar physical and regional characteristics that may have influence on the macroinvertebrate community (e.g., geology, stream slope, natural substrate, season and climate), as is the case in this application. For the WV null models, EPA first calculated the probability of capture (Pc) as the proportion of a taxon's occurrence in spring and summer at all mountain reference sites (combined ecoregions 67, Ridge and Valley, and ecoregion 69, Central Appalachians). For example, the stonefly *Leuctra* was present at 94% of mountain reference sites in spring, so its Pc value for spring is 0.94. EPA conducted this probability calculation for all non-chironomid taxa. The Pc's of all taxa with a Pc greater than 0.1 were then summed to yield the *Expected* number of taxa at a site for the given season (Table 7). Therefore, the *Expected* total number of taxa at a mountain site in spring is 20.4 and in summer is 18.7.

A site that is a perfect match to the richness of expected indigenous taxa will score 1.0, while downward deviation from 1.0 indicates increasing loss of expected taxa compared to regional reference (e.g., a score of 0.50 indicates a 50% loss of the expected taxa). Upward deviation (greater than 1.0) simply indicates that more taxa were collected than expected. (When a taxon is observed at a test site, that taxon is counted as 1 for the observed score, so if the Pc is less than 1 for that taxon, this can lead to O/E scores

greater than 1. For example, for the stonefly *Leuctra*, the Pc of capture is 0.94, so its tally for E is only 0.94, but if the taxa is observed at a site, its tally for O is 1.

We chose the 5th percentile of reference site O/E scores as a threshold to correspond to WVDEP's bioassessment threshold for assessing aquatic life support. This O/E 5th percentile was 0.64, indicating a loss of 36% of expected taxa.

The WV null model indicates that macroinvertebrate assemblages in Pigeonroost Branch, Oldhouse Branch and the upstream White Oak Branch are comparable to WVDEP mountain ecoregion reference sites and that there is adverse impact (O/E less than 0.64) to streams receiving drainage from MTM/VF operations in WV, including streams adjacent to the Spruce mine area (Tables 3 and 4). The highest O/E scores (1.18) were in Pigeonroost, Oldhouse and White Oak Branches. The lowest O/E scores (0.20) were in Beech and Left Fork of Beech Creek, both of which have been impacted by mining operations.

The model indicates that macroinvertebrate assemblages in Pigeonroost Branch and Oldhouse Branch are comparable to WVDEP mountain ecoregion reference sites. In contrast, past mining by Mingo Logan has led to the estimated extirpation of ~70% of the native expected taxa in their adjacent Dal-Tex mine operation (Table 7). It is highly likely that conditions in the unfilled portions of Pigeonroost Branch and Oldhouse Branch will follow this pattern of genus-level extirpation if valley fills are constructed in those waters as currently authorized. See Appendix 1 for for more details on O/E. and model development.

Table 7. Summary of WV O/E null model results for the Spruce No. 1 Project area. The biological impairment threshold is 0.64 (corresponding to the 5th percentile of WVDEP reference site distributions). An O/E score of ~1.0 means that the number of Observed native taxa is equivalent to the Expected number of native taxa. SD = standard deviation.

Table 7			
		Mean (SD) O/E	
	Spruce No. 1	**Dal-Tex**	
	Pigeonroost,Oldhouse, White Oak	Beech, LF Beech	Rockhouse
Spring	0.98 (0.20); n=9	0.26 (0.06);n=5	0.31 (0.10); n=3
Summer	0.85 (0.15); n=2	0.32 (0.08); n=2	0.38 (0.08); n=2
● Adjacent mined sites include LF Beech, Beech, and Rockhouse			
● The highest O/E scores were recorded in Pigeonroost, Oldhouse, and White Oak (each scored 1.18)			
● The lowest O/E scores were recorded in Beech and LF Beech on Dal-Tex (each scored 0.20)			
Based on WVDEP Mountain reference sites, on average:			
● Spruce No. 1 samples are missing ~2% of expected taxa in Spring, and ~15% in Summer			
● Dal-Tex sites are missing ~74% of expected taxa in Spring, and ~68% in Summer.[17]			
● SD for Spruce No. 1 streams had similar or better precision (SD) to the WVDEP reference model			
● SD for Dal-Tex was very low indicating that all observations consistently show missing taxa			

iii. Comparison of WVSCI scores

States routinely use macroinvertebrate assemblage data to assess compliance with their narrative water quality standards and to determine support of aquatic life. For the past several cycles of Section 303(d) lists of impaired waters, WVDEP has used a family-level multi metric index called the WV Stream Condition Index or WVSCI. The WVSCI uses six (6) component metrics to summarize and analyze family-level macroinvertebrate taxa lists. The six metrics are total number of EPT (Ephemeroptera, Plecoptera and Trichoptera or maflies, stoneflies and caddisflies) taxa, total number of taxa, percent of organisms that are EPT, percent of organisms that are Chironomidae (midges), the percent of organisms in the top two dominant taxa, and the Hilsenhoff Biotic Index. All metrics are computed at the family-level with a 200 fixed count subsample. The metrics are scored against Best Standard Values (BSVs) for the entire dataset, as a percent of the BSV and normalized to a score of 100. The average of all six metrics makes up the final WVSCI score. Simply put, the lower the score, the more degraded the macroinvertebrate assemblage. For more information on the WVSCI, go to http://www.wvdep.org/Docs/536_WV-Index.pdf.

[17] Based on EPA data (Pond et al. 2008), all mined sites lost 47% of expected taxa, on average.

Examination of the West Virginia dataset has shown that the family-level metrics used by WVDEP generally underestimate degradation of the macroinvertebrate community impairment of aquatic life uses as compared to more sensitive genus-level indices due to the coarse level of taxonomy. Despite this lower sensitivity, bioassessments using WVSCI have documented adverse impacts to aquatic life due to mining in streams on mined sites near the project area

EPA sampled several streams within the Spruce Fork watershed for the Mountaintop Mining/Valley Fill Programmatic Environmental Impact Study (PEIS) (Green et al. 2000; Bryant et al. 2002). These assessments indicate that the unmined streams within and near the project area, including White Oak Branch, Oldhouse Branch and Pigeonroost Branch were high quality streams that fully support the aquatic life use, based on the family-level WVSCI and water quality data (see Appendix 1 and 2). The streams located in the historically MTM/VF mined areas located nearby (Rockhouse Branch, Beech Creek, and the Left Fork of Beech Creek) had WVSCI scores that would indicate they did not fully support aquatic life. These EPA data indicate that the aquatic life in streams on the project area (i.e., Oldhouse Branch and Pigeonroost Branch) would be likely degraded to the conditions exhibited in the Beech Creek and Rockhouse sub-watersheds after they are mined.

WVDEP data and assessments confirm that the aquatic life is adversely impacted not only in the nearby mined streams, but further downstream, on the mainstem of Spruce Fork, Pond Fork and the Little Coal River (see Appendix 1). The adverse impacts in the mainstem of Spruce Fork, Pond Fork, and the Little Coal are likely due to a combination of stressors, including mining and residential stressors. (WVDEP 1997).

Construction of valley fills, sediment ponds, and other discharges into Pigeonroost Branch and Oldhouse Branch as authorized by the DA Permit No. would be likely to export additional contaminants (conductivity) to Spruce Fork. Due to the sensitivity of native macroinvertebrate wildlife to elevated and increasing levels of conductivity, these contaminants are likely to hinder the maintenance or recovery of these biological communities.

b. Salamanders

As stated above, the ecoregion where the Spruce No. 1 project is located has one of the richest salamander fauna in the world. Impacts from the activities authorized as part of the project will have a significant adverse impact on this wildlife group located within the project area. Based on literature values (Williams 2002) for mean densities within reference reaches of Pigeonroost Branch, Bend Branch (another tributary of Spruce Fork), and Ash Fork (a tributary of Gauley River) and a 2004 USFWS study in White Oak Branch, EPA estimates aquatic salamander density in Pigeonroost Branch and Oldhouse Branch at ~5-6 per square meter along stream channels. Approximately seven acres of stream channel would be filled in Pigeonroost Branch and Oldhouse Branch by the project as currently authorized which means that more than 200,000 stream-dwelling

salamanders would be buried by the currently authorized valley fills. It is not expected that stream salamanders will return to the site due to the burial of their existing habitat and the inadequacy of proposed mitigation to replace the habitat required by these wildlife. Gingerich (2009) found no expected stream salamanders inhabiting 3-20 yrs old sediment ditches (5 out of 5 mines) on West Virginia MTM areas. Furthermore the USFWS has indicated that, to its knowledge, it has not been demonstrated that salamanders return to surface-mined areas and achieve densities similar to those that occurred prior to mining.

Since salamanders represent the main vertebrate predator in these headwater streams, and will be eradicated under the project, EPA believes that a key component of the aquatic food web would be likely to be lost from the aquatic ecosystem within Pigeonroost Branch and Oldhouse Branch portions of the Spruce No. 1 mine area.

According to the USFWS, adverse impacts to salamanders as a result of construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch will not be localized to the area to be filled. Because construction of the valley fills and other discharges are very likely to increase conductivity and selenium levels in the downstream receiving waters (See Section V.B.1 above), salamanders that are not directly buried and killed beneath the fills are also likely to be impacted; directly via exposure to these contaminants and perhaps indirectly via impacts of contaminants on food sources. (Patnode, et al. 2005) Such impacts are likely to occur as far downstream as elevated conductivity, selenium or other contaminants persist, and to affect any salamanders that spend some part of their life in the aquatic environment or in immediately adjacent riparian terrestrial habitats. These impacts would likely be exacerbated by the loss of fresh water dilution from Pigeonroost and Old House Branch.

USFWS also indicated that while range-wide populations of common species may not be significantly impacted, the salamander communities in individual headwater systems behave essentially as isolated populations because there is limited interaction (immigration and emigration) with communities in adjacent watersheds (Dr. Thomas Pauley, Marshall University and personal communication with Jim Zelenak USFWS WV Field Office). Therefore, the populations within the watersheds that will be impacted by fill (the footprints of the valley fills and the downstream toxicity in the form of elevated conductivity, selenium, and potentially other contaminants), and are very likely to be significantly impacted.

Furthermore, as set forth in Section V.B.2.c.i. below, construction of valley fills and other discharges into Pigeonroost Branch and Oldhouse Branch has the potential to contribute to conditions that would support blooms of golden algae *(Prymnesium parvum)*, which can produce a toxin that is highly toxic to aquatic life and was associated with an extensive aquatic life kill of both fish and lungless salamanders in Dunkard Creek in West Virginia in September 2009.

c. Fish

As described in Section IV.B.3. above, the fish assemblages in Pigeonroost Branch and Oldhouse Branch are typical of headwater streams, containing only a few species. The fish assemblages in Spruce Fork are in relatively good condition. While some studies have documented adverse impacts to fish communities associated with surface coal mining, based on the fish community in Spruce Fork downstream of the Dal-Tex operation, it appears that the fish within Spruce Fork are fairly tolerant of increases in conductivity and total dissolved solids. Nevertheless, increases in conductivity and total dissolved solids and construction of sediment ponds associated with valley fills authorized in Pigeonroost Branch and Oldhouse Branch will create conditions considered favorable to the growth of golden algae (*Prymnesium parvum)*, which has caused large aquatic life kills. Fish also would be likely to be exposed to increases in selenium concentrations, which could lead to bioaccumulation in fish tissues and to reproductive effects (see Section V.B.1.a. above). Because of the potential to promote the growth of golden algae and because of the likely increased exposure to selenium, Region III concludes that construction of valley fills in Pigeonroost Branch and Oldhouse Branch would be likely to have an adverse effect on the fish population in those waters and in Spruce Fork.

i. Potential to promote growth of golden algae

Construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch as currently authorized are likely to contribute to instream conditions in or near Spruce Fork that may support the growth of golden algae (*Prymnesium parvum),* which releases toxins that kill fish and other gill-breathing aquatic organisms. *P. parvum* is a haptophyte (flagellated) algae now distributed worldwide. This algae has been known to North America since the 1980's (Baker et al., 2007) and has since become established in many Texas and Oklahoma rivers and reservoirs. *P. parvum* is responsible for Harmful Algal Blooms (HAB's) that have killed millions of fish in Texas and Oklahoma, and has been implicated in kills from North Carolina to Arizona.

P. parvum has also been associated with an extensive and severe aquatic life kill, which destroyed thousands of fish, mussels and other aquatic life in Dunkard Creek, West Virginia and Pennsylvania in September 2009. At the time of the Dunkard Creek aquatic life kill, biologists reported observations of thousands of dead fish, mussels and salamanders. Mud puppies (an aquatic salamander that lives its entire life underwater) crawled out of the water and onto rocks and the shoreline in an attempt to escape from the toxic water. Field biologists observed numerous individuals as dried up carcasses on rocks and along the shoreline. Fish were observed avoiding the mainstem of Dunkard Creek by practically "stacking –up" in the mouths of tributaries, subjecting themselves to feeding by blue heron rather than remaining in the toxic water of mainstem Dunkard Creek. The identification of *P. parvum* in 2009 in Dunkard Creek was the first identification of this invasive aquatic species in the Mid-Atlantic States.

The factors that are most closely associated with supporting growth of *P. parvum* are believed to be:

1. Proximity to a known source of *Prymnesium parvum*.
2. TDS in high enough amounts to support *P. parvum* (estimated to be between 500 and 1000 mg/L (conductivity 714-1428 µS/cm).
3. Nutrients of great enough amount to initiate a bloom of *P. parvum*
4. pH greater than 6.5. Risk increases with increasing pH.

Areas of habitat that are pooled (large beaver dams, natural residual pools, or manmade ponds)

EPA believes that the Spruce No. 1 project is likely to increase the likelihood that all five factors are met within the Spruce Fork sub-watershed, as outlined below.

1) Proximity to Known Source: P. parvum was identified (in very high numbers) in Cabin Creek of the Kanawha drainage, only 25 miles over the ridge to the East. Because this algae can easily move with waterfowl, the risk of introducing *P. parvum* in the Spruce Fork drainage is high.

Although not currently found in Spruce Fork, WVDEP has identified Spruce Fork as a "water of concern" because of its potential (due to already high levels of TDS/conductivity) to support *P. parvum* blooms consistent with the factors shown above.

2) *High TDS:* The lower TDS limits for the growth of *P. parvum* appears to be ~500 mg/l TDS, or ~700µS/cm conductivity for the ion mixtures typical of alkaline mine drainage. Recent data indicate that growth of *P. parvum* increases 2-3 fold when conductivity increases from 500 µS/cm to 1000 µS/cm (unpublished data, WVDEP, 2010). The waters draining the nearby Dal-Tex Mine operation have conductivity levels greater than these values. Many of the sampling sites on the mainstem of Spruce Fork, Pond Fork and the Little Coal River also have conductivity levels exceeding these endpoints. Other waters of concern near the Spruce No. 1 project include the Little Coal River and West Fork/Pond Fork

As described in SectionV.A, construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch would be likely to increase levels of TDS/conductivity in Spruce Fork, thus creating conditions more favorable to *P. parvum*.

In addition, DA Permit No. 199800436-3 (Section 10: Coal River) authorizes construction of numerous sedimentation ponds in Pigeonroost Branch and Oldhouse Branch. These will create areas of pooled habitat more favorable to *P. parvum.* During low flows, when conductivity is highest, flow is lowest, increasing the possibility that blooms could occur in very slow moving residual pools within the channel.

3) *Suitable Nutrient Levels:* Nutrients in the Spruce Fork are of similar availability to Dunkard Creek and other watersheds with *P. parvum* algae present (e.g. Whitely Creek, PA). Phosphorous in Spruce Fork was over 100 µg/L on two sampling occasions during the PEIS.

4) *High pH:* Discharges from Spruce No. 1 are likely to be alkaline, consistent with pH of discharges from Dal-Tex and other operations, etc. etc.

5) *Existence of Pooled Habitats*: Pooled habitats with little to no flow are common in streams like Spruce Fork in low flow conditions of September and October, when TDS is highest.

ii. Increased exposure to selenium

As set forth in Section V.B.1.a, construction of valley fills and other discharges authorized by the DA Permit into Pigeonroost Branch and Oldhouse Branch would be likely to result in elevated levels of selenium in receiving waters. While selenium is a naturally occurring chemical element that is an essential micronutrient, excessive amounts of selenium can also have toxic effects on fish. Selenium toxicity is primarily manifested as reproductive impairment and birth defects due to maternal transfer, resulting in embryotoxicity and teratogenicity in egglaying vertebrates (e.g. fish and ducks). The most sensitive toxicity endpoints in fish larvae are teratogenic deformities such as skeletal, craniofacial, and fin deformities, and various forms of edema. Embryo mortality and severe development abnormalities can result in impaired recruitment of individuals into populations (Chapman et al. 2009). A WV draft study indicates that elevated selenium concentrations in fish eggs, increased larval deformity rates and increased deformity rates in mature fish are occurring in the Mud River Reservoir, Boone County, WV due to mining activities. These adverse conditions were all associated with elevated water column selenium concentrations (WVDEP, 2009, draft).

In summary, construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch would likely result in increased instream levels of selenium that can have toxic effects on fish.

iii. Other potential impacts to fish

A number of studies have documented adverse impacts to fish communities associated with surface coal mining. It is important to consider basin size when assessing the potential effects of valley fills because small streams (less than10 km^2) have shown effects to the fish assemblage while larger streams have not (e.g., Fulk et al. 2003). As noted by Fulk et al. (2003) using fish indices like the Mid-Atlantic Highlands Index of Biotic Integrity (MAHA IBI) of McCormick et al. (2001) is problematic in small streams that are species depauperate (limited diversity) because the index is greatly affected by the addition or subtraction of one or two individuals of a different species. Nevertheless, Fulk et al. did analyze small streams in their report and found significant differences in

total IBI scores between mined and unmined streams. This difference was attributed to changes in cyprinid species richness and the percent of the assemblage composed of benthic invertivores. There was no significant difference in percent cottids (sculpin).

Some studies have shown that mountaintop mining for coal and construction of valley fills has had a harmful effect on the composition of stream fish communities (Fulk et al., 2003, Stauffer and Ferreri, 2002). Comparison of streams without mining in the watershed and sites downstream of valley fills in Kentucky and West Virginia indicate that streams affected by mining had significantly fewer total fish species and fewer benthic fish species than streams without mining in the same areas (Stauffer and Ferreri, 2002).

Fulk et al. (2003) used the Mid-Atlantic Highlands Index of Biotic Integrity (IBI - a multi-metric index used to assess biotic health) to analyze fish data from 27 streams in West Virginia. In their study, Fulk et al. (2003) classified streams (no mining in the watershed, mountaintop mining in the watershed, sites downstream of valley fills, and sites with both mining and residential development in the watershed) and compared fish assemblage health among stream classes. The study showed that assessment scores from the sites downstream of valley fills were significantly lower than scores from sites without mining in the watershed, indicating that fish communities were degraded in sites downstream of valley fills. Sites with residences in addition to mining, however, scored similarly to the unmined sites.

Sites that were sampled in Spruce Fork for the PEIS were classified as "filled with residences." Sampling data in the Spruce Fork sub-watershed downstream of the Dal-Tex operation scores similarly to filled residential sites in the PEIS, There is no difference between filled residential sites and unmined sites in the PEIS.

In summary, there remains the potential that construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) into Pigeonroost Branch and Oldhouse Branch have the potential to promote the growth of golden algae and increase exposure to selenium. For these reasons, Region III concludes that construction of valley fills and other discharges authorized into Pigeonroost Branch and Oldhouse Branch would be likely to have an adverse effect on the fish population in those waters and in Spruce Fork.

d. Water-dependent birds

Loss of headwater streams from the project would be likely to impact water dependent birds, such as the Louisiana waterthrush, that require forested headwater streams for foraging on insects and nesting by elimination of the headwater areas associated with Pigeonroost Branch and Oldhouse Branch.

The Louisiana waterthrush has been designated by USFWS as a Bird of Conservation Concern (BCC) within the Appalachian Mountains Bird Conservation Region (AMBCR) that may be impacted by Mountaintop Mining – Valley Fills (MTM-VF).

According to USFWS, the Louisiana waterthrush is an area-sensitive riparian-obligate species that nests and forages along headwater streams of intact interior forests; it relies for breeding success on the diverse and productive assemblage of aquatic insects supported by healthy headwater systems (Mattson et al. 2009). Studies indicate that breeding territory density and occupancy were reduced along streams where benthic macroinvertebrate communities had been degraded due to anthropogenic land uses and acidification. Lower breeding territory densities occurred along streams impacted by acid mine drainage more so than along circumneutral streams. Similarly, some indices of benthic macroinvertebrate integrity were higher where breeding Louisiana waterthrushes were present than areas from which they were absent. Stream reaches where breeding birds were detected had a greater proportion of pollution-sensitive benthic macroinvertebrates than reaches where they were not detected supporting the concept that good water quality is a key component of the species breeding habitat.[18] Management for this species has focused on protecting core wooded riparian habitat, including establishment of undisturbed riparian forest cover, and preservation and improvement of water quality to ensure aquatic insect biomass and diversity.

For water-dependent wildlife, like the Loiusiana waterthrush, preservation of large tracts of forest containing headwater streams is needed for the conservation of this species in the central Appalachians. The waterthrush is particularly vulnerable to degradation of water quality and aquatic insect communities (Mattsson and Cooper 2006, Mulvihill et al. 2008).

3. Summary

In summary, construction of valley fills, sedimentation ponds, and other discharges authorized by DA Permit No. 199800436-3 (Section 10: Coal River) to Pigeonroost Branch and Oldhouse Branch would eliminate headwater stream systems that support some of the last remaining least-degraded conditions within the Coal River sub-basin, destroy (through burial) diverse and healthy wildlife communities and habitat within those headwater stream systems. In addition, the discharges would likely convert previously healthy, functioning headwater streams into sources of contaminants to downstream waters that would likely adversely affect wildlife in those downstream waters. These impacts likely will cause significant degradation of the Nation's waters as described in 40 C.F.R. 230.10(c), particularly within the context of of the mine-impacted Coal River sub-basin and Spruce Fork sub-watershed. As set forth in Section V.C.

[18] In addition to stream pollution from anthropogenic land uses, elevated predator numbers from landscape-scale forest fragmentation and the loss of riparian forest canopy could also negatively impact future population levels of the Louisiana waterthrush. Ongoing impacts associated with landscape disturbances, including defoliation, increased stream temperatures, and compositional shifts in benthic macroinvertebrate communities, also could reduce populations in the AMBCR. Therefore, measures of Louisiana waterthrush distribution and reproduction may be useful indicators of both stream and forest ecosystem integrity.

below, Region III has determined that the compensatory mitigation plan for this project would be unlikely to compensate adequately for the impacted resources or to reduce the impacts described above to an acceptable level.

C. Mitigation is not likely to ffset anticipated impacts

The Section 404(b)(1) Guidelines require that the permit authorize only the least environmentally damaging practicable alternative. 40 C.F.R. 230.10(a). In addition, no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem. 40 C.F.R. 230.10(d). Thus, impacts must be first avoided and then minimized It is only after practicable and appropriate steps have beeen taken to to avoid and minimize impacts that compensatory mitigation to offset unavoidable adverse impacts to aquatic resources authorized by Clean Water Act Section 404 permits and other Department of the Army (DA) permits may be considered.

Analysis by Region III indicates that there appear to be alternative configurations that would avoid much of the discharges to Pigeonroost Branch and Oldhouse Branch. Because the scope of this Recommended Determination is limited to withdrawal of specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material in connecton with the Spruce No. 1 Mine, Region III takes no position at this time as to whether the alternatives that Region III has identified would be likely to result in acceptable or unacceptable effects on wildlife or satisfy the Section 404(b)(1) Guidelines.

If constructed as authorized the Spruce No. 1 Mine will result in direct impacts (through discharge of dredged and/or fill material) to approximately 35,368 linear feet (about 6.6 miles) of stream in Pigeonroost Branch and Oldhouse Branch. The impacts from these discharges are discussed in Sections V.A. & V.B. above.

While Region III recognizes that the project includes mitigation efforts (including stream creation and enhancement of existing streams) to compensate for unavoidable adverse impacts, Region III is concerned that known compensatory mitigation techniques would be unlikely to replace the high quality resources in Pigeonroost Branch and Oldhouse Branch. Additionally, Region III believes that the current mitigation plan does not adequately account for the quality and function of the impacted resources.

The Compensatory Mitigation Plan (CMP) submitted by Mingo Logan describes on-site and off-site, in-kind mitigation. On-site compensation would include the restoration of 7,132 linear feet of stream segments temporarily impacted by the sedimentation ponds, and the creation of 43,565 linear feet of on-bench stream channel within the project area. Off-site compensation includes stream enhancements to Spruce Fork and Rockhouse Creek through a combination of physical, aquatic habitat, and stream stabilization improvements. Finally, the CMP proposes to direct surface water flow from the project area in existing drainage ways to promote the development of more defined channels, thus creating 26,625 linear feet of streams.

Both EPA and the USFWS have regularly identified problems with the mitigation techniques that are part of the CMP for the Spruce No. 1 Mine. Region III's comments on the 2006 draft and final EISs for the Spruce No. 1 Mine expressed concern that the compensatory mitigation plan did not fully mitigate all adverse impacts and was inadequate in terms of its lack of functional assessment and concerns whether headwater stream creation would in fact replace impacted resources Region III emphasized the importance of headwater stream functions that would be lost and likely not replaced, particularly by conversions of existing drainageways to streams as described in the CMP. In their December 4, 2001, letter the USFWS expressed similar concerns that the proposed mitigation was unlikely "to provide sufficient mitigation for permanent stream and riparian habitat loss and for the losses of the functions and values of the stream to aquatic species in the fill footprint and to the downstream ecosystem."

As discussed below, the project fails to include all appropriate and practicable steps to minimize and compensate for the project's adverse impacts on the aquatic ecosystem as required by 40 CFR 230.10(d). Further, EPA Region III believes that the anticipated level of adverse impacts associated with the Spruce No. 1 Mine will not be adequately offset by the required compensatory mitigation.

1. Proposed mitigation likely will not replace high quality resources in Pigeonroost Branch and Oldhouse Branch

There is no evidence in the peer-reviewed literature that the type of stream creation included in the CMP will successfully replace lost biological function and comparable stream chemistry to high quality stream resources, such as Pigeonroost Branch and Oldhouse Branch. Studies have demonstrated that replacement of streams is among the most difficult and frequently unsuccessful forms of mitigation. Even if stream structure and hydrology can be replaced, it is not clear that replacing structure and hydrology will result in true replacement of functions, especially the native aquatic community and headwater functions. Based upon these studies, the Corps and EPA have stated:

> "We recognize that the scientific literature regarding the issue of stream establishment and re-establishment is limited and that some past projects have had limited success (Bernhardt and others 2007). Accordingly, we have added a new paragraph at 33 CFR 332.3(e) (3) [40 CFR 230.93(e) (3)] that specifically notes that there are some aquatic resources types that are difficult to replace and streams are included among these. It emphasizes the need to avoid and minimize impacts to these 'difficult-to-replace' resources and requires that any compensation be provided by in-kind preservation, rehabilitation, or enhancement to the extent practicable. This language is intended to discourage stream establishment and re-establishment projects while still requiring compensation for unavoidable stream impacts in the form of stream corridor restoration (via rehabilitation), enhancement, and preservation projects, where practicable."[19]

[19] EPA recognizes that the effective date of the regulations governing compensatory mitigation that were promulgated at 73 Fed. Reg. 19594 (April 10, 2008) is June 9, 2008, and therefore those regulations do not

Furthermore, the USFWS frequently has stated that, "we continue to believe that it is not possible to fully replace the critical aquatic and terrestrial ecosystem functions of healthy headwater streams," and that USFWS "is not aware of any scientific support for the concept that . . . ditches can be considered biologically equivalent to, or even rough approximations of, flowing streams."

The streams of Pigeonroost and Oldhouse Branch have been shown to exhibit high water quality and high functioning capacity. Given the difficulty of stream re-establishment to mitigate for impacts to streams in general, Region III believes it is even more unlikely that high value streams such as these can be replaced by on-site stream creation techniques involving conversion of sediment ditches. EPA Region III believes that the mitigation for the Spruce No. 1 project is unlikely to offset the anticipated impacts to an acceptable level.

2. The compensatory mitigation plan is based upon a misclassification of the impacted resources

The starting point for an adequate compensatory mitigation plan is accurate characterization of the impacted resources. Region III believes that the compensatory mitigation plan is based upon a misclassification of impacts to perennial and intermittent streams, thereby resulting in an insufficient baseline from which to design adequate stream compensation.

Overall, through onsite visits and biological data collection, Region III conservatively estimates that, within the mine footprints of Right Fork Seng Camp, Pigeonroost, and Oldhouse Branch, over five miles of stream (~27,000 feet) are perennial. This is in contrast to the DA Permit estimation of 165 feet of perennial waters within the entire project area. This misclassification has a critical impact upon the type of mitigation that would be required to offset these impacts. The resource type plays an important role in the types of expected aquatic communities, the degree in which each resource provides structure and function, and the amount of organic matter and nutrients (and contaminants) ultimately retained or loaded to receiving streams. This misclassification means that the compensatory mitigation plan does not properly account for, and therefore would not offset the full range of adverse impacts related to the project. A more detailed description of EPA's analysis of stream type is described in Appendix 3.

3. The compensatory mitigation plan lacks an adequate functional assessment

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apply to DA Permit No. 199800436-3 (Section 10: Coal River). Nevertheless, the above-quoted statement, taken from the preamble to those regulations, summarizes scientific research and literature that is applicable to consideration of the likely efficacy of the compensatory mitigation proposed for the Spruce No. 1 Mine.

In addition to being based on a misclassification of resource type, the CMP also is based upon an inadequate functional assessment of the impacted resources. Compensatory mitigation must replace the aquatic resource function lost or adversely affected by authorized activities. Therefore, to ensure that the functions are being replaced, the compensatory mitigation must create/restore streams that are capable of sustaining comparable biological, communities and chemical and physical characteristics of the streams that have been eliminated by the mining activity.

The CMP utlized an assessment method referred to as the Stream Habitat Unit (SHU) method to calculate mitigation debits and credits. This assessment entails a combination of linear lengths of impact, habitat assessment scores, and stream hydrological status[20]. The SHU as presented in the CMP only accounts for the physical aspects of stream condition and fails to account for the interrelationship of water chemistry and biological resources in stream functioning.

The USFWS expressed this concern in regard to the CMP:

> "The Stream Habitat Unit (SHU) assessment methodology selected by the applicant only considers the physical characteristics of the stream. It does not include biological or chemical characteristics of the stream. Without those attributes, the assessment does not meet the requirements of a "functional" assessment. The Service recommends that the applicant use an assessment method that incorporates biological and chemical, as well as habitat, characteristics to determine the true function of the stream."

The basis for the SHU as presented by the CMP is based on the premise that stream habitat (HAV as scored by EPA's RBP Habitat Assessment) accounts for the total ecological "currency" at the site. This premise has been demonstrated to be flawed. Studies (for example, Fritz et al., 2010) have found no correlation between functional measurements and RBP Habitat Assessments. More importantly, there was no use of existing water chemistry or biological resource measurements factored into the SHU's ecological currency of the sites. This shortcoming underscores the need for a more thorough investigation of impacts and mitigation offsets.

Since the permittee applied the SHU methodology, which has no functional component, to describe the streams, the compensatory mitigation plan only addresses the physical elements of the streams. As a result of this EPA believes the current CMP does not adequately account for or replace the functional components of the lost streams. Region III does not believe that increased ratios of intermittent or ephemeral streams offsets this inadequacy. While DA Permit No. 199800436-3 (Section 10: Coal River) refers to biological success criteria, the permit terms do not clearly require the replacement of lost

[20] Even though the Corps did not finally rely solely on the SHU for mitigation requirements, the Corps did not categorically prevent the permittee from using this approach as a basis for its mitigation plan, and thereby allowing Mingo Logan to use this approach to help justify their mitigation performance and success criteri ***a.***

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biological function and comparable stream chemistry to meet adequate compensatory mitigation success criteria.

4. Conversion of erosion control channels would be unlikely to successfully replace the impacted resources

Based on observations of other on-bench SMCRA drainage or erosion control ditches (Kirk 1999; Green et al. 2000, and Gingerich 2009), the CMP's proposed conversion of these ditches is unlikely to successfully replace the impacted resources, alone or in concert with other proposed mitigation contained in the CMP. Over 50% of the linear stream length in the Spruce mitigation plan relies on conversion of ono-bench SMCRA drainage or control ditches. On-bench sediment ditches are a consequence of SMCRA-required Best Management Practices (BMPs) to control runoff. Data show that water quality in these types of sediment ditches in the MTM region is typically highly degraded as a result of water in these ditches percolating through mine spoil. Even when the sediment ditches are enhanced for benthic substrata and riparian vegetation, such as through adding boulder clusters every 500-1000 feet, resulting water quality will likely be so degraded that the ditches will not meet or exceed pre-mining water chemistry baselines.

As described previously, degraded water chemistry (such as the addition of conductivity and selenium as a result of water percolation through mine spoil) typically results in degraded biological communities. As a result of this degraded water chemistry, these created waterbodies would be unlikely to support the healthy and diverse biological communities that they are intended to replace. These created streams would be considered degraded and would be unlikely to successfully replace Pigeonroost Branch and Oldhouse Branch as sources of freshwater dilution and healthy biological communities and function, either alone or in concert with other proposed mitigation contained in the CMP.

A more detailed discussion of on-bench sediment ditches for mitigation is provided in Appendix 3.

5. The CMP does not account for the loss of ecological services of headwater streams

Another compelling problem with the Spruce No. 1 CMP is the separation of the ecological elements into single, separate aspects of the ecology with limited treatment of the interconnectedness of the entire ecosystem. The forested slopes and coves located within the Spruce No. 1 project area are drained by a dendritic mosaic of ephemeral, intermittent and perennial headwater streams and water courses. The watershed is inextricably linked with the stream system that drains it. The overwhelming bulk of the organic matter that sustains the stream biota in Spruce Fork is a function of the upstream environment.

In a pre-mined condition receiving streams are recipients of allochthonous (i.e., material originating from outside of the stream system) material and water inputs (i.e., surface, subsurface and groundwater) from the surrounding forested communities. The post-mined environment, however, creates severely altered conditions in stream courses that are not destroyed by valley fills. Those alterations include:

a. Elimination of water and processed organic material from former upstream tributaries that will be under valley fills.

b. Altered contributions of water and allochthonous material from the surrounding upland watershed. This is due to the altered character of the soil and vegetation communities in a post-mine environment.

c. Altered hydrograph with new flow regimes that markedly depart from that under which the streams have evolved.

d. Altered timing, temperature and chemical composition of post-mine discharges of water to receiving streams.

Mountaintop mining and associated valley fills profoundly alter the contributing watershed. Effectively the new landscape widely departs from that within which the stream network has evolved. The subsequent ecosystem is an entirely new system. Assumptions that much of the structure and function of the pre-mined conditions can be recaptured with mitigation are very optimistic and highly speculative.

In summary, Region III believes that it is unlikely that the adverse impacts associated with the Spruce No. 1 project as authorized would be offset by the mitigation described in the CMP.

D. Summary

In summary, Region III believes that Spruce No. 1 Mine would eliminate the entire suite of important physical, chemical and biological functions provided by the streams of Pigeonroost Branch and Oldhouse Branch including maintenance of biologically diverse wildlife habitat. Region III maintains that impacts to these functions at the scale associated with this project will result in significant degradation (40 CFR 230.10(c)) of the Nation's waters, particularly in light of the extensive historic stream losses in the Spruce Fork and Coal River watersheds. Region III does not believe the potential impacts of these stream resources can be adequately mitigated to reduce the impacts to an acceptable level by the compensatory mitigation described in the CMP.

VI. Other Considerations

As set forth above, Region III has determined that the impacts from the discharges to Pigeonroost Branch and Oldhouse Branch as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) described in Section V would be likely to have an unacceptable

adverse effect on wildlife that will not be offset by the compensatory mitigation plan. This section identifies other, additional considerations that are of concern to the Region but are not part of the basis for our conclusion that the impacts would be likely to have an unacceptable adverse effect.

A. Impacts From Activities Dependent Upon Specification of Pigeonroost Branch and Oldhouse Branch as Disposal Sites for the Construction of Valley Fills and Sedimentation Ponds for the Spruce No. 1 Mine

To the extent that discharge of excess spoil to areas outside jurisdictional waters and other mining-related activites, such as deforestation, necessarily depend upon specification of Pigeonroost Branch and Oldhouse Branch for construction of valley fills and sedimentation ponds for the Spruce No. 1 Mine, Region III has considered those impacts.

1. Migratory Birds

Approximately 2,278 acres of deciduous forests will be destroyed by the Spruce No. 1 Mine. Among the many migratory birds likely to breed in the project area, there are six species that the USFWS has designated as Birds of Conservation Concern within the Appalachian Mountains Bird Conservation Region that may be impacted by Mountaintop Mining – Valley Fills. These include the cerulean, Kentucky, Swainson's and worm-eating warblers, the wood thrush, and the Louisiana waterthrush. The water-dependent Louisiana waterthrush was discussed in Section V.B.2.d above. The other five avian species are also designated as BCC species within the USFWS's Northeast Region as a whole and nationally (U.S. Fish and Wildlife Service 2008). The first four are also considered to be among the 100 most at-risk bird species in North America (Wells 2007).

Cerulean and worm-eating warblers are also both area-sensitive species that rely on large blocks of intact, mature, interior forest habitats to support productive breeding populations. The cerulean warbler breeding population is thought to have declined by about 75% over the past 45 years – the most dramatic decline of any North American warbler monitored by the Breeding Bird Survey (Sauer et al. 2005). Both species are threatened by the loss and fragmentation of these habitats (U.S. Fish and Wildlife Service 2007, Wells 2007). Deforestation associated the Spruce No. 1 Mine may adversely impact their breeding populations (Weakland and Wood 2005, Wells 2007).

The project also could impact other bird species that rely on mature forest habitats. Bird species that rely on mature forest habitats that are abundant in the Appalachian region are Kentucky warblers in the understory; and wood thrush, Swainson's warbler, Acadian flycatcher, and ovenbirds in mesic hardwoods. These and many other avian species are all impacted by forest fragmentation and habitat loss, such as that which would occur in connection with the Spruce No. 1 mine. Spatial analyses of the effect of Appalachian mountaintop mining on interior forest indicate that the loss of interior forest is 1.75-5.0 times greater than the direct loss of forest due to mountaintop mining. Investigators

concluded that the loss of Appalachian interior forest is of global significance due to the rarity worldwide of large expanses of temperate deciduous forest.

The Spruce No. 1 Mine will impact mature forested habitat, over a substantial timeframe, replacing the impacted areas with reclaimed areas dominated by grasses and herbaceous species. Many reclaimed areas such as those expected at Spruce No. 1 show little or no regrowth of woody vegetation even after 15 years. The PEIS found significant differences in bird populations between forested and reclaimed sites, namely the loss of the above-mentioned species, and subsequent replacement by more opportunistic grassland species. Also, the loss of the healthy headwater areas of Spruce Fork will reduce the feeding and foraging areas available to specialist bird species in this ecoregion. This reduction in available habitat could potentially impact their viability in the Spruce Fork watershed and the larger ecoregion.

In recent communications with Region III (August 2010) in regards to EPA's Proposed Determination on the Spruce No. 1 Mine the USFWS indicated its belief that past selective logging in some parts of the project area would not preclude use of the site by forest interior species of migratory birds or that birds currently using the project area during the breeding season will be unaffected by the mine and associated valley fills. The USFWS evaluated the terrestrial habitats of the project area and concluded that construction of the mine was likely to impact migratory birds via the loss and fragmentation of forest habitat, decreasing habitat heterogeneity, increasing isolation of populations, and increasing exposure to nest predators and parasites (U.S. Fish and Wildlife Service 1998).

The USFWS expressed concerns specific to bird populations within the Coal River Sub-basin related to adverse impacts of the Spruce No. 1 Surface Mine. These concerns included …"direct loss of habitat and direct and indirect loss of food resources, for forest interior and riparian-obligate species of migratory birds, including six species the Service considers Birds of Conservation Concern (i.e., cerulean, Kentucky, Swainson's, and worm-eating warblers; Louisiana waterthrush; wood thrush)" (USFWS, 2008).

The USFWS also continues to believe that construction of the Spruce No. 1 Surface Mine will adversely impact these and other forest-breeding migratory birds. The valley fills will result in the permanent loss of headwater streams that may be used by Louisiana waterthrushes. The USFWS indicates they are unaware of peer-reviewed research that suggests that these birds will simply relocate to an adjacent, unimpacted watershed and have comparable survival and reproductive success. The downstream increases in conductivity, selenium and perhaps other contaminants are also likely to adversely affect those waterthrushes not excluded by the direct impacts of the fill via impacts to their food base. In some freshwater food webs, selenium has bioaccumulated to four times the level considered toxic, which can expose birds to reproductive failure when they eat fish or insects with high selenium levels.

While the work of the Appalachian Regional Reforestation Initiative (ARRI) shows substantial promise for better reclamation of mined lands, it has not been demonstrated

that these reclaimed areas will generate and sustain forests that provide habitat characteristics and qualities comparable to those of native forest. For these reasons, the USFWS believes that construction of the Spruce No. 1 Surface Mine is likely to result in permanent and/or long-term loss of breeding habitats important to several migratory bird species of conservation concern.

2. Bats

Large-scale mountaintop removal/valley fill mining has been identified among the threats to bat species in the region according to information supplied to EPA by the USFWS. Loss of the bat's habitat, foraging areas, and food sources – in conjunction with recently identified concerns related to white-nose syndrome – may result in unacceptable adverse impacts to these wildlife resources.

As set forth in Section IV.B.5., it is possible that Indiana bats could occur in or near the project area, and that they could be impacted by the loss of forest habitat associated with the Spruce No. 1 Mine and by the loss of headwater streams, riparian areas and associated aquatic and terrestrial insects, as well as by the downstream degradation of these resources likely to be caused by the project.

In addition to Indiana bats, the USFWS was recently petitioned to list two other bat species, the eastern small-footed bat and northern long-eared bat, under the Endangered Species Act (Center for Biological Diversity 2010). Like Indiana bats, these two species are susceptible to population-level impacts from White Nose Syndrome (WNS), which has devastated some populations of eastern bats. Both species occur in the vicinity of the Spruce No. 1 Surface Mine, and both were captured during mist net surveys at the project site. Five eastern small-footed bats and 16 northern long-eared bats were captured during mist net surveys in 2004, representing 7.6 and 24.2 percent, respectively, of all bats captured (U.S. Army Corps of Engineers 2006, Appendix M). Given the rapid spread and potentially dramatic effects of WNS, the potential exists that even more bat species could decline to the point that listing under the ESA will be warranted.

If WNS affects West Virginia bats as it has bats in other states, and if large die-offs occur, it will further complicate the already complex challenge of conserving bat species. Previous mining and logging activities and forest loss have also been identified as having adverse affects on bat populations. Commonly used reclamation techniques, many of which are designed to minimize erosion and provide backfill stability, are incompatible with re-establishment of trees necessary for successful roosting by bats. Such reclamation techniques have the potential to further stress bat populations.

B. Environmental Justice Concerns

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EPA has this goal for all communities and persons across this Nation. Executive Order 12898

directs: "To the greatest extent practicable…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations…"

According to the 2000 United States Census, Spruce No. 1 is located in a census block group which contains 335 people. A census block group is a geographical unit used by the U.S. Census Bureau (Bureau) which is between a census tract and a census block in size and scale. It is the smallest geographical unit for which the Bureau publishes data. Census block groups generally contain between 600 and 3,000 people, with a target size of 1,500 people.

Spruce No. 1 is located in a census block group where the average per capita income is $15,411. This is over $6,000 less than the national average of $21,587 and over $1,000 less than the West Virginia state average of $16,477. The average median family income is also almost $13,000 less than the national average of $52,029. Moreover, 24% of the residents of Logan County live below the poverty line which also exceeds state and national averages.

Region III notes that the Corps included a discussion of environmental justice in the Spruce No. 1 EIS, however, as noted in EPA's comment letters in June and October 2006, the Region III remains concerned that the Corps did not fully consider and address the potential for disproportionately high and adverse effects on this population. EPA's environmental justice analysis indicates that there may be a disproportionately high and adverse impact on the low income population affected by the mining activity. Additionally, EPA remains concerned that the local community did not have the necessary information, or the opportunity, to meaningfully participate in the EIS process. Specifically, EPA is concerned the community was not informed when changes were made to different aspects of the mine project during the permitting and EIS process and therefore was not able to meaningfully comment on the final aspects of the mine.

Consideration of these issues in the context of authorizing the significant disturbance associated with construction of valley fills associated with the Spruce No. 1 Mine should include a characterization of the status of residents near the site and the conditions they face including any effects relating to the proximity of the blasting zone, locations of discharges of fill material, truck traffic, noise, fugitive dust, and habitat loss. Information concerning sources of drinking water for the effected populations (including municipal water supplies and private sources of drinking water including streams and/or wells) also should be considered.

The cultural implications of mountain top mining also were not sufficiently considered. The mountains affected by Spruce No. 1 are viewed as a cultural resource by many residents. In many cases the mountains have helped define their society and influence their daily lives. For example, the mountain ridges of southern West Virginia have for over two centuries been viewed largely as a "commons," where local residents have

gathered wild medicinal herbs such as American Ginseng (*Panax quinquefolius*) and Goldenseal (*Hydrastis Canadensis*). In many cases, collection of these wild herbe provide much needed extra income to local communities during times of unemployment or economic hardship (Baily 1999, Hufford, 1997). Removing these mountains may have profound cultural changes on the residents in the area so it is important that cultural impacts be considered as well.

It is important that consideration be given as to whether the types of impacts described above will extend over a broad area or will be concentrated in particular areas. Detailed maps outlining the residential areas in relation to these activities may help accomplish this. It is also important that the effects be considered both independently and cumulatively. Considering the effects cumulatively provides the most realistic "snapshot" of what the community will be facing when the project reaches fruition. Having this information readily available will help engage the affected communities during public outreach and ensure that they can be meaningfully involved.

EPA considers action pursuant to section 404(c) within the scope of the policy directive of Executive Order 12898. A section 404(c) action has the potential to affect human health or the environment of low-income or minority populations. Accordingly, EPA includes environmental justice concerns when undertaking an action pursuant to section 404(c). In this case, Region III conducted a public hearing on May 18, 2010 and received comments both orally and in writing. Region III has considered that members of the community expressed concern about loss of jobs and tax revenue (supporting local communities and schools) in the event that EPA's Section 404(c) action would preclude any activities currently authorized at the Spruce No. 1 Mine. At the same time, Region III also has considered that members of the community have expressed concern regarding the adverse environmental and cultural aspects of the project described above. EPA also has received a petition from a variety of stakeholders raising concerns related to environmental justice issues associated with mountaintop mining.

In order to satisfy Executive Order 12898, EPA has considered whether there is a "…disproportionately high and adverse human health or environmental effects…" from its regulatory action. The scope of the inquiry for purposes of EPA's environmental justice analysis is directly tied to the scope of the regulatory action that EPA is taking. In the context of a Clean Water Act Section 404(c) action, EPA is authorized to prohibit, restrict, or deny specification (or withdraw specification) of the discharge of dredged or fill material at defined sites in waters of the United States whenever it determines that use of such sites for disposal would have an unacceptable adverse impact on "municipal water supplies, shellfish beds, fishery areas (including spawning and breeding areas), wildlife, or recreational areas."

Accordingly, EPA has considered its environmental justice analysis in the context of this Recommended Determination under Section 404(c) action the potential effects prohibiting the discharge will have on the municipal water supplies, shellfish beds, fishery areas, wildlife and recreational areas (i.e., 404(c) resources) of the project site. EPA also considered whether those effects, if any, of EPA's 404(c) action on the 404(c)

resources will have a "disproportionately high and adverse human health or environmental [effect]" on "minority populations and low-income populations" of the project area.

EPA concludes, to the greatest extent practicable, after performing the EJ analysis contemplated in Executive Order 12898, and incorporating public comment, thatthis Recommended Determination under 404(c) in and of itself or if incorporated within any Final Determination, will not have a disproportionately high and adverse human health or environmental effect on the low-income and minority populations of the project area. EPA notes that the scope of this Recommended Determination is limited to withdrawal of specification of Pigeonroost Branch and Oldhouse Branch as disposal sites for the discharge of dredged and/or fill material for the construction of valley fills and sediment ponds associated with the Spruce No. 1 Mine as currently authorized. This action neither prohibits nor authorizes coal mining.

C. Public Health

As interest in the overall environmental and human health effects from mountain top mining has been increasing, a growing body of research has suggested that health disparities are not uniformly distributed across the Appalachian region but are concentrated in areas, like the Spruce No. 1 Mine project area, where MTM activity takes place. Region III has conducted a preliminary review of existing literature on health impacts from MTM. The studies reviewed by Region III sought to evaluate whether associations between MTM and health exist. These studies do not provide direct assessments of environmental air and water quality in mining areas in relation to individual exposures and health outcomes. This more comprehensive research, including environmental chemical analyses and biological monitoring, would require significantly greater study than is appropriate for this Recommended Determination.

However, the results of these associational studies identify significant correlations between MTM activity and a variety of health disparities. These study findings indicate that health disparities are elevated in Appalachian coal mining regions for mortality rates for chronic respiratory, cardiovascular, and kidney disease, and for some forms of cancer including lung cancer. These studies by their nature could not and do not establish any causal linkage between MTM and these elevated rates of adverse health effects, but because they point to significant associations between MTM and elevated rates of adverse health impacts, the results warrant more research using rigorous epidemiological methods. The existing body of literature suggests that various negative health outcomes are not the result of a single exposure, but may reflect chronic exposures to multiple environmental contaminants, both air and/or water, which will vary for each individual.

The studies noted the following:

• Residents of areas in which coal mining activities take place have higher risk of cardiovascular disease (CVD) (OR=1.22, 95% CI 1.14-1.30), angina or coronary heart disease (CHD) (OR=1.29, 95% CI=1.19-1.39), and heart attack (MI) (OR=1.19, 95% CI

= 1.10-1.30) after adjusting for smoking, alcohol, gender, education, race, income, physician supply, and metropolitan status.

• Lung cancer mortality is higher in heavy coal-mining areas, followed by all other areas of Appalachia and the nation ($p<.001$) after accounting for covariates of gender, education, poverty, race, urban status, smoking, southern states, and Appalachian country.

• Total chronic heart, respiratory, and kidney disease, and kidney disease mortality rates were significantly higher in coal mining areas of Appalachia than non-coal mining areas.

• Among West Virginia adults, residential proximity to heavy coal production was associated with poorer health status and with higher risk for cardiopulmonary disease, chronic lung disease, hypertension, and kidney disease, after controlling for covariates (Spruce No.1 mine is in an area characterized by heavy coal production.

• Distance-weighted, at-risk population coal mining exposure measure was significantly correlated to cancer mortality in WV. For total cancer and three cancer-type subgroups, exposure was correlated after controlling for smoking rates. The variables had positive spatial autocorrelation and were spatially dependent. All components of mining (injection, preparation plants, impoundments, and mining sites) were related to one or more cancer types.

• Volume of coal mining significantly related to hospitalization risk for hyptertension (odds increased 1% for each 1462 tons of coal) and COPD (odds increased 1% for each 1873 tons of coal) controlled for age, gender, insurance, co-morbidities, county poverty, county and social capital.

• The heaviest coal mining areas of Appalachia had the poorest socioeconomic conditions. Before adjusting for covariates, the number of excess annual age-adjusted deaths in coal mining areas ranged from 3,975 to 10,923, depending on years studied and comparison group.

• Living in proximity to mining areas increases the odds of low birth weight. In mining areas, odds of low birth weight are increased by 14 to 16% depending on the amount of mining as compared to areas with no coal mining.

• Ecological integrity was inversely related to age-adjusted cancer mortality rates (total $p<.01$; digestive, breast, and respiratory $p<.01$; urinary $p<.05$), controlled for poverty, access to health care providers, urbanization, education, smoking. Ecological integrity was significantly related to mining and cancer mortality and mining was significantly related to total cancer mortality.

D. Cumulative Impacts

Fundamental to the Section 404(b)(1) Guidelines "is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." 40 C.F.R. § 230.1(c).

The Section 404(b)(1) Guidelines (at 40 C.F.R. § 230.11(g)) also direct that factual findings be made regarding cumulative impacts on the aquatic ecosystem and that those findings be considered in determining whether the discharge complies with the foregoing restriction. To that end, the Section 404(b)(1) Guidelines describe the factual finding that must be made with respect to cumulative impacts as follows:

> *Determination of cumulative effects on the aquatic ecosystem.* (1) Cumulative impacts are the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems.

For purposes of this analysis, Region III has considered cumulative impacts to the Coal River sub-basin (891 mi^2) and the Spruce Fork sub-watershed (126.4 mi^2) if the Spruce No. 1 Mine is constructed as authorized by DA Permit No. 199800436-3 (Section 10: Coal River) and other reasonably foreseeable (proposed and authorized but not constructed) surface mining projects within the Coal River sub-basin are constructed. This cumulative effects analysis also takes into consideration the past and present mining projects within the sub-basin and sub-watershed, and the extent to which they have affected the current baseline conditions within the sub-basin and sub-watershed (see Figure 14).

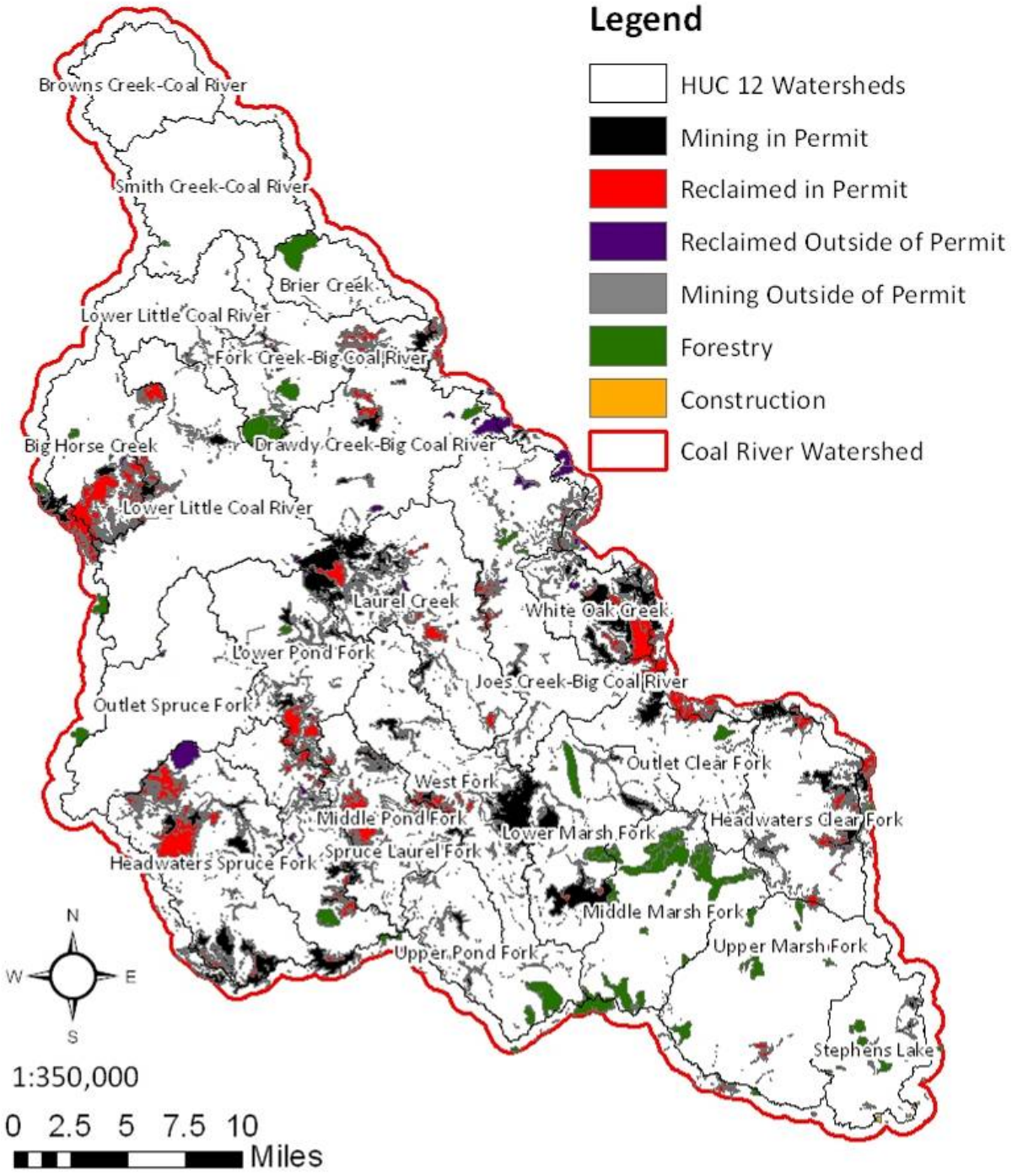


Figure 14: Illustration of the types of disturbance currently found in the Coal River sub-basin.

As has been described in Section IV.A.2., the Coal River sub-basin and the Spruce Fork sub-watershed are already impacted by mining activity. Based upon the National Land Cover Database (NLCD) change product for 1992-2001 and WVDEP's GIS mining files, more than 257 past and present surface mining permits have been issued in the Coal River sub-basin, which collectively occupy more than 13% of the land area (see Figure

13). In the Spruce Fork sub-watershed, more than 34 past and present surface mine permits have been issued, which collectively occupy more than 33% of the land area. The proposed project will affect an additional 2,278 acres (3.56 mi^2), which is equivalent to approximately 2.8% of the Spruce Fork sub-watershed. This percentage of land cover affected by surface mines will continue to increase in the Coal River sub-basin, as additional projects are proposed and authorized.

A 1997 WVDEP ecological assessment of the Coal River sub-basin indicated that because the sub-basin is becoming increasingly impaired due to stressors such as mining, there is a need to protect the remaining quality resources, highlighting the need to "[l]ocate and protect the few remaining high quality streams in the Coal River watershed.…" Pigeonroost Branch and Oldhouse Branch, two of the streams directly affected by the proposed action, are high quality resources that support an exceptionally high number of mayfly taxa, both within the Central Appalachian Region and statewide (see Appendix 1). By directly impacting these streams, which serve as refugia for aquatic life and potential sources for recolonizing nearby waters, the proposed action will be likely to have a significant cumulative effect on the aquatic ecosystem integrity in the sub-basin.

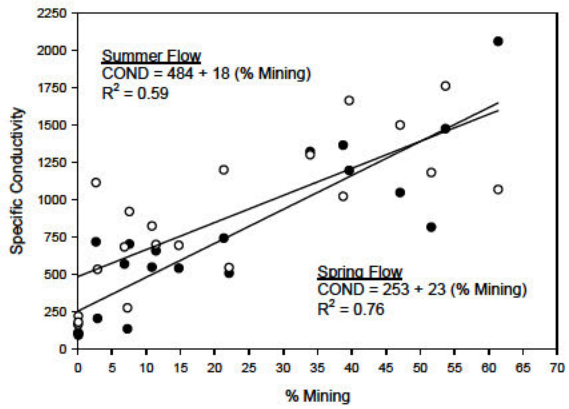
EPA is aware of at least 11 additional mining operations either proposed or authorized but not constructed in addition to Spruce No.1 in the Coal River sub-basin. Construction of valley fills and other discharges authorized by DA Permit No 199800436-3 (Section 10: Coal River) along with these additional projects in the Coal River Sub-basin, if constructed, would directly impact approximately 29.4 miles of stream channels, and would be likely to have significant secondary and cumulative effects on downstream waters in the Coal River sub-basin. Impacts from these projects can be expected to include reduced freshwater dilution, reduced headwater stream functional inputs, increased discharges of pollutants from the valley fills, including total dissolved solids (TDS) and selenium, and the potential to contribute to existing impairments within the Spruce Fork watershed and the Coal River sub-basin.

The Little Coal watershed contains 98 miles of impaired streams (33% of the streams in the watershed), and the Coal River sub-basin has 743 miles of impaired streams (30% of the streams in the sub-basin). WVDEP has listed these stream segments for selenium and biological impairment. The additional fills associated with the proposed action, in combination with past and present mining by the applicant and other mining in the sub-basin, will likely cause or contribute to significant cumulative adverse impacts to the stream resources in the Coal River sub-basin, and will likely contribute to current water quality impairments within the sub-basin.

Preliminary results from current research based upon WVDEP data show a strong correlation between the percentage of a watershed that is disturbed by mining activity and downstream conductivity levels (see Figure 15).

Coal River Watershed

Relationship between % Mining and Conductivity



Thresholds

Cond	% M_sp	% M_su
300	**2**	---
500	**12**	**1**
750	**23**	**15**
1000	**34**	**30**

*Analyses based on mining only sites; Equations do not differ significantly.

Figure 15: Coal River Watershed: Mining and Conductivity

Levels of conductivity on the mainstem of Spruce Fork, Pond Fork and the Little Coal River exceeded 500 µS/cm almost every time WVDEP sampled these sites in 1997, 2002-2003, 2005 and 2008. The US Army Corps of Engineers Huntington District also reported conductivity values as part of the baseline water quality for Spruce Fork upstream and downstream of the proposed project area in the EIS for the proposed project (U.S. Army Corps of Engineers Huntington District 2006, DEIS Spruce No. 1 Mine). The DEIS reported that the minimum, average and maximum conductivity levels for Spruce Fork upstream of the propose project area were 112, 656 and 1130 µS/cm at that time, indicating that on average the conductivity in Spruce Fork was already elevated greater than 500 µS/cm, and maximum conductivity levels exceeded twice that level.

Because construction of the Spruce No. 1 project and 11 additional mining operations would increase the percent of the sub-basin that is impacted by mining activity, it can be expected that these water quality effects will likely be exacerbated by these additional mines. EPA believes that the Spruce No. 1 project, in conjunction with the other mining operations either under construction or proposed for the Coal River sub-basin, will be likely to contribute to the significant cumulative loss of aquatic resources and degradation of water quality.

VII. Conclusions and Recommended Determination

Based on the foregoing analyses and upon consideration of the public comments received in response to Region III's Proposed Determination, Region III has determined that discharges of dredged and/or fill material to Pigeonroost Branch and Oldhouse Branch for the purpose of constructing the Spruce No. 1 Surface Mine as currently authorized by

DA Permit No. 199800436-3 (Section 10: Coal River) would likely have unacceptable adverse effects on wildlife. DA Permit No. 199800436-3 (Section 10: Coal River) authorizes construction of valley fills and sedimentation ponds and other discharges into Pigeonroost Branch and Oldhouse Branch that will bury approximately 6.6 miles of high quality headwater streams. Pigeonroost Branch and Oldhouse Branch support diverse and healthy biological communities comparable with conditions in nearby White Oak Branch, recognized by WVDEP as supporting least-degraded, reference quality conditions. Pigeonroost Branch and Oldhouse Branch represent streams within the larger Spruce Fork sub-watershed and Coal River sub-basin that remain relatively free of water quality degradation. As such, Pigeonroost Branch and Oldhouse Branch are valuable in and of themselves and within the context of the Spruce Fork sub-watershed and Coal River sub-basin.

As currently authorized the DA Permit discharges to Pigonroost Branch and Oldhouse Branch would bury wildlife that live in those streams or within the footprint of the valley fills and minethrough areas. Other wildlife will lose important headwater stream habitat on which they depend for all or part of their lifecycles.

Wildlife impacts from the activities authorized by the permit will not be limited to direct burial of wildlife. Burial of Pigeonroost Branch and Oldhouse Branch would likely result in effects to downstream waters and downstream wildlife caused by the removal of functions performed by the buried resources and by transformation of the buried areas into sources that contribute contaminants to downstream waters. In addition, currently authorized discharges to Pigeonroost Branch and Oldhouse Branch would be likely to contribute to conditions that would support blooms of golden algae that release toxins that kill fish and other aquatic life would likely contribute to conditions that would support blooms of golden algae that release toxins that kill fish and other aquatic life.

Particularly in light of the high quality of the impacted resources, it is unlikely that the CMP for the project would offset these impacts. The proposed on-site created streams will be unlikely to replace the physical, chemical, and especially biological functions of Pigeonroost Branch and Oldhouse Branch.

For these reasons, I find that discharges to Pigeonroost Branch and Oldhouse Branch as currently authorized by DA Permit No. 199800436-3 (Section 10: Coal River) would be likely to have unacceptable adverse effects on wildlife.

Region III notes that, in addition to the adverse effects that form the basis of this Recommended Determination, there are other impacts about which Region III continues to have concerns. To the extent that discharge of excess spoil outside jurisdictional waters, deforestation, and other activities associated with the project depend upon specification of Pigeonroost Branch and Oldhouse Branch as disposal sites, adverse impacts on wildlife would likely result from those dependent activities. In addition, impacts from the project will contribute to cumulative impacts from multiple surface mining activities in the Coal River sub-basin. Region III continues to be concerned regarding environmental justice issues.

Accordingly, pursuant to Section 404(c) of the Clean Water Act and its implementing regulations at 40 C.F.R. Part 231 and for the reasons set forth herein, it is my recommendation that the specification embodied in DA Permit No. 199800436-3 (Section 10: Coal River) of Pigeonroost Branch and Oldhouse Branch as disposal sites for discharges of dredged and/or fill material for construction of the Spruce No. 1 Surface Mine be withdrawn.

Dated: September 24, 2010

Shawn M. Garvin
Regional Administrator
EPA Region III

Richard Paiste/R3/USEPA/US

11/17/2010 11:24 AM

To AshleyL Williams, Christopher Hunter

cc Bill Jenkins

bcc

Subject Journal Articles

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Coal Mining and Low Birth Weight.pdf

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Well water quality in the vicinity of a coal slurry impoundment near Williamson, West Virginia.

Prepared in response to:
Questions from citizens attending the January 15, 2004 training session of the Coal Impoundment Location and Warning System,
Delbarton, West Virginia

Prepared by:
Ben M. Stout III, Ph.D. and Jomana Papillo, Research Assistant
Wheeling Jesuit University
December 10, 2004

Executive summary

Fifteen wells were sampled within 2 air miles of the Sprouse Creek Slurry Impoundment at the request of citizens attending the January 15, 2004 training session of the Coal Slurry Impoundment Location and Warning System. Wells in the area of Sprigg, Merrimac, Rawl, and Lick Creek near Williamson, West Virginia, reportedly had good quality water approximately 10-15 years prior to this study. More recently, households consistently reported periodic "blackwater" events in their well water, fixtures that corroded within 2 years, red and black stains on their porcelain, walls, clothing and dishes, and health problems including cancer and kidney stones. This study focused on 7 heavy metals regulated by Environmental Protection Agency primary drinking water standards, and 5 metals regulated by secondary standards. An experimental design was implemented to capture spatial (geographic) and temporal (low flow versus high flow) variation in well water quality conditions. We hypothesized that if coal slurry was impacting wells, then well water would reflect the elemental constituents of coal slurry.

Primary drinking water standards for the 7 metals tested were exceeded 13 times in samples collected from 15 different wells. Standards were exceeded for lead (8), arsenic (2), barium (1), beryllium (1), and selenium (1), but not for cadmium or chromium. Lead was detected in 6 of 12 wells during low flow conditions with concentrations ranging from 6 to 23 ppb, and 5 of 12 wells exceeded the standard. Lead was detected in 7of 8 wells during high flow conditions with concentrations ranging from 9 to 110 ppb, and 3 wells exceeding the primary standard. Arsenic was detected in 1 of 12 wells sampled during low flow conditions, and no wells exceeded the primary water quality standard. Arsenic was detected in 6 of 8 wells during high flow conditions with concentrations ranging from 4.2 to 340.0 ppb and 2 wells exceeding the 10 ppb standard.

Secondary drinking water standards for the 5 metals tested were exceeded a total of 36 times in samples collected from 15 different wells. Standards were exceeded for iron (17), manganese (17), aluminum (1), and zinc (1), but not for copper. During low flow conditions 10 of 12 wells exceeded the 300 ppb secondary drinking water standard for iron. Iron exceeded the standard in all 8 wells sampled during high flow conditions, with

concentrations ranging from 371 to 57,588 ppb. Manganese concentrations during low flow conditions ranged from not detected in a spring and in a 26 foot deep dug well, to 2,999 ppb in a 76 foot deep drilled well (Table 1). Manganese exceeded the 50 ppb standard in 9 of 12 wells during low flow. Under high flow conditions manganese exceeded the secondary standard in all 8 wells sampled with concentrations ranging from 82 to 4,063 ppb.

One sample was collected by decanting water off the sludge from a hot water heater. The sludge was dark red, as was the liquid. The sample contained exceptionally high concentrations of 4 metals that exceeded primary standards including arsenic (150 ppb), barium (3,000 ppb), lead (188 ppb), and selenium (646 ppb). Most interesting, arsenic and selenium were not detected in the source well from which the hot water heater was supplied. For those elements detected in both the source well and the hot water heater, concentrations were 30 times greater for barium, 7 times greater for chromium, and 12 times greater for lead in the hot water heater versus the source well. Hot water heaters appear to represent a significant water supply concentrating mechanism for heavy metals regulated by primary standards. The dark red color of the sludge was due to 557,700 ppb of iron and 27,260 ppb of manganese.

A comparison of water quality during low flow (base flow) versus high flow (event flow) was conducted by re-sampling 5 wells in response to citizen concerns regarding "blackwater" in their wells following rainfall events. Arsenic was detected in 1 well during low flow, but in 4 of the 5 wells during high flow. Barium was detected consistently in all wells under all conditions. Beryllium and cadmium were not detected in the 5 wells under any flow condition. Chromium was detected in 3 wells during low flow and all 5 wells during high flow. Lead was detected in 3 wells during low flow and 4 wells during high flow. Selenium was detected in 1 well during low flow, but was not detected during high flow. Among the non-regulated chemicals tested, vanadium was detected in 3 of 5 wells during low flow, but was not detected during high flow. Flow condition causes significant differences in the elemental composition of well water in the study area.

A comparison of Williamson area well water with the available data from domestic wells in neighboring counties of southern West Virginia and Eastern Kentucky indicated that Williamson area wells had the poorest water quality in the coalfield region. Poor water quality in these communities had been indicated by some past studies, but refuted more recently in a study by the Agency for Toxic Substances and Disease Registry. The information presented here indicates significant metals contamination at concentrations well beyond what should be used as a water supply source. Additional studies are required to determine the exact source of contamination.

Based on the results of this study a thorough and comprehensive assessment of the relationship between well water quality and human health is warranted in the area of Sprigg, Merrimac, Rawl, and Lick Creek near Williamson, West Virginia.

Introduction

A study of drinking water quality was conducted in response to the requests of citizens at a meeting of the Coal Impoundment Study in Delbarton, West Virginia. Citizens were primarily concerned with potential health effects due to heavy metals in their well water, which they felt was related to the Sprouse Creek Slurry Impoundment (MSHA identification number: 1211-WV04-40516-02, WV DEP permit number: O-41-84) and an underground injection system. Prior to field sampling, a phone conversation with Dr. Diane Schafer, an orthopedic surgeon in Williamson, WV revealed her opinion that "there is no question about illnesses [in Mingo County] caused by poor water quality (personal communication, Feb.3, 2004)." She said that there are definitely some water quality problems and that Rawl is the worst of the communities. Among the citizens of Rawl, Sprigg, Merrimac, and Lick Creek, there are high incidences of Alzheimer's disease, blood problems, cancers not related to smoking, diseases of the environment, and Attention Deficit Disorder. According to Dr. Schafer, the water is "brackish." Illnesses that citizens have complained of also include: kidney stones and kidney failure, environmental toxic poisoning, arsenic poisoning, dementia, birth defects, cancer, thyroid problems, and gastrointestinal problems that appear to be related to *H. pylori* bacteria.

In response to their concerns, the investigators made arrangements with the Water Quality Laboratory at Heidelberg College to analyze 23 samples of water from wells used by citizens. The Water Quality Laboratory was chosen based on cost comparisons and because of their well-established well water sampling program including over 30,000 wells nationwide. Heavy metals were analyzed because this was of main concern to the citizens.

There are 2 categories that the metals standards fall into: regulated and non-regulated. Regulated metals are broken down into 3 categories: primary standards, secondary standards, and lifetime health advisories. The US Environmental Protection Agency (EPA) describes a National Primary Drinking Water Regulation (primary standard) as "a legally-enforceable standard that applies to public water systems. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water" (EPA, 2004b). The National Secondary Drinking Water Regulation (secondary standard) is a "non-enforceable guideline regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. The EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards." This means that although the chemical may make the water smell, look, or taste peculiar, that does not necessarily mean it will harm your health (US EPA, 2004a). "Health Advisories are guidance values based on non-cancer health effects for different durations of exposure (e.g., one-day, ten-day, longer-term, and lifetime). Health Advisories provide technical guidance to EPA Regional Offices, State governments, and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination" (US EPA, 2004b).

Metals tested in this study and regulated by primary standards are: arsenic, barium, beryllium, cadmium, chromium, lead, and selenium. Metals regulated by secondary standards included: aluminum, copper, iron, manganese, and nickel. Metals regulated by lifetime advisories are sodium and zinc. Non-regulated chemicals tested in this study include calcium, strontium, cobalt, magnesium, potassium, silica, and vanadium. For non-regulated chemicals, health effects are either minimal or are not well known. It should also be known that standards referred to in this study are for the purpose of comparison because standards apply to public water systems, not private wells.

Hypothesis:

We hypothesized that if coal slurry was impacting wells, then well water would reflect the elemental constituents of coal slurry, particularly high levels of arsenic, barium, cadmium, chromium, lead, and selenium because these metals were observed in excess of primary standards in a coal slurry sample collected March 20,1985, approximately 4 miles south of Williamson (EPA, 1985). It was also noted that copper, iron, and manganese exceeded secondary standards in the coal slurry sample.

Materials and Methods

Sample collection and analysis

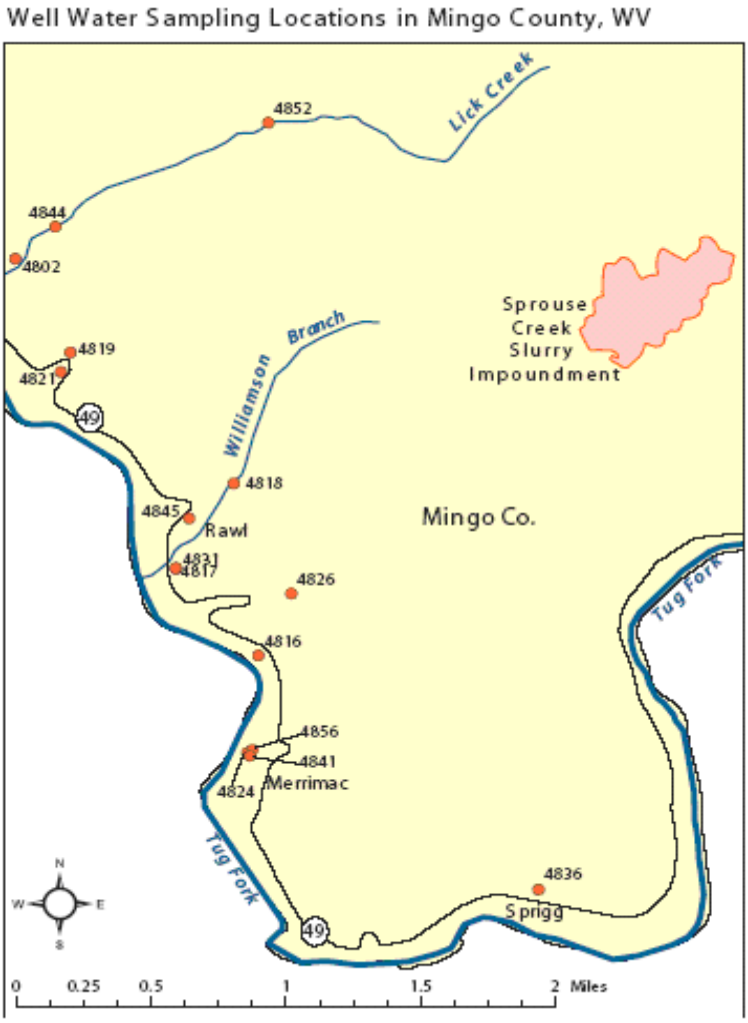
Water quality sampling followed the protocol for well water sampling as mandated by the Water Quality Laboratory at Heidelberg College. For each well, 3 plastic bottles were filled with water. One bottle was used for the analysis of arsenic, and the remaining 2 bottles were used for analysis of barium, beryllium, cadmium, chromium, lead, selenium, aluminum, copper, iron, manganese, nickel, sodium, zinc, calcium, strontium, cobalt, magnesium, potassium, silica, and vanadium. A “Cooperative Private Water Supply Testing Program Participant Information Sheet” was filled out for each well. A number was assigned to each well, and a bar code for each sample was placed on all 3 bottles and on the accompanying information sheet. Samples were analyzed in the Water Quality Laboratory using Standard Methods (Clesceri, *et al* 1999).

Water from wells 4819, 4844, 4802, and 4852 was taken from the kitchen tap. The cold water tap was allowed to run into the sink for approximately 1 minute. Each of the 3 bottles was filled in this stream of water and then labeled. The remaining well samples were taken directly from the well by first disconnecting the household system (typically located in the basement, crawlspace, or nearby shed) and then flushing for 1 minute before filling bottles as described above. Three samples were taken from sources that were not wells, including: a spring on the east side of the Norfolk Southern railroad tracks that is used as a water supply source by many area residents (4816), a municipal source originating from the Williamson water treatment plant and taken directly from the tap in a local business (4824), and a hot water heater (4831) from which supernatant water was decanted from the sludge that accumulated in the bottom of the heater. The sludge had been removed from the hot water heater and placed into a clean 5 gallon

bucket prior to decanting. The well (4826) that feeds the hot water heater (4831) was also sampled after disconnecting it from the household system as described above.

Study area

Sampling locations were chosen geospatially to obtain representative wells in the 4 sub-watersheds of Lick Creek, Rawl, Merrimac, and Sprigg, WV. The investigators sampled at the head, middle, and bottom of the hollow in these watersheds (Map 1). Latitude and longitude were obtained using a global positioning system. Five wells were re-sampled during high flow conditions (described below) and thus have well numbers corresponding to previous sampling points. Three wells sampled during high water conditions were described by street addresses, but latitude and longitude were not acquired.

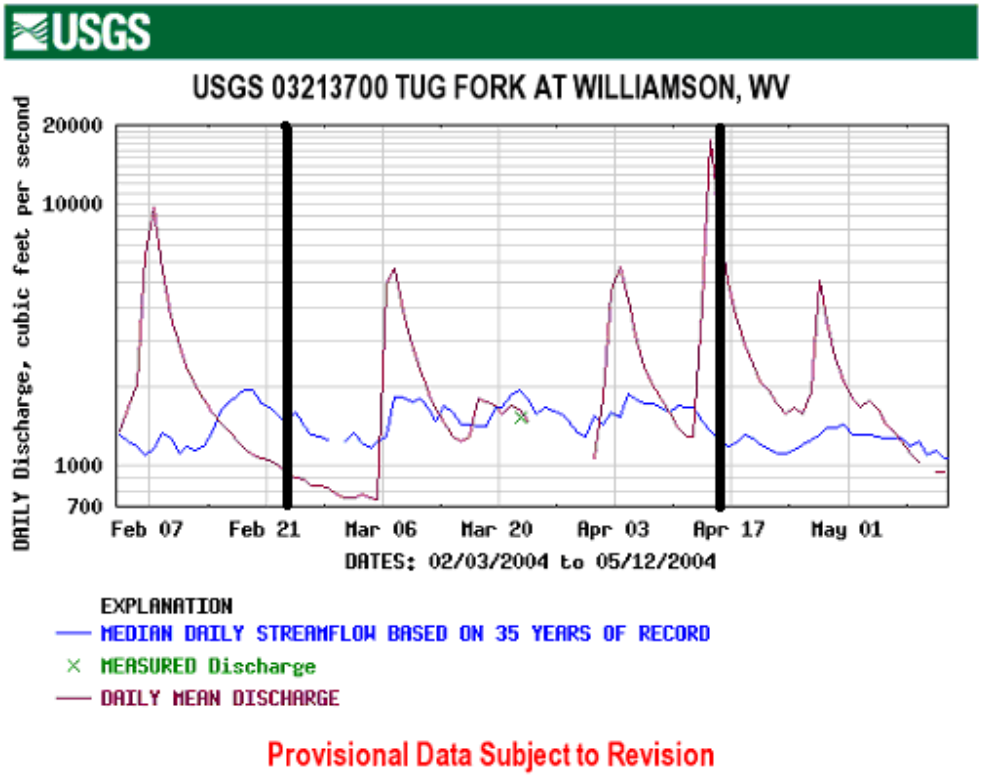


Map 1. Williamson area well water sampling locations, Mingo County, WV.

Sampling during low flow and high flow conditions

Fifteen samples were taken during a low flow period on February 25 and 26, 2004 when mean daily stream flow was between 882 and 841 cubic feet per second at the Tug Fork River gauging station at Williamson (Hydrograph 1). During low flow sampling discharge in the Tug Fork River was approximately 38% of the 35 year median flow condition for those dates.

Eight samples were taken during a high flow period on April 16, 2004 when mean daily stream flow was 5,120 cubic feet per second in the Tug Fork River, or 270% the 35 year median flow condition for that date (Hydrograph 1). The 8 high flow samples were collected by citizens who had been trained by the investigators on how to take samples, label them, fill out data sheets, and mail them according to the Water Quality Lab protocol. The samples were labeled and mailed to Wheeling Jesuit University where sample data sheets were photocopied prior to mailing the samples to the Water Quality Laboratory.



Hydrograph 1. Stream discharge (ft^3/second) at the US Geological Survey Tug Fork recording station near Williamson, West Virginia showing discharge in relation to median flow on February 25-26, and April 16, 2004 well water sampling dates (indicated by vertical black lines).

Results

Water chemistry in Williamson area wells

Well water was tested for 7 metals regulated by primary standards, 5 metals regulated by secondary standards, 2 metals regulated by lifetime health advisories, and 7 non-regulated chemicals.

Metals regulated by primary standards in Williamson area well water

Six of 7 metals that were tested for and that are regulated by primary standards were detected in at least one Williamson area well (Tables 1 & 2). Cadmium was not detected in any well sample. Arsenic was detected in 6 of the 15 different wells, twice in excess the primary standard. Barium was detected in 12 of the 15 wells, once in excess of the standard. Beryllium was detected in 2 of the 15 wells, once in excess of the standard. Chromium was detected in 11 of 15 wells and did not exceed the standard. Lead was detected in 14 of the 15 wells, exceeding the standard in 7 different wells including twice in 1 of the 5 wells that was re-sampled during high flow conditions. Selenium was detected in 1 well and that sample exceeded the primary standard. Primary drinking water standards for the 7 metals tested were exceeded 13 times in samples collected from 15 different wells. Standards were exceeded for lead (8), arsenic (2), barium (1), beryllium (1), and selenium (1), but not for cadmium or chromium.

A sample from a spring used by many families as their drinking water source yielded 1 chemical, chromium, regulated by primary standards. The spring sample had 7 ppb chromium, and was well below the standard of 10 ppb. A sample from the Williamson area municipal supply yielded 2 metals, chromium (3 ppb) and lead (16 ppb) that were tested for and are regulated by primary drinking water standards. In the municipal sample only lead exceeded the 15 ppb standard. In contrast, a sample of the supernatant water decanted from sludge that had collected in the bottom of a hot water heater (source identity 4831) yielded 6 of the 7 tested metals of primary concern, with only cadmium not detected. Four of the 7 metals tested in the hot water heater exceeded primary drinking water standards by factors of 15X for arsenic (150 ppb), 1.5X for barium (3,000 ppb), 12.5X for lead (188 ppb), and 129.2X for selenium (646 ppb). Most interesting, arsenic and selenium were not detected in the sample from the source well (4826) from which the hot water heater (4831) was supplied. Of the 7 metals tested only lead exceeded the primary standard in the source well. When concentration factors for metals of primary concern are calculated by dividing the concentration in the hot water heater by the concentration in the source well (for those elements detected in the source well) the multiplication factor for barium is 30X, chromium 7.3X, and lead 11.8X.

Whereas no households with drilled wells had used their well water as a drinking source for some time, all households actively used their well water as a source for bathing and washing. Therefore, concentration of metals in hot water heaters followed by vaporization during bathing (most used showers) indicates that inhalation, ingestion, and absorption may be significant human exposure pathways. Many households complained

of difficulty in keeping the walls of their bathrooms clean due to buildup of black and red precipitates. Additionally, all households had to use plastic, not metal, fixtures in their bathrooms and kitchen sinks because metal fixtures corroded and dissolved "within 2 years." Most households had replaced their hot water heater within the past 2 years because of corrosion leading to failure of their hot water heater. One additional observation was that when well samples were collected by disengaging the well supply from the household plumbing, as was done in 10 of the 15 different wells sampled (5 samples were collected from the tap as stated and identified specifically in the Methods Section), derelict hot water heaters were observed alongside new hot water heaters in most of the basements and sheds that were visited.

Arsenic was detected in 1 of 12 wells sampled during low flow conditions, with a concentration of 3.2 ppb being below the 10 ppb primary water quality standard (Table 1). Arsenic was 150 ppb in the sample collected from the hot water heater. Arsenic was detected in 6 of 8 wells during high flow conditions with concentrations ranging from 4.2 to 340.0 ppb where detected, and 2 wells exceeding the 10 ppb standard (Table 2).

Barium was detected in 10 of 12 wells sampled at base flow, and one well yielding 2,400 ppb exceeded the 2,000 ppb standard (Table 1). Barium was not detected in the spring or the municipal supply. Barium was 3,000 ppb in the sample from the hot water heater. Barium was detected in 7 of 8 wells tested during high flow conditions with concentrations ranging from 200 to 500 ppb (Table 2).

Beryllium was not detected in wells at low flow, the municipal water sample, or the sample from the spring (Table 1). Beryllium was detected at 1 ppb in the hot water heater sample. Under high flow conditions beryllium was detected in 2 of 8 wells with concentrations of 1 and 7 ppb, therefore one sample exceeded the standard of 4 ppb at high flow (Table 2).

Cadmium was the only metal out of 7 metals tested that are regulated by primary drinking water standards that was not detected in any samples under any condition in Williamson area wells (Tables 1 & 2). Cadmium was also the only metal regulated by primary drinking water standards that was not detected in the sample from the hot water heater.

Chromium was detected in 6 of 12 wells under low flow conditions, with concentrations of 3 to 9 ppb being well below the standard of 100 ppb (Table 1). Chromium was detected in the spring (7 ppb), the municipal water sample (3 ppb), and the hot water heater (29 ppb). Under high flow conditions chromium was detected in all 8 wells with concentrations ranging from 2 to 24 ppb (Table 2). Chromium did not exceed primary drinking water standard of 100 ppb in any of the wells tested.

Lead was detected in 6 of 12 wells during low flow conditions with concentrations ranging from 6 to 23 ppb (Table 1). Five of 12 wells exceeded the 15 ppb primary standard. Lead was not detected in the spring, but exceeded the primary standard in the municipal water sample (16 ppb) and was 188 ppb in the hot water heater sample.

Lead was detected in 7 of 8 wells under high flow conditions with concentrations ranging from 9 to 110 ppb, and 3 wells exceeded the primary standard (Table 2).

Selenium was detected in only 1 of 12 wells under low flow conditions with a concentration of 65 ppb in excess of the 50 ppb standard (Table 1). Selenium was not detected in the spring or the municipal water sample. The selenium concentration was 646 ppb in the sample from the hot water heater. Selenium was not detected in any well under high flow conditions (Table 2).

Metals regulated by secondary standards in Williamson area well water

All 5 of the metals tested that are regulated by secondary drinking water standards were detected in Williamson area wells (Tables 1 & 2). Aluminum was detected in 12 of the 15 different wells tested, and the aluminum secondary standard was exceeded in 1 well. Copper was detected in 3 of 15 different wells and did not exceed the secondary standard in any well. Iron was detected in all 15 wells and exceeded the secondary standard in 13 of the wells, including twice in 4 of the 5 wells that were re-sampled during high flow conditions. Manganese was detected in 14 of the 15 different wells tested. Manganese exceeded the secondary standard in 13 of the 15 wells, including twice in 4 of the 5 wells re-sampled during high flow conditions. Zinc was detected in 14 of the 15 different wells tested. Zinc exceeded the secondary drinking water standard in 1 of the 15 wells. Secondary drinking water standards for the 5 metals tested were exceeded a total of 36 times in samples collected from 15 different wells. Standards were exceeded for iron (17), manganese (17), aluminum (1), and zinc (1), but not for copper.

A spring water sample contained only 1 of 5 metals tested and regulated by secondary standards: iron at 14 ppb. The sample from the Williamson municipal supply contained aluminum at 30 ppb and manganese at 35 ppb. In contrast, a sample of supernatant water decanted from the sludge which had collected in the bottom of a hot water heater (source identity 4831) yielded all 5 of the tested metals of secondary concern. Two of the 5 metals tested in the hot water heater exceeded secondary drinking water standards by factors of 1,859X for iron, and 5,452X for manganese. Most interesting, iron was 1.6X above standard and manganese 1.1X above standard in the sample from the source well (4826) from which the hot water heater (4831) was supplied. Here again, the hot water heater acts as a concentrating mechanism from which vaporization and subsequent inhalation, as well as ingestion and absorption exposure during bathing may be a significant human exposure pathway as described previously for metals of primary concern. Neither copper nor aluminum were detected in the source well, but both were detected in the hot water heater. Zinc was concentrated by a factor of 81.5X in the hot water heater (4831) compared to the source well (4826), iron was concentrated by 1,179.1X, and manganese 485.6X.

Aluminum was detected in 8 of 12 wells tested during base flow condition with concentrations ranging from 10 to 60 ppb (Table 1). Aluminum was not detected in the spring and was 30 ppb in the municipal water sample. Aluminum was 200 ppb in the hot

water heater sample, equal to the 200 ppb secondary standard. Aluminum concentrations ranged from 30 to 170 ppb during high flow with one exception: one well tested during high flow had a concentration of 8,030 ppb, well in excess of the 200 ppb secondary standard (Table 2).

Copper was detected in only 1 well at base flow with a concentration of 53 ppb, well below the 1,300 ppb secondary standard (Table 1). Copper was not detected in the spring or the municipal supply and was below the standard with a concentration of 390 ppb in the hot water heater. Copper was detected in 2 of 8 wells sampled during high flow conditions with concentrations of 131 and 758 ppb being below the secondary standard (Table 2).

Iron was the predominant metal regulated by secondary standards that was detected in study wells, with concentrations ranging from 39 ppb to 25,280 ppb (Table 1). Iron was not detected in the sample from the municipal water supply, and 14 ppb were found in the spring water sample. Ten of 12 wells exceeded the drinking water standard of 300ppb during base flow. Iron was 557,700 ppb in the sample from the hot water heater. Iron exceeded the 300 ppb standard in all wells under high flow conditions, with concentrations ranging from 371 to 57,588 ppb (Table 2).

Manganese concentrations under low flow conditions ranged from not detected in the spring and a 26 foot deep dug well to 2,999 ppb in a 76-foot-deep drilled well (Table 1). Manganese was 35 ppb in the municipal water sample. Manganese exceeded the 50 ppb standard in 9 of 12 wells. Manganese was 27,260 ppb in the sample from the hot water heater. Under high flow conditions manganese exceeded the secondary standard in all 8 wells sampled with concentrations ranging from 82 to 4,063 ppb (Table 2).

Zinc was detected in 9 of 12 wells sampled during low flow conditions with concentrations ranging from 12 to 239 ppb, and no samples in excess of the 5,000 ppb secondary standard (Table 1). Zinc was not detected in the spring or the municipal supply. The hot water heater had a zinc concentration of 2,118 ppb. Zinc was detected in all 8 wells tested during high flow conditions and one well exceeded the secondary standard with a concentration of 5,658 ppb (Table 2).

Regulated chemicals with lifetime health advisories in Williamson area well water

Two metals tested and regulated by lifetime health advisories included nickel and sodium. Nickel was detected in only one for the 15 wells tested; a concentration of 285 ppb in excess of the 10 ppb standard (Tables 1 & 2). Nickel was not detected in the spring, the municipal supply, or the hot water heater (Table 1). Nickel was detected in only one well, and that sample was collected during high flow conditions (Table 2).

Sodium was detected in all samples ranging in concentration from 7,600 to 184,400 ppb during low flow conditions (Table 1), and 8,300 to 189,100 ppb during high flow conditions (Table 2). In wells sodium exceeded the 20,000 ppb standard in 13 of the 15 different wells tested (Tables 1 & 2). The sodium standard was exceeded in 10 of 12