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January 10, 2017

Robert J. Martineau, Jr.
Commissioner
Tennessee Department of Environment and Conservation
William Snodgrass Tower
312 Rosa L. Parks Avenue, 2nd Floor
Nashville, Tennessee 37243

Chuck Head
Senior Advisor, TDEC Division of Solid Waste

Via email to Bob.Martineau@tn.gov and Chuck.Head@tn.gov

Re: Groundwater contamination at Bull Run Fossil Plant

Dear Commissioner Martineau and Mr. Head:

The undersigned groups write to bring your attention to recent evidence of ongoing and increasingly severe groundwater contamination at the Bull Run Fossil Plant. The Environmental Integrity Project has previously documented the evidence of coal ash contamination at TVA coal plants in detail.[1] This letter specifically focuses on recent data from two disposal areas at Bull Run.

Coal ash disposal at the Bull Run plant has unquestionably contaminated the groundwater. Monitoring data show contamination at the Dry Fly Ash Stack, or DFAS, and at the Gypsum Disposal Area, or GDA.[2] In both cases the contamination bears all of the hallmarks of coal ash, and in both cases the groundwater is now hazardous to human health. Evidence from at least one well at each disposal area shows groundwater quality deteriorating over the past few years. As we demonstrate below, the extent and severity of contamination means that TVA is currently in violation of the federal coal ash rule because it has not commenced corrective action. TVA is

[1] Environmental Integrity Project, TVA's Toxic Legacy: Groundwater Contaminated by Tennessee Valley Authority Coal Ash (Nov. 2013), attached hereto as Attachment A (hereinafter "EIP Report").
[2] Although this letter is focused on the DFAS and the GDA, we note that there is additional evidence of coal ash contamination in the voluntary monitoring data from the Bull Run ash pond area.

also subject to corrective action requirements of a recent TDEC enforcement order and other state requirements. As both TDEC[3] and the undersigned groups[4] have observed, much of the coal ash at Bull Run is buried beneath the water table and saturated with groundwater. In this state, it will continue to leach pollutants into the groundwater until it is removed. When TVA does commence corrective action, it will have to remove all coal ash from groundwater-saturated areas.

TVA continues to brazenly deny the plain facts and to ignore the data that are most relevant for assessing the effects of coal ash. We encourage TDEC to hold TVA accountable, to require corrective action, and to prohibit TVA from leaving coal ash buried in groundwater at Bull Run.

1. Legal background

The Dry Fly Ash Stack (DFAS) and the Gypsum Disposal Area (GDA) are currently subject to at least three overlapping sets of legal requirements – the federal coal ash rule, state solid waste law, and a recent TDEC enforcement order. All three are discussed below.

The Dry Fly Ash Stack (DFAS) and the Gypsum Disposal Area (GDA) are subject to the federal coal ash rule.[5] TVA may not agree,[6] but the DFAS is still an active landfill,[7] and the GDA is both an active landfill under state law (as it is being regulated by TDEC with an active landfill permit) and an inactive surface impoundment.[8] Federal law requires groundwater monitoring at these coal ash disposal areas,[9] and where monitoring reveals contamination, the law requires corrective action.[10]

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[3] Letter from Chuck Head, TDEC, to Paul Pearman, TVA, re: TVA Bull Run Fossil Plant Environmental Investigation Plan, at page 3 (Sep. 13, 2016) (noting that at the GDA, "waste is probably submerged in groundwater at the lower levels of the fill.").

[4] Letter from Amanda Garcia, Southern Environmental Law Center, to Ashley Farless, TVA, re: TVA's Obligation to Prepare a Supplemental Environmental Impact Statement (May 23, 2016); *see also* Letter from Mark Quarles to Ashley Farless, TVA, Re; Supplemental Comments Regarding the Draft Environmental Impact Statement (Bull Run Ash Pond closure), pages 7-8 (May 20, 2016).

[5] 40 C.F.R. § 257, Subpart D.

[6] See, e.g., TVA, Bull Run Coal Combustion Residuals, https://www.tva.gov/Environment/Environmental-Stewardship/Coal-Combustion-Residuals/Bull-Run (omitting the DFAS and the GDA from areas that TVA believes to be subject to the coal ash rule).

[7] The DFAS is still being regulated by TDEC with an active landfill permit, Phase II of the original landfill has not been closed or capped and may still be receiving ash, and the "expansion" of the landfill is still receiving ash, which means that the landfill as a whole is still active for purposes of the coal ash rule. 40 C.F.R. § 257.53 (definition of existing CCR landfill).

[8] See letter from Amanda Garcia, Southern Environmental Law Center, to Robert Martineau, TDEC Commissioner, re: TVA's Noncompliance with Federal Coal Ash Rule and State Law, pages 4 – 5 (Dec. 21, 2016) (showing that impoundments such as the Bull Run GDA that contain groundwater-saturated ash are inactive surface impoundments for purposes of the coal ash rule because they continue to impound ash and liquids); 40 CFR § 257.53 (definitions of "CCR surface impoundment" and "inactive CCR surface impoundment").

[9] 40 C.F.R. § 257.90 – 257.95.

[10] 40 C.F.R. § 257.96 – 257.98.

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The monitoring requirements in the rule follow a typical schedule that begins with detection monitoring and then, if detection monitoring constituents (listed in Appendix III[11] to the coal ash rule) exceed background levels, assessment monitoring. If assessment monitoring constituents (listed in Appendix IV[12] to the rule) are found to significantly exceed groundwater protection standards, then the rule requires corrective action. Although the rule formally proceeds in stages for new monitoring networks, EPA has made clear that an existing groundwater monitoring network can support an immediate corrective action requirement:

> If the pre-existing data and accompanying data analysis are as scientifically valid and consistent with the data and analysis required and developed under the CCR rule and they provide equivalent confidence that the standard in § 257.96 (a) has been met, such data would trigger the corrective action requirements in §§ 257.96-.98 … [A] s a general matter, if a facility has any data that indicates groundwater contamination may be occurring, the facility should be taking appropriate steps without hesitation to address the issue or potential issues shown by the data or sampling results.[13]

As we discuss in detail below, the existing groundwater quality database clearly shows exceedances for Appendix III detection monitoring constituents, and exceedances for Appendix IV assessment monitoring constituents, and TVA should therefore be undertaking corrective action.

As a matter of state law, many of the constituents known to be indicators of coal ash, including many of the coal ash rule monitoring constituents, are not regulated with generic statewide groundwater protection standards. However TDEC has the legal authority – and responsibility – to establish site-specific groundwater protection standards. Tennessee regulations explicitly state that TDEC should expand the list of monitoring parameters when TDEC knows that there are indicators of the waste being regulated. According to Tenn. Comp. R. & Regs. 0400-11-01-.04:

> The Commissioner may establish an alternative list of inorganic indicator parameters for a SWLF unit, in lieu of some or all of the heavy metals (constituents 1-17 in Appendix I to this rule), if the alternative parameters provide

[11] 40 C.F.R. Part 257, Appendix III. Detection monitoring constituents include boron, calcium, chloride, fluoride, pH, sulfate, and Total Dissolved Solids (TDS).

[12] 40 C.F.R. Part 257, Appendix IV. Assessment monitoring constituents include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, and two isotopes of radium.

[13] U.S. EPA, Relationship Between the Resource Conservation and Recovery Act's Coal Combustion Residuals Rule and the Clean Water Act's National Pollutant Discharge Elimination System Permit Requirements: Use of Groundwater Data Obtained Prior to the CCR Rule, https://www.epa.gov/coalash/relationship-between-resource-conservation-and-recovery-acts-coal-combustion-residuals-rule, and attached hereto as Attachment B.

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a reliable indication of inorganic releases from the SWLF unit to the ground water.[14]

TVA, like EPA, has acknowledged that several pollutants on the coal ash rule monitoring lists are useful indicators of coal ash contamination.[15] In fact, TVA has requested, and TDEC has approved, changes to the permits for the GDA and DFAS adding monitoring for coal ash rule constituents. Given the formal monitoring now underway, TDEC must have some standard by which to evaluate the monitoring data. TDEC has, in the past, used site-specific groundwater protection standards at Bull Run for some of these constituents (e.g., cobalt), basing the standards on EPA Regional Screening Levels and upgradient groundwater quality data.[16]

The Bull Run ash disposal areas are currently in assessment monitoring under state law.[17] If TDEC were to establish and enforce site-specific standards for all coal ash monitoring constituents as a matter of state law, then TVA would be required to undertake corrective action as a matter of state law[18] (in addition to its independent obligation under federal law, as discussed above).

Finally, TDEC is currently enforcing Commissioner's Order OGC15-0177, which applies to "all areas where CCR disposal has occurred" at Bull Run and other TVA coal plants.[19] Among other things, the Order requires TVA to "discuss and provide information about … detection of CCR constituents listed in Appendix III and Appendix IV for the CCR rule."[20] To the best of our knowledge, TVA has sampled for, but has not otherwise discussed, the concentrations of key coal ash pollutants in groundwater at or near the GDA and DFAS.[21] This letter provides a brief analysis of the relevant data.

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[14] This Class I landfill rule applies to Class II landfills per Tenn. Comp. R. & Regs. 0400-11-01-.04(7)(b). ("Class II disposal facilities must meet the same ground water protection/monitoring standards for Class I facilities [with listed exceptions]."). See also Tenn. Comp. R. & Regs. 0400-11-01-.04(7)(b)(5).

[15] *See, e.g.*, TVA, *Colbert Fossil Plant Groundwater Assessment*, 51 (Oct. 1994) (stating that "pH, sulfate, and TDS are considered to be indicators of coal ash leachate in groundwater" and that aluminum, manganese and iron can be associated with ash leachate); *id.* at 52 (stating that boron, molybdenum, and strontium are often considered to be indicators of ash leachate); TVA, *Groundwater Monitoring Report – Allen Fossil Plant*, at 2 (Aug. 22, 2008) (identifying arsenic, boron, and sulfate as "ash leachate indicators").

[16] See, e.g., EIP report, Attachment A, pages 37 – 38.

[17] See, e.g., Letter from Sam Hixson, TVA, to Patrick Mulligan, TDEC, transmitting Bull Run Fossil Plant Dry Fly Ash Landfill Groundwater Assessment Monitoring Report, May 2016 resample (Aug. 2, 2016); Letter from Sam Hixson, TVA, to Patrick Mulligan, TDEC, transmitting TVA Bull Run Fossil Plant Gypsum/Coal-Ash Landfill Groundwater Assessment Monitoring Report May/June Resample (July 27, 2016).

[18] See, e.g.,Tenn. Comp. R. & Regs. 0400-11-01-.04(7)(a)7 – (7)(a)9 (corrective action requirements for Class I landfills); Tenn. Comp. R. & Regs. 0400-11-01-.04(7)(b) (applying Class I corrective action requirements to Class II landfills).

[19] TDEC, Commissioner's Order OGC15-0177, page 4 (Aug. 6, 2015).

[20] Id. at 5.

[21] For example, in the August 2016 Groundwater Monitoring Report for the DFAS, TVA simply stated that "[c]oncentrations of the detected constituents were all below GWPS and applicable promulgated MCLs or were non-detectable." This ignores the pollutants that have no state GWPS or federal MCLs, including boron, cobalt, sulfate, lithium, and molybdenum, the pollutants discussed in this letter. August 2, 2016 Hixson letter, supra note 17, at 10.

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The TDEC Order also requires TVA to remediate contaminated groundwater.[22] So far, TVA has not provided a transparent characterization of the extent of contamination that will have to be remediated. Even if TDEC were to take the position that the DFAS and GDA are not subject to the federal coal ash rule, the monitoring framework laid out in that rule, including the list of indicator pollutants and procedures for establishing groundwater protection standards, provide TDEC with a template for enforcing its own Order.

The data discussed below show the scale of contamination at both the DFAS and the GDA, and also the trend – it is currently getting worse.

2. Groundwater data and health guidelines

This letter focuses on three "detection monitoring" pollutants from Appendix III of the federal rule: boron, sulfate, and Total Dissolved Solids (TDS). Boron and sulfate, in particular, have been identified by EPA as uniquely valuable indicators. The Agency notes that they are "the most prevalent contaminants identified" among the contaminants regulated with Secondary Maximum Contaminant Levels, and explains that "[t]he high mobility of boron and sulfate explains the prevalence of these constituents in damage cases that are associated with groundwater impacts."[23]

It is important to note that these are not merely indicators – boron and sulfate also present significant health risks. Boron, in particular, was a leading driver of coal ash risks in the coal ash rule risk assessment. Specifically, EPA identified nine pollutants posing unacceptable risks to either human health or the environment.[24] Boron, which is associated with developmental and reproductive toxicity,[25] was one of the nine, and it was notably the only pollutant that posed risks to <u>both</u> human health and the environment.[26] The detection monitoring data alone would therefore show evidence of unsafe drinking water.

This letter also focuses on three "assessment monitoring" pollutants from Appendix IV of the federal rule: cobalt, lithium, and molybdenum. All three were among the list of nine risk drivers in EPA's risk assessment,[27] and all three present serious risks to human health, either through exposure to onsite groundwater, or through exposure to downstream surface water contaminated by groundwater from Bull Run.

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[22] TDEC Order at 7.
[23] 80 Fed. Reg. 21456.
[24] Id. at 21451 ("Risks to residential receptors were identified primarily from exposures to arsenic, lithium, and molybdenum . . . but additional risks from boron, cadmium, cobalt, fluoride, mercury and thallium were identified for specific subsets of national waste disposal practices"); .S. EPA, Human and Ecological Risk Assessment of Coal Combustion Residuals, EPA-HQ-RCRA-2009-0640-11993, Table 5-5 (Dec. 2014).
[25] See, e.g., U.S. EPA, Toxicological Review of Boron and Compounds (June 2004); Agency for Toxic Substances and Disease Registry, Toxicological Profile for Boron (November 2010).
[26] Id.
[27] Id.; 80 Fed. Reg. 21451.

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Health effects of, and EPA guidelines for, each pollutant are discussed in more detail in the attached EIP report.[28] The health guidelines shown in this letter are EPA drinking water advisories[29] (for boron, molybdenum, and sulfate) or EPA Regional Screening Levels[30] (for cobalt and lithium). The data for this report were obtained from TVA through Freedom of Information Act (FOIA) requests. To the best of our knowledge, all data come from groundwater monitoring reports that were also sent to TDEC.

The remainder of the letter discusses groundwater quality data from the DFAS and the GDA separately.

3. Dry Fly Ash Stack

TVA has recently been undertaking additional monitoring at the Dry Fly Ash Stack (DFAS) due to "statistical exceedances" for arsenic at well F45R.[31] TVA argues that there are "no discernable upward trends for any constituent" at the site, and that the arsenic exceedances are "not indicative of a release from the landfill."[32] Both statements are false.

As shown in Figure 3-1 and Table 3-1 below, boron, chloride, molybdenum, sulfate, and TDS – all coal ash indicators – have clearly been increasing in well F45R since 2008.

[28] EIP report, Attachment A, pages 17 – 22, 158 – 161..
[29] U.S. EPA, 2012 Edition of the Drinking Water Standards and Advisories , EPA 822-S-12-001 (Apr., 2012).
[30] U.S. EPA, Regional Screening Levels, https://www.epa.gov/sites/production/files/2016-06/documents/master_sl_table_run_may2016.pdf (May, 2016).
[31] See, e.g., Letter from Sam Hixson, TVA, to Patrick Mulligan, TDEC, transmitting Bull Run Fossil Plant Dry Fly Ash Landfill Groundwater Assessment Monitoring Report, May 2016 resample (Aug. 2, 2016).
[32] Id.

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Figure 3-1: Selected coal ash pollutants at Bull Run well F45R, shown relative to pollutant-specific means over the 2008-2016 time period.

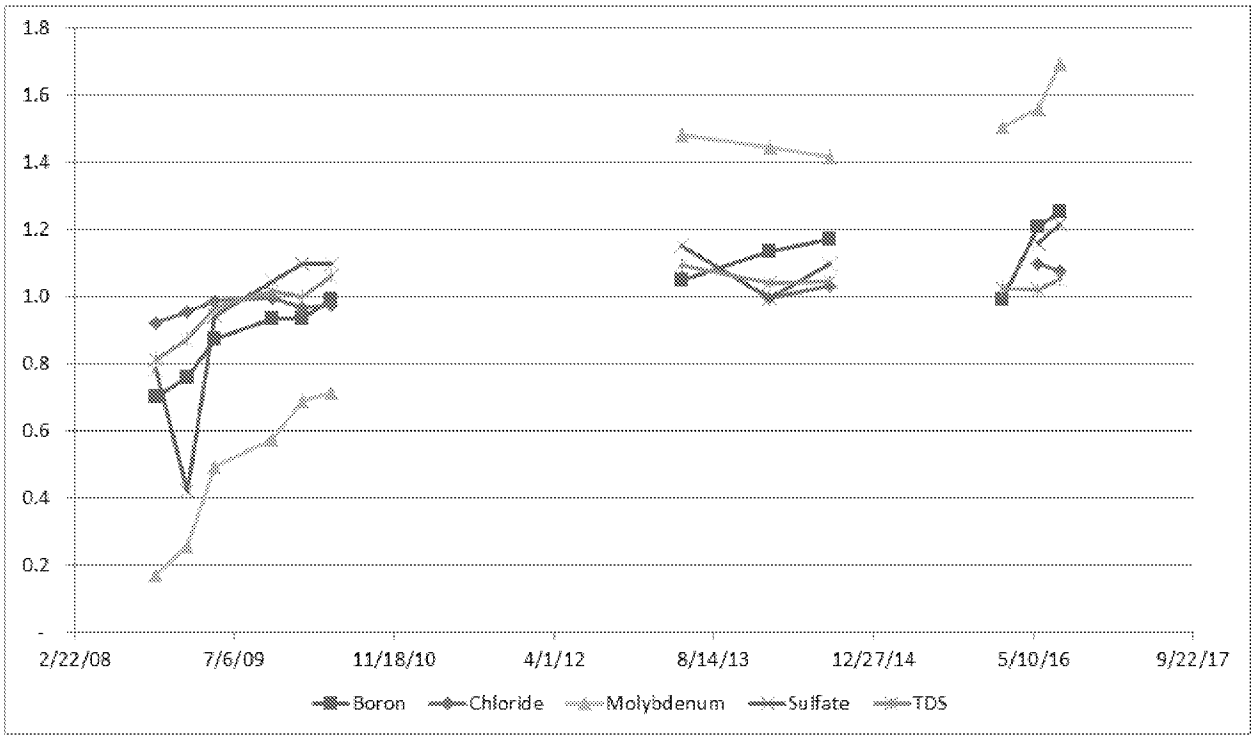

Table 3-1: Selected coal ash indicator pollutants at Bull Run well 45R.

All concentrations in mg/L	Mean concentration, 2008-2009	Mean concentration, 2016	Safe drinking water guideline
Boron	14.0	19.7	3
Chloride	8.6	9.7	-
Molybdenum	0.046	0.193	0.040
Sulfate	1,525	2,275	500
TDS	2,937	3,302	-

In short, many pollutants have been increasing at the DFAS, despite TVA's statements to the contrary.

As for the idea that the arsenic exceedances are unrelated to coal ash, it is important to note that the groundwater, particularly in well F45R, shows all of the hallmarks of coal ash contamination. Figures 3-2 and 3-3, and Table 3-2, show that wells F45R, G, and J all show concentrations of boron, sulfate and/or TDS that exceed background by large margins.[33] This tells us three things:

- First, the groundwater at the DFAS exceeds background concentration of detection monitoring constituents, which means that the DFAS should be undergoing federal assessment monitoring. As discussed below, assessment monitoring would also show exceedances, which means that TVA should be undertaking corrective action at the DFAS.

- Second, the clear evidence of coal ash contamination indicates that the arsenic exceedances are also likely related to coal ash.

- Finally, the boron and sulfate data show that the water is unsafe to drink. Boron concentrations in well F45R are more five times higher than the Child Health Advisory, and sulfate concentrations are more than three times higher than the Drinking Water Advisory. Unless TVA undertakes corrective action, this groundwater aquifer will continue to be unsafe indefinitely. The health risks are particularly pronounced here because there are multiple residential wells and municipal water intakes within one mile of the DFAS.[34]

[33] Although we did not conduct a statistical analysis, we note that the minimum concentration in downgradient wells frequently exceeds the maximum concentration in upgradient wells. In this case, any statistical analysis would show a significant difference between the downgradient and upgradient wells.

[34] See, e.g., Letter from Chuck Head, TDEC, to Paul Pearman, TVA, re: TVA Bull Run Fossil Plant Environmental Investigation Plan, at page 2 (Sep. 13, 2016); TVA, Part II Permit Application and Hydrogeologic Site Investigation for "CCP Proposed Landfill" at Bull Run, Appendix A (June 12, 2015) (showing multiple residential wells and a municipal drinking water intake within one mile of the DFAS).

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Figure 3-2: Boron contamination at the Bull Run Dry Fly Ash Stack (mg/L). The red line depicts the EPA Child Health Advisory for boron (3 mg/L).

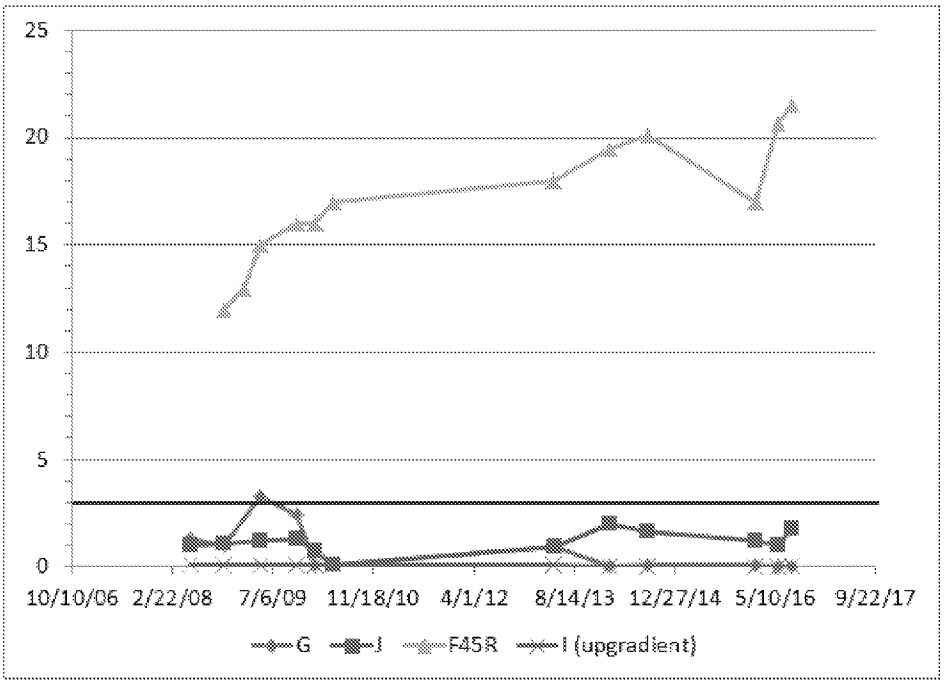

Figure 3-3: Sulfate contamination at the Bull Run Dry Fly Ash Stack (mg/L). The red line depicts the EPA Drinking Water Advisory for sulfate (500 mg/L).

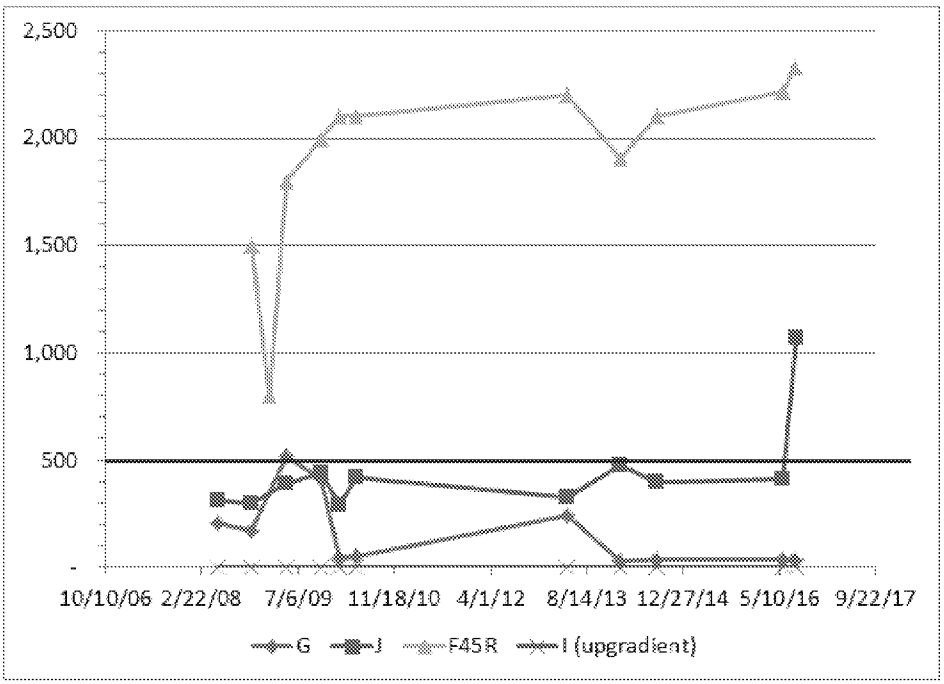

Table 3-2: Detection monitoring constituents at the Bull Run Dry Fly Ash Stack, 2008-2016.[35]

Well	**Boron:** Mean (range), mg/L	**Sulfate:** Mean (range), mg/L	**TDS:** Mean (range), mg/L
I (upgradient)	*(<0.05 – <0.2)*	*3 (<5 – 5)*	*307 (280 – 337)*
F45R	17.15 (12.00 – 21.50)	1,914 (800 – 2,330)	3,202 (2,600 – 3,500)
G	0.79 (<0.05 – 3.30)	163 (34 – 520)	449 (230 – 1,000)
J	1.17 (<0.20 – 2.01)	439 (290 – 1,070)	764 (320 – 967)
Health guideline	3.00	500	-

Table 3-3 shows that "assessment monitoring" for the DFAS would trigger corrective action. For lithium and molybdenum, which do not have Maximum Contaminant Levels, the groundwater protection standards under the federal rule would be their background concentrations.[36]

Table 3-3: Assessment monitoring constituents at the Bull Run Dry Fly Ash Stack, 2008-2016.[37]

Well	**Lithium:** Mean (range), ug/L[38]	**Molybdenum:** Mean (range), ug/L
I (upgradient)	*(<50)*	*(<2 - <50)*
F45R	8,220 (7,685 – 9,275)	122 (21 – 206)
G	(<50)	21 (<2 – 100)
J	(<50)	(<2 – <50)
Health guideline	40	40

Again, these data tell us three things:

- First, there is no question that lithium and molybdenum concentrations are statistically higher in well F45R than they are in upgradient well I. The federal coal ash rule requires corrective action in this case.
- Second, these results confirm that the groundwater has been contaminated by coal ash. The statistical arsenic exceedances seen by TVA are almost certainly due to coal ash.
- Finally, the lithium and molybdenum concentrations exceed safe levels by large margins. The regional screening level for lithium is 40 ug/L. The groundwater in well F45R is <u>more than 200 times higher</u> than the safe level.

[35] For purposes of averaging, nondetects were treated as being present at one-half of the reported detection limit.
[36] 40 C.F.R. § 257.95(h)(2).
[37] For purposes of averaging, nondetects were treated as being present at one-half of the reported detection limit.
[38] TVA only started measuring lithium in 2016.

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In sum, the Dry Fly Ash Stack is currently contaminating groundwater in violation of federal law, making the groundwater hazardous to human health. TDEC must not allow TVA to persist in the fiction that there is nothing wrong with this landfill. Instead, TVA must be required to undertake corrective action to restore groundwater quality.

4. Gypsum Disposal Area.

As with the DFAS, TVA has recently been undertaking additional monitoring at the Gypsum Disposal Area (GDA) and has found "statistical exceedances" for arsenic, cobalt, and selenium, in this case in wells 47, 48 and 49.[39] As with the DFAS, TVA attempts to downplay the evidence of contamination, attributing high levels of coal ash pollutants to natural sources and stating that there are "no upward trends" in the data.[40] In fact, the evidence of contamination is quite serious.

To begin with, well 49 shows very clear, dramatic increases in many coal ash pollutants over the past eight years. Figure 4-1 and Table 4-1 below show increasing concentrations of boron, chloride, cobalt, sulfate, and TDS. Boron, cobalt, and sulfate have increased more than five-fold and now exceed safe drinking water guidelines by wide margins.

[39] See, e.g., Letter from Sam Hixson, TVA, to Patrick Mulligan, TDEC, transmitting TVA Bull Run Fossil Plant Gypsum/Coal-Ash Landfill Groundwater Assessment Monitoring Report May/June Resample (July 27, 2016).
[40] See, e.g., TVA, Bull Run Fossil Plant Gypsum/Coal-Ash Landfill Groundwater Assessment Monitoring Report – February 2016, at 12 (Apr. 27, 2016).

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Figure 4-1: Selected coal ash pollutants at Bull Run well 49, shown relative to pollutant-specific means over the 2008-2016 time period.

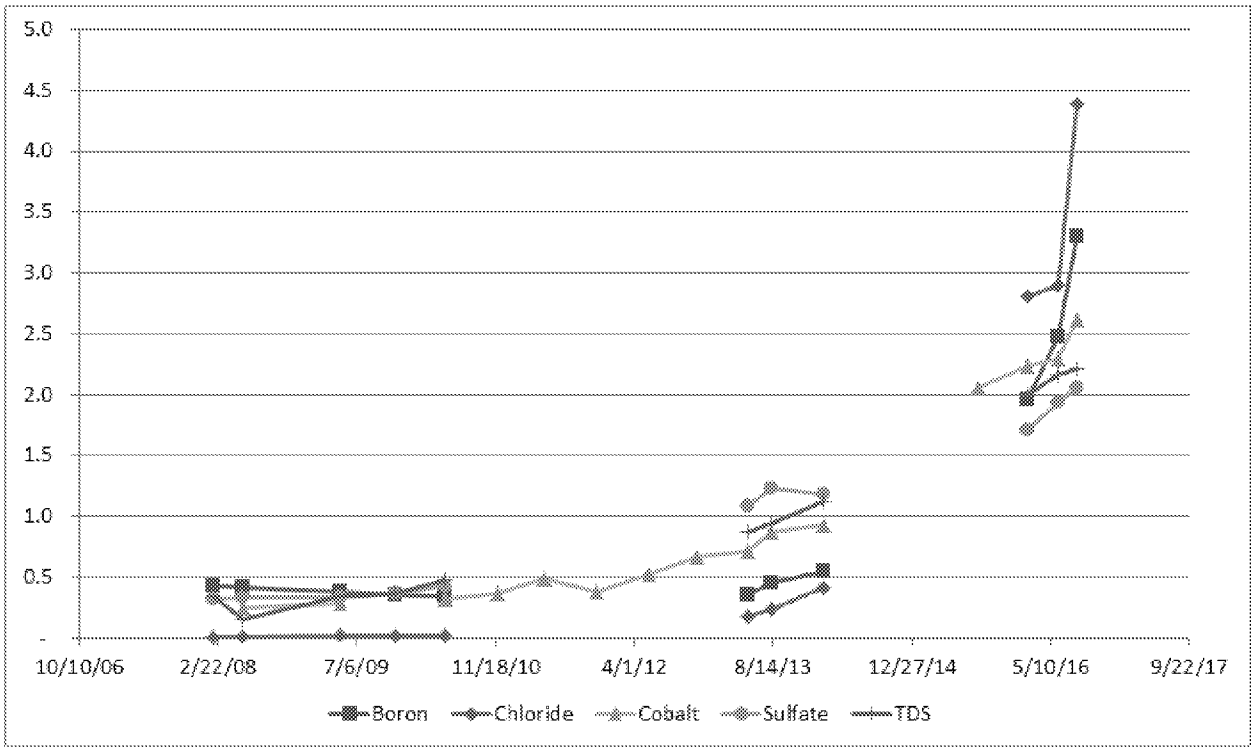

Table 4-1: Selected coal ash indicator pollutants at Bull Run well 49

All concentrations in mg/L	Mean concentration, 2008-2009	Mean concentration, 2016	Health guideline
Boron	2.1	13.7	3
Chloride	3.3	717	-
Cobalt	0.002	0.014	0.006
Sulfate	233	1,293	500
TDS	486	3,397	-

The data for detection monitoring constituents at the Gypsum Disposal Area show all of the hallmarks of coal ash contamination. Figures 4-2 and 4-3, and Table 4-2, show that all downgradient wells have concentrations of boron, sulfate and/or TDS that exceed background, typically by large margins.[41] This tells us three things:

- First, the groundwater at the GDA exceeds background concentration of detection monitoring constituents, which means that the GDA should be undergoing federal assessment monitoring. As discussed below, assessment monitoring would also show exceedances, which means that TVA should be undertaking corrective action at the GDA.
- Second, the clear evidence of coal ash contamination indicates that the arsenic, cobalt, and selenium exceedances are also related to coal ash.
- Finally, the boron and sulfate data show that the water is unsafe to drink. Unless TVA undertakes corrective action, this groundwater aquifer will continue to be unsafe indefinitely.

Corrective action and remediation at the GDA will necessarily entail removal of the coal ash, also known as "clean closure."[42] Because the ash in this area is partially submerged in groundwater, anything short of removal will fail to interrupt recent trends: Leaching will continue, and will continue to get worse. The only way to restore groundwater quality is to remove the source of contamination.

[41] Although we did not conduct a statistical analysis, we note that the minimum concentration in downgradient wells frequently exceeds the maximum concentration in upgradient wells. In this case, any statistical analysis would show a significant difference between the downgradient and upgradient wells.
[42] See, e.g., 40 C.F.R. § 257.102(c) (requirement for closure by removal of [coal ash] under the federal coal ash rule).

Figure 4-2: Boron contamination at the Bull Run Gypsum Disposal Area (mg/L). The red line depicts the EPA Child Health Advisory for boron (3 mg/L).

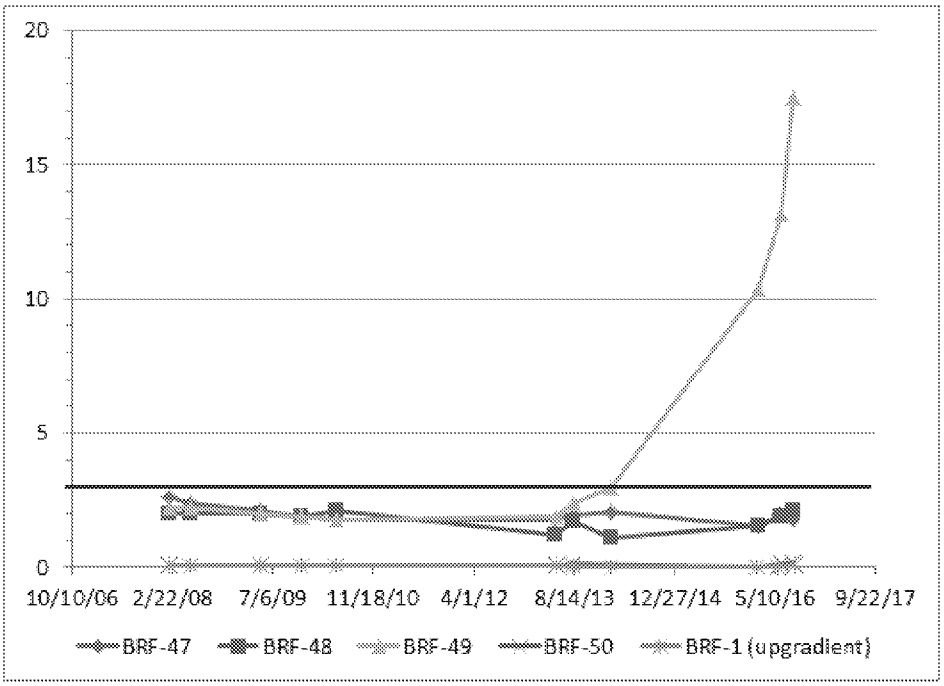

Figure 4-3: Sulfate contamination at the Bull Run Gypsum Disposal Area (mg/L). The red line depicts the EPA Drinking Water Advisory for sulfate (500 mg/L).

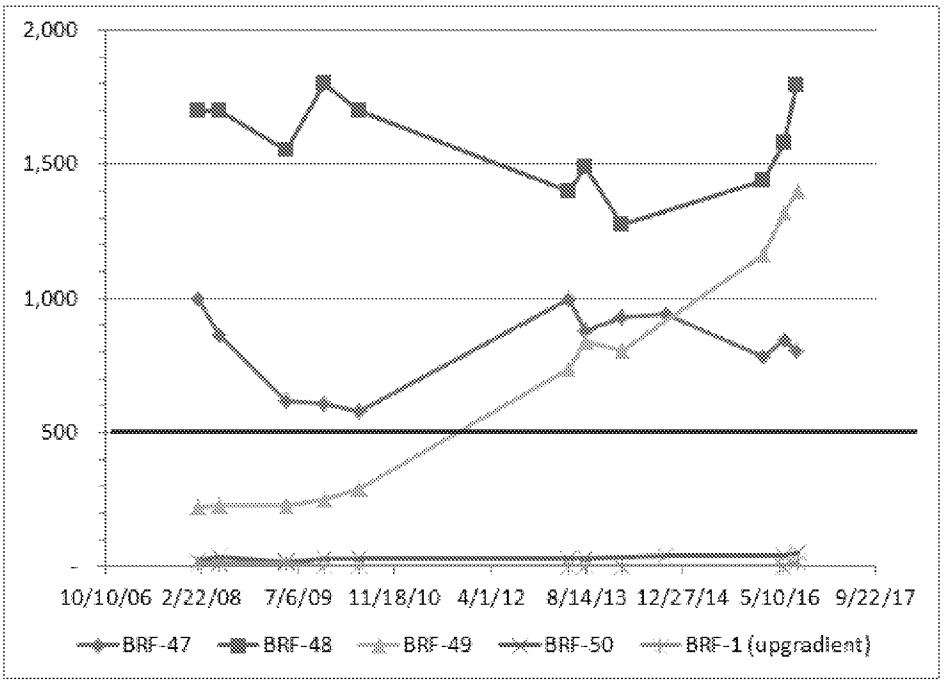

Table 4-2: Detection monitoring constituents at the Bull Run Gypsum Disposal Area, 2008-2016.[43]

Well	**Boron:** Mean (range), mg/L	**Sulfate:** Mean (range), mg/L	**TDS:** Mean (range), mg/L
BRF-1 (upgradient)	*(<0.05 – <0.2)*	*7 (<1 – 17)*	*230 (182 – 262)*
BRF-47	1.99 (1.56 – 2.60)	821 (580 – 1,000)	1,351 (1,000 – 1,500)
BRF-48	1.78 (1.12 – 2.11)	1,585 (1,275 – 1,800)	2,364 (1,905 – 2,600)
BRF-49	5.31 (1.80 – 17.50)	680 (220 – 1,400)	1,600 (250 – 3,530)
BRF-50	(<0.5 – <1.0)	34 (21 – 55)	571 (310 – 685)
Health guideline	3.00	500	na

Table 4-3 shows that "assessment monitoring" for the Gypsum Disposal Area would trigger corrective action. For lithium and molybdenum, which do not have Maximum Contaminant Levels, the groundwater protection standards under the federal rule would be their background concentrations.[44]

Table 4-3: Assessment monitoring constituents at the Bull Run Dry Gypsum Disposal Area, 2008-2016.[45]

Well	**Lithium:** Mean (range), ug/L[46]	**Molybdenum:** Mean (range), ug/L
BRF-1 (upgradient)	*(<50)*	*<2 - 6*
BRF-47	392 (337 – 480)	45 (22 – 67)
BRF-48	153 (139 – 163)	(<2 – 6)
BRF-49	504 (423 – 624)	488 (272 – 700)
BRF-50	(<50)	(<2 – 6)
Health guideline	40	40

Again, these data tell us three things:

- First, there is no question that lithium and molybdenum concentrations are statistically higher in downgradient groundwater than they are in upgradient well BRF-1. The federal coal ash rule requires corrective action in this case.

[43] For purposes of averaging, nondetects were treated as being present at one-half of the reported detection limit.
[44] 40 C.F.R. § 257.95(h)(2).
[45] For purposes of averaging, nondetects were treated as being present at one-half of the reported detection limit.
[46] TVA only started measuring lithium in 2016.

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- Second, these results confirm that the groundwater has been contaminated by coal ash. TDEC should presume that the statistical exceedances for other coal ash pollutants (arsenic, cobalt, and selenium) are also due to coal ash.

- Finally, the lithium and molybdenum concentrations exceed safe levels by large margins. At well 49, for example, both lithium and molybdenum are more than 10 times higher than their respective health guidelines.

In sum, the Gypsum Disposal Area is currently contaminating groundwater in violation of federal law, making the groundwater hazardous to human health. As with the Dry Fly Ash Stack, TVA must be required to undertake corrective action to restore groundwater quality.

5. Conclusion

Although TVA continues to insist that there is no coal ash-related groundwater contamination at Bull Run, the facts plainly show otherwise. Recent groundwater monitoring reports reveal that at both the Dry Fly Ash Stack and the Gypsum Disposal Area, the groundwater has high concentrations of coal ash pollutants, is hazardous to human health, and is getting worse. Absent meaningful corrective action, including excavation and removal of coal ash, the situation will not improve, and may deteriorate further. We strongly urge TDEC to require TVA to properly close the Gypsum Disposal Area and to remediate both the GDA and the Dry Fly Ash Stack as soon as possible.

Sincerely,

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ATTACHMENT A:

Environmental Integrity Project, TVA's Toxic Legacy: Groundwater Contaminated by Tennessee Valley Authority Coal Ash (Nov. 2013)

TVA's Toxic Legacy:

Groundwater Contaminated by Tennessee Valley Authority Coal Ash

November 2013

About the Environmental Integrity Project
The Environmental Integrity Project (EIP) is a nonpartisan, nonprofit organization dedicated to the enforcement of the nation's anti-pollution laws and to the prevention of political interference with those laws. EIP provides objective analysis of how the failure to enforce or implement environmental laws increases pollution and harms public health, and helps local communities obtain the protection of environmental laws.

Data Limitations
EIP based its analysis of groundwater quality on publicly available data retrieved from the Tennessee Valley Authority through Freedom of Information Act Requests. The amount of information available, and the date of the most recent information available, varies by site. The range of dates for which we had information on file is described in each site-specific section of the report. EIP is committed to ensuring that the data we present are as accurate as possible. We will correct any errors that are verifiable.

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Executive Summary

The billion-gallon spill at the Tennessee Valley Authority's (TVA's) Kingston plant in 2008 reminded us that unregulated and poorly maintained coal ash ponds are an invitation to disaster. Although less visible, contamination below the surface of TVA's power plants may be the more serious, long-lasting legacy from decades of mismanagement. Based on a review of documents obtained through Freedom of Information Act requests, this report shows that TVA's ponds and landfills have contaminated groundwater under and around all eleven of the utility's fleet of coal-fired power plants.

The impacted groundwater is now unsafe for human consumption. The polluted groundwater is also draining into nearby rivers and streams, presenting a long-term environmental threat. The evidence of contamination is substantial, but it understates the damage due to gaps in data collection and because TVA stopped monitoring at some sites after initial results indicated high levels of contamination. No cleanup plans are in place at these sites, as state oversight is minimal and EPA has yet to set federal standards to guide the monitoring and cleanup of groundwater at coal ash sites. TVA needs a comprehensive, system-wide plan to strengthen its groundwater monitoring network and remediate the toxic legacy that coal ash disposal has created.

CONTAMINATION: WIDESPREAD AND PERSISTENT

Table ES-1 highlights the pollutants that exceed health-based guidelines in wells likely to be affected by coal ash, and peak levels measured over the past five years. Some of the spikes are sky-high – peak concentrations of arsenic in one TVA monitoring well were nearly eight times above the Safe Drinking Water Act standard, while manganese concentrations in another were 700 times above the health advisory for lifetime exposure. Table ES-1 also shows that the contamination is widespread. Arsenic has exceeded the federal drinking water standard in 17 downgradient wells. Boron, cobalt and sulfate have each exceeded health-based guidelines in 30 or more downgradient TVA wells, while manganese has exceeded its guideline in 56 wells.

The contamination is also persistent. Table ES-2 summarizes a subset of wells where *average* concentrations of several coal ash pollutants exceeded federal health-based over the past five years. Table ES-2 highlights the following pollutants:

> **Arsenic** has been linked to cancers of the skin, bladder, kidneys and other organs. Average concentrations exceeded the Safe Drinking Water Act Maximum Contaminant Level (MCL) of 10 micrograms per liter at five TVA plants: Allen, Bull Run, Colbert,

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Cumberland Paradise, and John Sevier. Three wells at the **Colbert** plant in Alabama had average arsenic concentrations of 48-69 ug/L, roughly five times the federal MCL. Wells at the **Allen** and **Bull Run** plants in Tennessee were roughly three times the MCL.

Boron may harm developing fetuses or contribute to testicular atrophy in male children, which is why EPA's Health Advisory recommends a daily limit of no more than 3.0 milligrams per liter of drinking water for young children. Average boron concentrations have exceeded EPA's recommended limit in thirty-two monitoring wells at nine TVA plants. Average concentrations exceeded 10 mg/L, more than three times the health advisory, in one or more wells at the **Bull Run**, **Cumberland**, and **John Sevier** plants in Tennessee, the **Paradise** and **Shawnee** plants in Kentucky, and the **Widows Creek** plant in Alabama.

Cobalt is associated with blood disease (polycythemia), heart disease, neurological symptoms, and reproductive toxicity. The health-based screening level for cobalt, 4.7 micrograms per liter, is based on studies showing polycythemia and reduced iodine uptake in humans. Average cobalt concentrations in 25 downgradient wells at 9 TVA plants exceed this level.

Manganese at high doses can cause neurological, developmental, and musculo-skeletal impairments. EPA's Health Advisory recommends limiting lifetime exposure to no more than 0.3 milligrams per liter of drinking water. Fifty wells at ten of TVA's eleven plants have average concentrations above this level. Manganese levels averaged more than 100 times the health advisory in one or more wells at the **Kingston** plant in Tennessee, the **Shawnee** and **Paradise** plants in Kentucky, and the **Widows Creek** plant in Alabama.

Molybdenum has been linked to gout (painful inflammation of the joints). EPA Health Advisories are design to limit lifetime exposure to 40 micrograms per liter, but six TVA sites report average molybdenum concentrations at least twice that level. One well at the **Shawnee** site in Kentucky averaged 556 micrograms, or nearly 14 times the limit, while a single sample taken from a well at Tennessee's **John Sevier** plant showed molybdenum at 2,200 micrograms (no further samples were taken after that).

Sulfate concentrations above 500 mg/L in drinking water can cause diarrhea, and the EPA established a drinking water advisory at this level to protect infants, who are more sensitive to water loss caused by diarrhea. Average sulfate concentrations exceed this level in 27 downgradient wells at 8 TVA plants.

Much of the contamination is slowly moving toward local rivers. Although this reduces the immediate threat to local residents who drink groundwater, it is a small comfort; in these cases

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the aquifers are rendered indefinitely unavailable for future residential use while local aquatic environments are forced to absorb an additional burden of bioaccumulative and toxic metals.

DON'T ASK, DON'T TELL: MONITORING GAPS, MONITORING STOPPED

While TVA has an extensive network of monitoring wells at some of its plants, it does not regularly collect data for some of the most important pollutants, including those most indicative of coal ash pollution. For reasons unclear, TVA also chose to stop monitoring many contaminated wells, including ones measured under a voluntary program promoted by the industry trade association after the Kingston spill. Table ES-3 summarizes instances in which TVA has reported evidence of contamination and either stopped measuring coal ash indicators or stopped monitoring wells altogether. For example:

- TVA has stopped monitoring many contaminated wells. Wells P2 and P3 at the **Allen** plant in Tennessee showed unsafe levels of arsenic and manganese in 2008, but have not been monitored since then. Another example is well 21 at the **Gallatin** plant in Tennessee, which showed consistently unsafe concentrations of cadmium, cobalt, manganese, mercury, and sulfate when TVA stopped sampling it in 2011. TVA collected one round of sampling data from new impoundment wells at the **Paradise** plant in Kentucky in 2011, and despite finding unsafe concentrations of arsenic, boron, cobalt, manganese, and other pollutants, stopped monitoring seven of these wells. Paradise well 10-9, at the site's bottom ash ponds, had boron at five times the Child Health Advisory, cobalt at 80 times the Regional Screening Level, and manganese at 200 times the Lifetime Health Advisory when TVA stopped monitoring this well.

- In the wells that TVA continues to monitor, it routinely fails to measure pollutants known to be associated with coal ash. For example, TVA stopped measuring boron, chloride, manganese, molybdenum, strontium, sulfate, and TDS in the voluntary monitoring wells at most of its plants after one round of sampling in 2011. TVA also frequently omits these pollutants from the wells that are monitored pursuant to state requirements. For example, TVA did not measure these pollutants at the **Bull Run** plant in 2011 or 2012. This is troubling for two reasons: Not only are these pollutants associated with coal ash leachate, they have also been found at high concentrations in downgradient TVA wells. Voluntary wells at **Allen** (TN), **Johnsonville** (TN), **Paradise** (KY), and **Widows Creek** (AL) all had high concentrations of boron and other pollutants when TVA stopped measuring these pollutants.

- TVA is not monitoring all coal ash disposal areas. This is particularly true of abandoned ash areas, including the abandoned ash pond at the **Allen** plant, the east/west dredge

cell at the **Bull Run** plant, and the abandoned "Area A" at the **Johnsonville** plant (all in Tennessee).

TVA WARNED OF RISKS AT SOME SITES

Many of TVA's ash disposal units are built over "karst" bedrock, which is characterized by dissolved fractures and cavities. TVA has long known that building on this kind of terrain creates the risk of sinkholes, which allow leachate mixed with solid waste to drain, unfiltered and unattenuated, into local groundwater and surface water. For example, before building Ash Pond 4 at the Colbert plant in Alabama, TVA knew that "[s]udden collapse of a small portion of the soil layer overlying the cavernous limestone could occur." As predicted, the pond bottom collapsed in 1984 and the pond had to be abandoned; this was one of several sinkholes at the Colbert site over the past 30 years.

Karst has also created problems at Gallatin, where TVA built the active ash pond complex over more than 100 known sinkholes, and at Kingston, where TVA recently built a new gypsum disposal facility over an area with known sinkholes, allowing gypsum slurry to drain into the Clinch River just a few years after the massive dredge cell collapse at the same plant. It was irresponsible for TVA to dispose of ash on karst when it knew of the risk involved, and it is particularly irresponsible to continue the practice after the risk has been repeatedly realized.

STATE ACTION: TOO LITTLE, TOO LATE

TVA has frequently abandoned old ash ponds with little or no oversight from the states. For example, Tennessee still considers the abandoned ash pond at the Allen Fossil Plant to be exempt from solid waste laws because it has a Clean Water Act permit – despite the fact that it has been inactive for over 20 years. As a result, TVA does not monitor the groundwater around the abandoned pond and the public has no way of knowing whether the area poses a threat to local water resources. The abandoned ash pond at the Gallatin plant, as described in this report, is leaching dangerously high concentrations of many pollutants into groundwater immediately connected to the Cumberland River.

RECOMMENDATIONS

TVA is currently in the process of phasing out its ash ponds and replacing them with landfills. This is a step in the right direction. Unfortunately, the process is not scheduled to be complete until 2021, and there is no guarantee that it will be completed on schedule, if at all. More importantly, the contamination caused by existing ponds and landfills has proven to be chronic

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and persistent; without clean closure of these disposal areas, the threat to local aquifers and ecosystems will continue long into the future. Finally, the data show that so-called "dry landfills" have also leaked into groundwater, which means that tighter standards are needed for any new landfills.

In order to minimize ongoing degradation of groundwater aquifers, and to facilitate remediation, TVA should implement a fleet-wide groundwater protection plan. As part of that plan, TVA should:

1) Resume monitoring contaminated wells, including wells P2 and P3 at the Allen plant, wells around the Colbert coal yard drainage basin, well 93-2 at Cumberland, well 21 at Gallatin, wells around Area 1 at Johnsonville, and all ash pond wells at Paradise and Widows Creek. TVA should also continue to monitor wells B6 and B8 at Johnsonville.
2) Monitor the right contaminants. Coal ash indicators including boron, chloride, manganese, sulfate, and TDS should be measured routinely and in every well.
3) Contain the problem. TVA should complete a full characterization of the ongoing impacts from coal ash disposal, including discharges to sensitive aquatic ecosystems, and immediately limit the contamination plumes.
4) Develop a fleet-wide cleanup plan with opportunities for public review and comment. Every contaminated aquifer beneath TVA ash ponds and landfills should be returned to background condition in a reasonable amount of time.

There are also steps that TVA can take outside of a groundwater protection plan. As it begins the process of moving beyond wet ash disposal, TVA must close its ash ponds in a way that protects groundwater and surface water, and must make the closure process transparent and enforceable through proper solid waste permitting. And for many reason, coal ash contamination among them, TVA should accelerate its planned transition away from coal and toward cleaner forms of energy.

Last but not least, in order to ensure that TVA and other utilities bring their coal ash disposal practices into the modern age, EPA must finalize its coal ash disposal regulations, and in those regulations must require rigorous closure and post-closure requirements, clean-up requirements, and groundwater protections.

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Table ES-1. Summary of pollutants and wells with maximum concentrations above health-based guidelines between 2008 and 2013.[1]

Pollutant	Health-based guideline[2]	Number of down-gradient TVA wells exceeding guideline	Maximum concentration
Aluminum	16 mg/L	4	125 mg/L
Antimony	6 ug/L	5	59 ug/L
Arsenic	10 ug/L	17	135 ug/L
Beryllium	4 ug/L	2	25 ug/L
Boron	3 mg/L	35	38 mg/L
Cadmium	5 ug/L	4	8 ug/L
Cobalt	4.7 ug/L	35	370 ug/L
Lead	15 ug/L	2	160 ug/L
Lithium	31 ug/L	4	200 ug/L
Manganese	0.3 mg/L	56	220 mg/L
Mercury	2 ug/L	1	3 ug/L
Molybdenum	40 ug/L	19	2,200 ug/L
Nickel	100 ug/L	6	250 ug/L
Selenium	50 ug/L	2	412 ug/L
Strontium	9.3 mg/L	1	10 mg/L
Sulfate	500 mg/L	31	6,300 mg/L
Vanadium	63 ug/L	2	200 ug/L

[1] For the purposes of this table, wells were not counted if boron was consistently below 1 mg/L and sulfate was consistently below 150 mg/L, and pollutants were not counted as exceedances if the mean concentration for that well was below the mean concentration for the relevant upgradient well (see section 13 for more detail). A full presentation of this analysis is shown in Table 13-3 of this report.

[2] See Table 1-1 in the Introduction for a detailed explanation of these values.

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Table ES-2. Summary of groundwater wells in which 2008-2013 average concentrations of selected pollutants exceeded health-based guidelines.[3] Table shows mean or range of means for each well or set of wells.

Pollutant		**Arsenic** (ug/L)	**Boron** (mg/L)	**Cobalt** (ug/L)	**Manga-nese** (ug/L)	**Molybd-enum** (ug/L)	**Sulfate** (mg/L)
Health-based guideline		10	3	4.7	0.3	40	500
Allen	# wells	1					
	Mean(s)	28.4					
Bull Run	# wells	1	2	2	2	2	4
	Mean(s)	27.5	3.6 - 15.3	10.3 - 49.1	6.7 - 9.7	76 - 605	745 - 1786
Colbert	# wells	3	3	1	4	7	
	Mean(s)	47.8 - 68.8	3.3 - 4.4	10.0	0.4 - 1.2	45 - 160	
Cumberland	# wells	1	4	4	6	1	2
	Mean(s)	11.6	5.6 - 34.9	5.1 - 140	1.2 - 16.5	469	776 - 1313
Gallatin	# wells		4	4	5		5
	Mean(s)		3.5 - 5.7	14.7 - 197	0.4 - 20.2		893 - 4088
John Sevier	# wells		2		3	1	3
	Mean(s)		5.0 - 13.3		2.6 - 4.1	2200	835 - 1337
Johnsonville	# wells		5	4	6		3
	Mean(s)		3.5 - 9.9	16.0 - 52.3	1.1 - 20.0		780 - 1028
Kingston	# wells			2	5		1
	Mean(s)			7.2 - 95.9	1.0 - 176		2967
Paradise	# wells	1	4	5	6		4
	Mean(s)	18.0	3.2 - 24	5.9 - 370	1.4 - 61.0		590 - 1900
Shawnee	# wells		7	2	8	1	2
	Mean(s)		5.0 - 19.8	11.1 - 35.2	0.9 - 66.4	559	1061 - 1230
Widows Creek	# wells		1	1	5		3
	Mean(s)		13.0	20.4	1.2 - 32.0		550 - 1100

[3] This analysis was limited to the pollutants shown (other pollutants, not shown, also exceeded health-based guidelines), was limited to wells in which half or more of available sample results exceeded health-based guidelines, and was limited to wells likely to be affected by coal ash (see 'restricted analysis' description in the text of the report). A full presentation of this analysis is shown in Table 13-4 of this report.

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Table ES-3 (page 1 of 2): Wells and pollutants dropped from monitoring network despite evidence of contamination.

Site	Wells	Groundwater quality issues	Monitoring gaps
Allen	P2 and P3	Unsafe levels of arsenic and manganese in 2004-2008.	Not monitored since 2008
Bull Run	Wells 10-51 and 10-52	Arsenic 22-31 ug/L in well 10-52 during 2011-2013; manganese exceeded LHA in both wells in 2011	Coal ash indicators not measured since first round of sampling in 2011
	Well S	Insufficient data	This well was installed in 2011, but coal ash indicators were never measured
Colbert	Wells around coal yard drainage basin	Very high aluminum, cadmium, manganese (up to 99 mg/L) and sulfate in the 1980s-1990s (see Colbert chapter)	Abandoned in 1999
Cumberland	Well 93-2	High arsenic, boron (up to 38 mg/L), cobalt, manganese (3-5 mg/L), molybdenum, and sulfate during 2009-2011.	TVA "replaced" this well with a new well, 93-2R, screened in a different geologic layer (see Cumberland chapter)
	Wells 10-1 and 10-2	High cobalt (up to 150 ug/L) and manganese (up to 17 mg/L).	Coal ash indicators not measured since 2011.
Gallatin	Well 21	Very high cobalt (up to 330 ug/L) and manganese (up to 18 mg/L); unsafe levels of cadmium, mercury, nickel, strontium and sulfate	Not monitored since 2011. This well may be affected by sources of pollution other than coal ash (see Gallatin chapter)
	Wells 19R, 20, and 26	Very high cobalt downgradient of abandoned ash pond	TDEC suspended cobalt monitoring and reporting requirements in 2011
John Sevier	Wells 10-36 and 10-37	Unsafe levels of manganese; no molybdenum data	Coal ash indicators not measured since first round of sampling in 2011

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Table ES-3 (page 2 of 2): Wells and pollutants dropped from monitoring network despite evidence of contaminations.

Site	Wells	Groundwater quality issues	Monitoring gaps
Johnsonville	Six wells around Area 1	Very high concentrations of many pollutants in the 1990s (see Johnsonville chapter)	Not monitored since 1994
	Areas 2 & 3 (ash island)	High boron (up to 6.3 mg/L) and manganese (up to 20 mg/L) in 2011, unsafe levels of other pollutants	Coal ash indicators not measured since first round of sampling in 2011
	Wells B6 and B8	Very high boron (up to 12 mg/L), cobalt, manganese, and sulfate (see Johnsonville chapter)	TDEC and TVA agreed to stop monitoring these wells[4]
Paradise	Wells 10-1 and 10-2 (scrubber sludge pond)	Very high boron (11-24 mg/L); unsafe levels of cobalt, manganese, and sulfate	Coal ash indicators not measured since first round of sampling in 2011
	Wells 10-3 through 10-9 (ash ponds)	Very high cobalt (370 ug/L) and manganese (61 mg/L) in well 10-9, high arsenic, boron, cobalt and other pollutants in other wells	All seven wells were sampled once, in June 2011, but not since then
Widows Creek	Wells 10-48 through 10-52	Unsafe levels of boron, manganese, and sulfate	Coal ash indicators not measured since first sample date in 2011; wells 10-48 through 10-52 not sampled at all since 2011

[4] TVA and TDEC agreed to abandon contaminated wells B6 and B8 in 2012 on the grounds that these wells may be showing the effect of the natural shale bedrock. Since then, a new upgradient shale-screened well has been installed and shows much lower naturally occurring concentrations. It is not clear whether TVA and TDEC are still planning to abandon these wells (see Johnsonville chapter).

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1 Introduction

The Tennessee Valley Authority (TVA) operates eleven coal plants in Alabama, Kentucky, and Tennessee. These plants create a range of environmental impacts, including greenhouse gas emissions, local air pollution, water pollution, and in some cases physical destruction of homes, infrastructure, and ecosystems, as happened with the collapse of the coal ash dredge cell at TVA's Kingston plant. The Environmental Integrity Project and other groups have written about TVA's general environmental impacts several times.[5] This report will focus more narrowly on recent groundwater monitoring data from the TVA coal plants. The data discussed in this report clearly show that the groundwater around TVA's ash disposal areas is unsafe to drink. This does not always mean that there are legal violations, however. In many cases existing state regulations do not address the most prevalent pollutants, like boron and manganese. Where pollutants do exceed regulatory thresholds, state regulations typically provide for extended monitoring, allowing the contamination to continue unabated. In many cases, TVA and the states simply fail to measure the pollutants that they should expect to be present, avoiding the problem altogether. This report will therefore emphasize gaps in the monitoring networks and groundwater quality database, and identify ways in which known groundwater contamination has failed to trigger regulatory responses.

1.1 Background

Some of the source material, technical concepts, and terminology used in this report are described here for ease of reading:

- **Units of measurement**. The concentration of a chemical in water is usually described as the mass of that chemical per volume of water; units are typically either milligrams per liter (mg/L) or micrograms per liter (µg/L). One mg/L is equal to 1,000 ug/L. Chemicals that exist at relatively high concentrations, like chlorides, are easier to report in units of mg/L. Chemicals found at lower concentrations, like arsenic, are easier to report using units of ug/L. Alternatively, some people report concentrations as the mass of a chemical per mass of water, usually in units of "parts per million" (ppm) or "parts per billion" (ppb). Since a liter of fresh water weighs 1 kg, one ppm is equal to one mg/L, and one ppb is equal to one ug/L.
- **Aquifers and wells**. Aquifers are permeable layers of soil or bedrock that contain groundwater. In many cases the TVA plants have two or more discreet aquifers beneath

[5] *See, e.g.*, EIP, OUTSIDE THE LAW: RESTORING ACCOUNTABILITY TO THE TENNESSEE VALLEY AUTHORITY (Dec. 2009); EIP and Earthjustice, OUT OF CONTROL: MOUNTING DAMAGES FROM COAL ASH WASTE SITES (Feb. 24, 2010); EIP, Earthjustice, and the Sierra Club, IN HARM'S WAY: LACK OF FEDERAL COAL ASH REGULATIONS ENDANGERS AMERICANS AND THEIR ENVIRONMENT (Aug. 26, 2010); EIP, RISKY BUSINESS: COAL ASH THREATENS AMERICA'S GROUNDWATER RESOURCES AT 19 MORE SITES (Dec. 12, 2011).

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them, either in artificial fill, in alluvial deposits, or in the bedrock. Wells are often drilled through one or more aquifers, but the open part of the well, or the "screen," can be restricted to a specific depth. A well "screened" in a given aquifer is expected to be drawing water from that aquifer.

- **Background or upgradient wells**. Most groundwater analyses compare wells that may be contaminated to wells from the same aquifer that are expected to be unaffected by coal ash. These wells are often described as "background" wells. In some cases, wells are selected based on the assumed direction of groundwater flow: Wells may be downgradient (picture downstream or downhill) of an ash disposal area, and impacted or threatened by contamination, or they may be upgradient, and theoretically drawing from groundwater that has not yet encountered the disposal area. However, some wells described as upgradient based on location can be affected by coal ash contamination because of the mounding of the water table beneath the disposal areas. These wells should not be considered background wells.
- **Groundwater mounding**. When water from permeable ash disposal areas percolates into the underlying soil, it can affect groundwater flow by creating a "mound," or local elevation, in the water table.[6] In these situations, the groundwater will often exhibit radial flow, meaning that the groundwater moves away from the disposal areas in all directions. We know that mounding is occurring at some areas (Ash Pond 4 at Colbert, for example), and it may be occurring at others areas. Where a groundwater mound exists, a well that appears to be located upgradient, especially if it is immediately adjacent to a disposal area, may in fact be contaminated by the coal ash disposal area.
- **Karst geology**. Many of the TVA plants are located over soluble limestone bedrock. When this kind of bedrock becomes weathered by water, leaving dissolved spaces throughout the solid matrix, it is known as "karst." The U.S. Geological Survey describes karst as "extremely vulnerable to contamination" due to "springs, caves, [and] sinkholes."[7] The consequences of sinkhole formation can be serious. For example, as described in this report, a 2010 sinkhole in the gypsum disposal area at the Kingston Fossil Plant allowed gypsum waste with high concentrations of selenium (measured at up to 412 ug/L in groundwater wells) to drain into the already-fragile Clinch River.[8] This was one of eleven known "dropouts" in the Kingston gypsum disposal area.[9]

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[6] *See, e.g.*, TVA, *Gallatin Fossil Plant Ash Impoundment Groundwater Monitoring Report* (Jan. 2013) ("The true flows from the facility would be expected to radiate out laterally from each side of the ash pond, since impounded waters would likely mound up over ambient water levels.").
[7] U.S. Geological Survey, What is Karst?, http://water.usgs.gov/ogw/karst/pages/whatiskarst.
[8] *See, e.g.*, TVA, *Kingston Fossil Plant – Gyspum Disposal Area – Groundwater Quality Assessment Plan* (May 6, 2011).
[9] *Id.*

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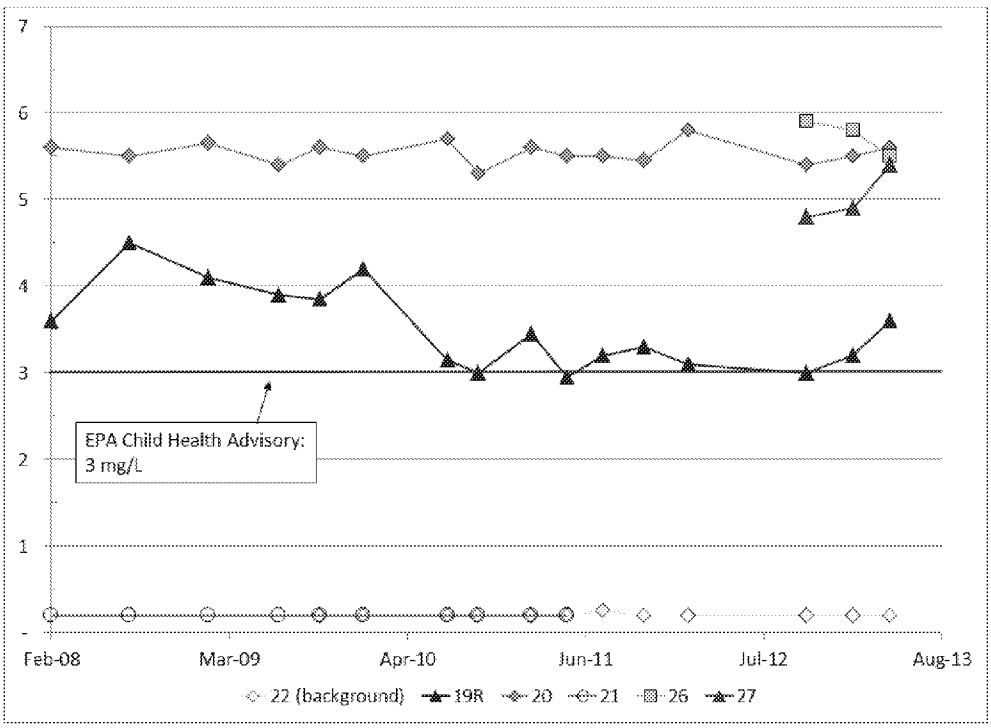
- **Coal ash indicators**. The U.S. EPA's proposed regulation for disposal of coal ash sets out pollutants that might serve as early indicators of coal ash pollution during detection monitoring. These include boron, chloride, sulfate, and Total Dissolved Solids (TDS).[10] The proposed EPA rule also includes a larger list of pollutants to be monitored in "assessment monitoring" once the early indicators show a problem. The assessment monitoring list includes most of the metals discussed in this report (e.g., arsenic, manganese, and selenium).[11] Like EPA, TVA has also recognized that aluminum, arsenic, boron, manganese, strontium, sulfate, and TDS are useful coal ash indicators.[12] These pollutants, and in particular boron, manganese, and sulfate, are regularly elevated relative to upgradient or background wells at TVA plants, and frequently much higher than health-based advisories. Figures 1-1 – 1-3 below depict a typical set of data, in this case for the abandoned ash pond at the Gallatin plant.

Figure 1-1: Boron concentrations (mg/L) in wells around the abandoned ash pond at the Gallatin Fossil Plant. Hollow data points are nondetects.



[10] *See* U.S. EPA co-proposed Subtitle D coal ash regulations, 75 Fed. Reg. 35128, 35253 (June 21, 2010).
[11] *Id*. The full list includes aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chloride, chromium, copper, fluoride, iron, lead, manganese, mercury, molybdenum, pH, selenium, sulfate, thallium, and TDS.
[12] *See, e.g.*, TVA, *Colbert Fossil Plant Groundwater Assessment*, 51 (Oct. 1994) (stating that "pH, sulfate, and TDS are considered to be indicators of coal ash leachate in groundwater" and that aluminum, manganese and iron can be associated with ash leachate); id. at 52 (stating that boron, molybdenum, and strontium are often considered to be indicators of ash leachate); TVA, *Groundwater Monitoring Report – Allen Fossil Plant*, at 2 (Aug. 22, 2008) (identifying arsenic, boron, and sulfate as "ash leachate indicators").

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Figure 1-2: Manganese concentrations (mg/L) in wells around the abandoned ash pond at the Gallatin Fossil Plant. Hollow data points are nondetects.

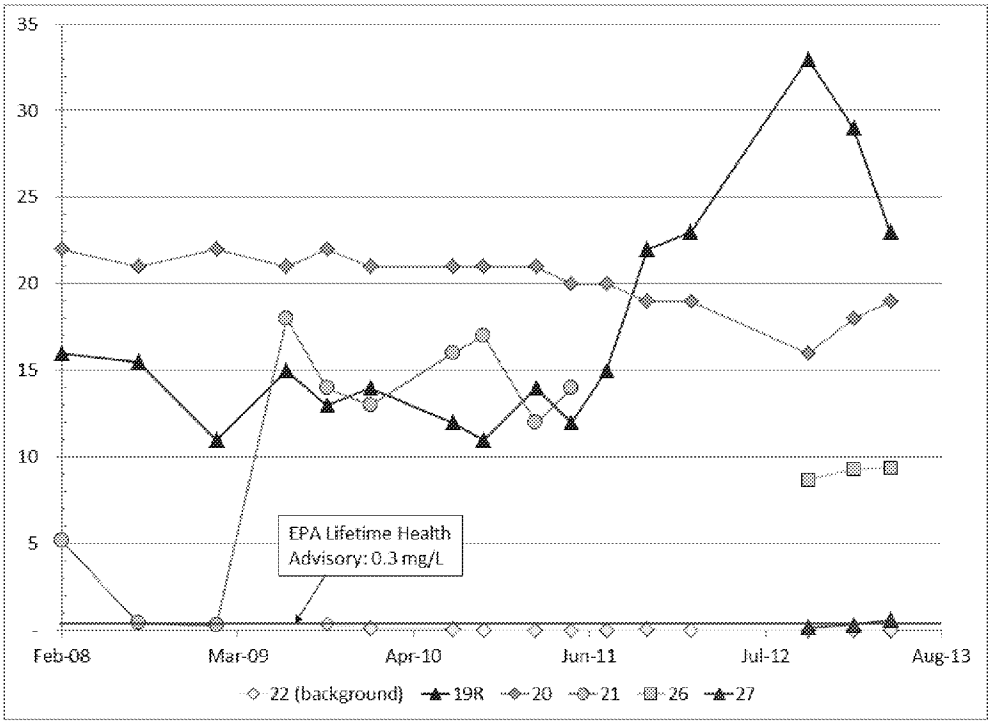
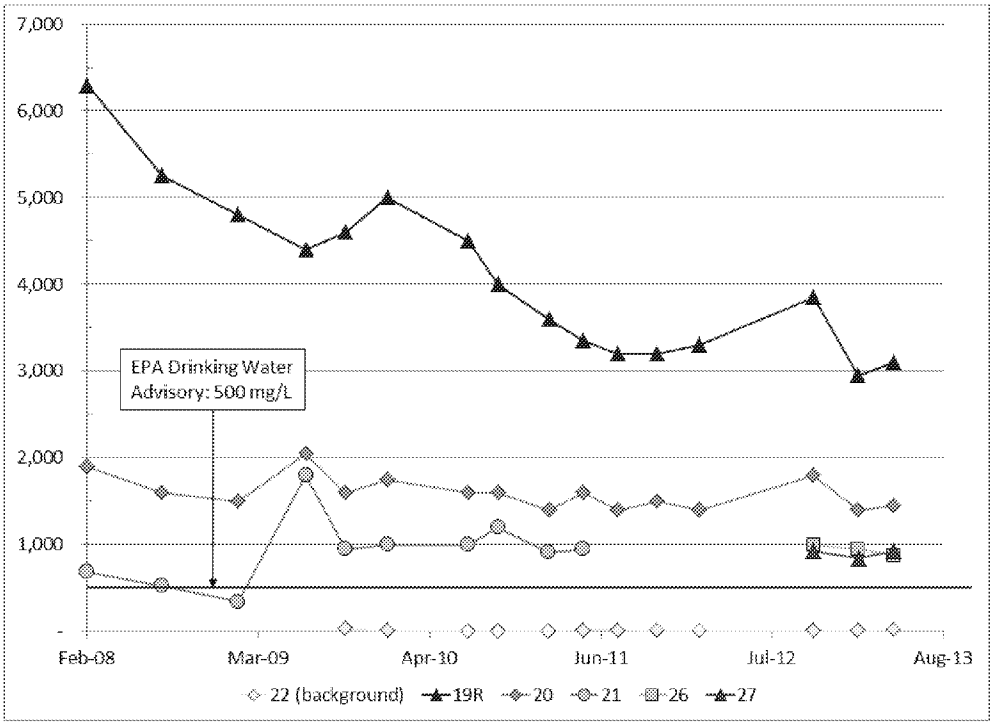


Figure 1-3: Sulfate concentrations (mg/L) in wells around the abandoned ash pond at the Gallatin Fossil Plant. Hollow data points are nondetects.



- **Groundwater standards**. State and federal agencies use a variety of standards to evaluate groundwater quality data. Some are health-based, while others are based on statistical assessments of historical data from a site:
    - Maximum Contaminant Levels (MCLs) are federal, legally enforceable limits on pollutants in public water supplies.[13] These are the criteria most commonly used by state agencies to evaluate groundwater quality. There are at least two problems with using MCLs. First, the U.S. EPA has not derived MCLs for several of the pollutants associated with coal ash, including boron, cobalt, and manganese. Second, MCLs are not purely health-based. Instead they are set as close to health-based goals as feasible after considering treatment technology and cost.[14] The MCL for arsenic, for example (10 ug/L), was set at a level deemed to be feasible for water treatment facilities.[15] A purely health-based value would be much lower.[16]
    - Secondary MCLs (SMCLs). The U.S. EPA has derived SMCLs for a short list of pollutants, including sulfate and manganese, based on aesthetic endpoints like odor, taste, or color. These pollutants may also have other, health-based standards.
    - Health Advisories (DWAs, LHAs, and CHAs). The U.S. EPA also publishes unenforceable recommendations for drinking water quality in the form of Health Advisories.[17] These are set at levels that are not expected to cause adverse non-cancer health effects generally (Drinking Water Advisories), in adults exposed over a lifetime (Lifetime Health Advisories), or in children exposed for 1-10 days (Child Health Advisories).
    - Regional Screening Levels (RSLs). Regional Screening Levels are purely health-based guidelines jointly published by three EPA regions to assist in the investigation of potential superfund sites.[18] These numbers are updated more often than MCLs and Health Advisories. RSLs cover a range of exposure routes; this report uses the RSLs for tapwater.

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[13] *See* U.S. EPA, National Primary Drinking Water Regulations, http://www.epa.gov/safewater/consumer/pdf/mcl.pdf.
[14] *Id.*
[15] U.S. EPA, National Primary Drinking Water Regulations; Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring, 66 FR 6976.
[16] Since arsenic is a carcinogen, the Maximum Contaminant Level Goal is zero. The Regional Screening Level for arsenic, which assumes some level of acceptable risk, is 0.045 ug/L.
[17] *See* U.S. EPA, 2012 Edition of the Drinking Water Standards and Health Advisories (Apr. 2012), http://water.epa.gov/action/advisories/drinking/upload/dwstandards2012.pdf.
[18] *See* U.S. EPA, Regional Screening Tables User's Guide (May 2013), http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm.

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- Upper Prediction Limits (UPLs). States sometimes establish site-specific groundwater standards based on a statistical analysis of local groundwater data. In this way states can establish a 'normal' range of groundwater chemistry, making it possible to identify any changes over time, regardless of the health implications. If a state is interested in analyzing how groundwater quality in each well changes over time, it will use historical data from each well to set the UPL, often at the 95th percentile of the data from a 2-year period. These are known as **intrawell UPLs**. If a state is instead interested in whether groundwater in some wells differs from normal groundwater quality for a site, it will derive the UPL from data for a reference, unaffected well; these are known as **interwell UPLs**.

1.2 Methods

Sources of information. We chose to focus on recent groundwater data in order to characterize ongoing groundwater quality issues. The exact range of dates varies by site due to differences in data availability, but this report generally focuses on the past four years (2009-present). The data in the report were drawn from several sources.

- The largest source of data is the reports that TVA submits to the three state agencies overseeing TVA's coal plants: The Alabama Department of Environmental Management (ADEM), the Kentucky Department for Environmental Protection (KDEP), and the Tennessee Department of Environmental Conservation (TDEC). EIP requested these reports, and the laboratory data that they were based on, from TVA through Freedom of Information Act (FOIA) requests. We assume that TVA is not generating more data than it provided.
- A second source of data is TVA's voluntary monitoring around its ash impoundments. TVA began collecting these data in 2011 as part of a voluntary agreement through an industry association known as the Utility Solid Waste Activities Group (USWAG); [19] these data are described in our report as "USWAG data." TVA uses some wells for both state-required reporting and USWAG voluntary monitoring, but in most cases the USWAG wells were installed exclusively for the voluntary program. The USWAG wells are generally sampled for a smaller subset of pollutants than the state-required wells. EIP obtained these data from TVA through FOIA requests.
- EIP also consulted a series of detailed geotechnical investigations conducted for TVA by Stantec Consulting Services in 2009 and 2010; these reports included helpful surveys of

[19] TVA Office of the Inspector General, *Inspection Report: TVA's Groundwater Monitoring at Coal Combustion Products Disposal Areas*, 12-13 (June 21, 2011).

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historical ash management practices at each site and identified some ongoing issues with seepage and structural stability.

- Finally, although this report is focused on current groundwater quality issues, we referred to historical documents for each site to help us identify legacy contamination that is no longer being monitored.

Pollutants discussed in this report. TVA measures different sets of pollutants at every coal plant. We chose to present these data in a uniform way using an inclusive list of pollutants. The list (and format) shown in Table 1 is used throughout the report. This is not, however, an exhaustive list. For example, some wells have been monitored for parameters like chemical oxygen demand, iron, magnesium, and pH. The pollutants discussed in this report include those that were most often measured at most of the TVA plants. As described above, several of these, including boron, manganese, and sulfate, serve as useful indicators of coal ash contamination. Our list also includes lithium; although this is only actively measured at Colbert, TVA has identified it as another possible coal ash leachate indicator.[20]

Each of these pollutants is associated with multiple health and environmental impacts. The human health effects have been most thoroughly researched, and are summarized in Table 1-1. More detailed information on each pollutant can be found in the Environmental Protection Agency's Integrated Risk Information System (IRIS),[21] support documents for Provisional Peer-Reviewed Toxicity Values,[22] and other support documents,[23] and in Toxicological Profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR).[24]

Comparison values used in this report. Choosing a set of benchmark values for evaluating groundwater data is a difficult process. Each candidate set of criteria answers a different question. MCLs generally indicate whether groundwater is safe to drink. More precisely, MCLs indicate whether groundwater meets standards set for municipal drinking water, and only for certain chemicals. Drinking water advisories and RSLs also indicate whether groundwater is safe to drink, and they cover most of the chemicals associated with coal ash, but they are not widely used as groundwater protection standards. Interwell UPLs indicate whether groundwater in a downgradient well is significantly different from background groundwater for a site. Intrawell UPLs indicate whether groundwater quality in a well has changed over time. The state agencies overseeing TVA operations have used a combination of the above, and not in a very coherent or helpful way (see discussion section of this report).

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[20] *See* TVA, *An Evaluation of the Impacts of the Gallatin Fly Ash Pond to Groundwater Resources*, 13 (Aug. 1989) (naming lithium and boron as good coal ash leachate indicators).
[21] http://www.epa.gov/IRIS/.
[22] http://hhpprtv.ornl.gov/quickview/pprtv_papers.php.
[23] http://water.epa.gov/drink/standards/hascience.cfm.
[24] http://www.atsdr.cdc.gov/toxprofiles/index.asp.

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Although the question of whether downgradient groundwater quality is different from background is significant, we chose not to emphasize site-specific statistical analyses for three reasons: First, we wanted a uniform set of criteria against which to compare all eleven TVA plants; second, TVA only compiles statistics for some pollutants at some plants, rarely including key coal ash indicators; finally, not every designated background or upgradient well is necessarily representative of background conditions, especially in locations where groundwater mounding has caused radial flow away from ash disposal areas.

This report therefore uses health-based criteria as benchmarks. We began by identifying MCLs, the most widely-used, peer-reviewed values available. For pollutants without MCLs, we next turned to EPA's health-based advisories. These were available for boron, manganese, molybdenum, nickel, silver, sulfate, and zinc. For pollutants without MCLs or drinking water advisories, including aluminum, cobalt, lithium, strontium, and vanadium, we used RSLs. Finally, for the remaining pollutants (chloride and TDS) we used Secondary MCLs. The full set of health-based criteria used in this report is shown in Table 1-1.

There a few caveats regarding this list:

- First, the list is not purely health-based. As described above, some of the MCLs are set at levels that may be unsafe to drink. Moreover, the cumulative effect of multiple pollutants, including carcinogens and neurotoxins, is not captured by chemical-by-chemical analyses. So it would be incorrect to say that groundwater below all of the criteria is 'safe.' On the other hand, it is clear that groundwater exceeding any of the criteria, other than those for chloride and TDS, is <u>un</u>safe.
- Second, water below the criteria may still be unusable, as judged against U.S. EPA Secondary MCLs. The SMCLs for aluminum, copper, fluoride, manganese, and sulfate, based on aesthetic effects like taste, odor, and color, are all lower than the health-based criteria used in our report. Some of the groundwater near the TVA sites may therefore taste or smell bad, or stain sinks and clothing, without being flagged in this report as exceeding any criteria.
- Finally, despite the fact that much of the contaminated groundwater under TVA's coal plants ends up in local rivers and streams, there are no readily useful criteria against which to evaluate this risk.[25] This may be the single largest unaddressed issue in the knowledge base regarding TVA's groundwater impacts.

[25] Although there are ecological criteria for surface water, including U.S. Department of Energy Preliminary Remediation Goals for Ecological Endpoints (Aug. 1997), the fate and transport of pollutants through groundwater to surface water must be modeled before these criteria can be applied. TVA has not, to our knowledge, done this.

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1.3 Structure of the report

The remainder of the report includes eleven sections describing each of the eleven coal plants. Each section includes a brief description of the plant and its ash disposal history, a description of the groundwater monitoring network, a discussion of monitoring results from recent years, and a summary of data gaps and, where applicable, instances where available data indicate that the states have failed to address a known problem. Each section also includes a map of the disposal areas and wells. We did not find comprehensive maps for any of the eleven sites, so we generated our own maps using multiple sources of information. The locations of disposal areas and wells are roughly accurate, but not precise.

Finally, each section includes a summary of the groundwater data in tabular form following the format shown in Table 1-1 below. Data reported as "<x" are consistently below detection at the given detection limit. Where multiple detection limits have been reported, the highest detection limit is shown. Ranges reflect minimum and maximum concentrations over given periods of time. A highlighted row indicates that a pollutant exceeded its criterion one or more of the sampling dates. Chloride and TDS, with criteria that are not health-based, are not highlighted when they exceed their respective criteria. Data are presented as a range of values for each pollutant, and rows are highlighted where pollutants exceeds their respective health-based criteria.[26]

The report concludes with a discussion of the overall state of groundwater, and groundwater monitoring, at the eleven TVA sites.

[26] Since the chloride and TDS criteria are not health-based, these rows are never highlighted.

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Table 1-1: Pollutants and health-based[27] criteria used in this report

Chemical	Principal Health Effects[28]	Criterion value	Criterion type
Aluminum	Neurotoxicity	16,000 ug/L	Regional Screening Level
Antimony	Reduced lifespan	6 ug/L	MCL
Arsenic	Cancer	10 ug/L	MCL
Barium	Kidney toxicity	2,000 ug/L	MCL
Beryllium	Intestinal toxicity	4 ug/L	MCL
Boron	Developmental and testicular toxicity	3,000 ug/L	Child Health Advisory
Cadmium	Kidney disease	5 ug/L	MCL
Chloride		250 mg/L	Secondary MCL
Chromium	Blood disease / cancer[29]	100 ug/L	MCL
Cobalt	Blood disease	4.7 ug/L	Regional Screening Level
Copper	Gastrointestinal symptoms	1,300 ug/L	Action Level[30]
Fluoride	Adverse changes in bones and teeth	4,000 ug/L	MCL
Lead	Neurotoxicity; Probable carcinogen	15 ug/L	Action Level[30]
Lithium	Various and uncertain	31 ug/L	Regional Screening Level
Manganese	Neurotoxicity	300 ug/L	Lifetime Health Advisory
Mercury	Neurotoxicity	2 ug/L	MCL
Molybdenum	Gout-like symptoms	40 ug/L	Lifetime Health Advisory
Nickel	Reduced body weight	100 ug/L	Lifetime Health Advisory
Nitrate	Blue baby syndrome	10,000 ug/L	MCL
Selenium	Hair and nail loss	50 ug/L	MCL
Silver	Skin discoloration	100 ug/L	Lifetime Health Advisory
Strontium	Bone toxicity	9,300 ug/L	Regional Screening Level
Sulfate	Diarrhea	500 mg/L	Drinking Water Advisory
TDS		500 mg/L	Secondary MCL
Thallium	Neurotoxicity and hair loss	2 ug/L	MCL
Vanadium	Various and uncertain	63 ug/L	Regional Screening Level
Zinc	Changes in blood chemistry	2,000 ug/L	Lifetime Health Advisory

[27] The Secondary MCLs for chloride and TDS are not health-based, but are instead based on aesthetic effects. These are both indicators of coal ash pollution, however, and are therefore tabulated with the other pollutants.
[28] The effects listed here are those used to establish chronic oral exposure guidelines and advisories.
[29] *See* California EPA, Public Health Goal for Hexavalent Chromium in Drinking Water (July 2011), http://www.oehha.ca.gov/water/phg/pdf/Cr6PHG072911.pdf.
[30] U.S. EPA "Action Levels" for copper and lead are enforceable primary drinking water regulations similar to, and published with, MCLs. *See* National Primary Drinking Water Regulations, Subpart I – Control of Lead and Copper, 40 CFR § 141.80 *et seq*.

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1.4 Acronyms

ADEM	Alabama Department of Environmental Management
ATSDR	Agency for Toxic Substances and Disease Registry
CHA	Child Health Advisory
DWA	Drinking Water Advisory
EIP	Environmental Integrity Project
EPA	U.S. Environmental Protection Agency
FGD	Flue Gas Desulfurization
FOIA	Freedom of Information Act
GWPS	Groundwater Protection Standard
IRIS	Integrated Risk Information System
KDEP	Kentucky Department for Environmental Protection
LHA	Lifetime Health Advisory
MCL	Maximum Contaminant Level
OIG	TVA Office of the Inspector General
RGA	Regional Groundwater Aquifer; an aquifer beneath the Shawnee Fossil Plant
RSL	Regional Screening Level
SMCL	Secondary Maximum Contaminant Level
TDEC	Tennessee Department of Environment & Conservation
TDS	Total Dissolved Solids
TVA	Tennessee Valley Authority
UCD	Upper Consolidated Deposits; an aquifer beneath the Shawnee Fossil Plant
UPL	Upper Prediction Limit
USWAG	Utility Solid Waste Activities Group

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2 Allen Fossil Plant

Background

The Allen Fossil Plant is located on the south shore of Lake McKellar outside of Memphis, TN. TVA has been operating Allen's three coal units since the 1950s. The original ash pond, located west of the site, was deactivated and pumped dry in 1992.[31] A chemical treatment pond was built inside the northeast corner of the abandoned ash pond.[32] The active ash pond was commissioned in 1967 and expanded in 1978.[33] The plant and the ash ponds rest on a mix of alluvial deposits, both naturally occurring and artificially in-filled.[34]

Monitoring

Figure 2-1 shows the approximate locations of the groundwater wells discussed below. Until 2010, the well network at Allen consisted of wells P1 through P5, which surround the main plant and the active ash pond. These wells were historically monitored every two years on a voluntary basis. The 2010 USWAG voluntary monitoring plan added well P6, located between the center of the active ash pond and Lake McKellar, and otherwise continued to monitor existing wells P1, P4, and P5. TVA apparently stopped monitoring wells P2 and P3 in 2008. The current monitoring program consists of voluntary monitoring of wells P1, P4, P5, and P6.

According to TVA's groundwater monitoring reports there is a strong "communication" between the alluvial aquifer beneath Allen and the adjacent Lake McKellar,[35] and "[t]he predominant flow of groundwater is towards Lake McKellar."[36] However, lake levels sometimes rise above the local groundwater table and reverse the direction of flow. The groundwater levels measured for the February 2008 sample collection, for example, showed groundwater movement away from the lake.[37]

Aside from the notable shortage of groundwater data, discussed further below under "data gaps," the biggest problem at Allen is the arsenic and other coal ash contaminants leaching into Lake McKellar. Unsafe concentrations of arsenic have been detected in three wells along the lake shore. Wells P2 and P3 are located at the northwest and northeast corners of the main

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[31] Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment – Coal Combustion Product Impoundments and Disposal Facilities – Appendix B, Allen Fossil Plant, West Ash Pond* page 1 (June 24, 2009).
[32] *Id.* at 3.
[33] *Id.* at Appendix B, Allen Fossil Plant, East Ash Pond and Dredge Cell, page 1.
[34] *Id.* at Appendix B, Phase 1 Plant Summary, page 2.
[35] TVA, *Groundwater Monitoring Report – Allen Fossil Plant – February 2008* (Aug. 22, 2008) ("Groundwater levels measured at Allen fluctuate with changes in McKellar Lake levels, driven by changes in Mississippi River elevation, which suggest a strong communication between groundwater under the site and nearby surface water.")
[36] *Id.*
[37] *Id.* at 5.

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plant (see Fig. 2-1). The data we have on file, collected in 2004, 2006, and 2008, show concentrations above and below the current MCL of 10 ug/L. TVA has recognized this as an ongoing historical problem and attributed it to the abandoned ash pond:

> Since 1988, groundwater sampling results at all Allen wells have produced detectable and consistent levels of arsenic, with well P2 typically being above the new MCL [10 ug/L]. Two of the last five bi-annual sampling events have shown P3 with arsenic levels at or above the MCL . . . The source of arsenic is potentially due to ash leachate from the inactive West Ash Pond. Elevated levels of ash leachate analytes boron and sulfate detected in adjacent well P2 indicate probable ash impoundment releases and migration. Concentrations of arsenic, boron, and sulfate are historically higher than the background (well P1) data. Significantly higher levels of these ash leachate indicators and total dissolved solids were measured from 1988 to 2000, indicating an active period of contaminant transmission.[38]

Well P6 was installed in 2010 and sampled seven times between February 2011 and February 2013. Arsenic concentrations in this well have been consistently higher than the MCL of 10 ug/L, fluctuating between 15 and 43 ug/L. Boron, TVA recognizes as an indicator of coal ash leachate,[39] has also been present at elevated and unsafe levels in this well.

Data Gaps

1. Infrequent and discontinued sampling. Prior to 2010, wells were only monitored biannually and on a voluntary basis. Wells P2 and P3, which showed elevated and unsafe levels of arsenic, have not been monitored since 2008.

2. Inadequate well network. Groundwater mounding is suspected at both the inactive and the active ash ponds, and as noted above, general groundwater flows at Allen sometimes reverse and flow away from the river. In other words, groundwater flows are dynamic and inconsistent. The existing well network is not capable of characterizing this situation, a fact that TVA acknowledged in its 2008 groundwater report: "The ash ponds and other impoundments likely produce radial groundwater flow away from their impoundments that cannot be adequately characterized with the existing well network."[40]

A more egregious problem is the fact that the abandoned ash pond is effectively unmonitored (see Fig. 2-1), with all wells situated east of the pond and no wells closer

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[38] TVA, *Groundwater Monitoring Report – Allen Fossil Plant – February 2008*, at 2 (Aug. 22, 2008).
[39] *Id.*
[40] *Id.* at 5.

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than 200 meters (the USWAG plan calls for wells within 150 meters of every pond[41]). Although TVA admitted that it needs at least one new well downgradient of the inactive ash pond,[42] it has not yet installed such a well.

Failure to regulate

Groundwater monitoring at Allen is strictly voluntary, which in practice means that TVA has no obligation to report exceedances to TDEC. As the OIG report observed,

> Elevated levels of boron and sulfate indicated probable ash impoundment releases and migration. Concentrations of arsenic, boron, and sulfate in that well have been historically higher than the background data. <u>According to TVA personnel, these levels have not been reported to TDEC because the testing was not required.</u>[43]

TDEC has flatly failed to regulate Allen's abandoned ash pond, even when it knew about the "active period of contaminant transmission" during the 1990s.[44] According to Tennessee law, ash ponds are regulated by the Water Division as long as they are actively treating waste, but must be regulated as landfills when they become inactive.[45] Landfill regulations include significant groundwater monitoring and a process that leads to corrective action when contamination reaches certain levels.[46] Allen's inactive ash pond was pumped dry in 1992, so these regulations should have been applied over twenty years ago. Proper regulation would have provided a full picture of the contamination leaching from the pond, and perhaps corrective action. Instead we have a very small amount of information from one barely relevant well; what we know may only be the tip of the iceberg. Although environmental

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[41] *See, e.g.*, URS, *TVA Gallatin Fossil Plant – Preliminary Ash Pond Closure Plan (Revision 0) – Prepared for TVA*, Appendix B page 4 (Sep. 25, 2012).

[42] *Id.* at 7 ("With coming [USWAG] voluntary surveillance measures, Allen Fossil Plant will likely be subject to required monitoring of groundwater surrounding the two onsite ash impoundments. This will likely necessitate installation of two additional wells, including . . . a new downgradient well for the inactive West Ash Pond.

[43] TVA Office of the Inspector General, *Inspection Report: TVA's Groundwater Monitoring at Coal Combustion Products Disposal Areas*, 7 (June 21, 2011) (emphasis added).

[44] TVA, *Groundwater Monitoring Report – Allen Fossil Plant – February 2008*, at 2 (Aug. 22, 2008).

[45] *See* Tenn. Code. Ann. § 68-211-106; Letter from Paul Sloan, TDEC Deputy Commissioner, to Josh Galperin, Southern Alliance for Clean Energy, and Kimberly Wilson, Environmental Integrity Project, 3 (Sept. 7, 2010) ("As previously indicated, TDEC regulates solid waste disposal units under solid waste rules found at 1200-01-07 and wastewater treatment units under NPDES permitting rules found at 1200-04-05. The Division of Solid Waste is the lead agency for solid waste disposal units containing CCW. <u>That would include impoundments formerly used for wastewater treatment that contain CCW and no longer provide treatment or discharge process wastewater</u>") (emphasis added); Letter from Robert J. Martineau, Jr.,TDEC Commissioner, to Joshua Galperin, Southern Alliance for Clean Energy (Apr. 23, 2012) ("Industrial and municipal wastewater treatment plants, such as TVA ash ponds, are not subject to solid waste permitting process...When the ash pond is converted from a wastewater treatment unit to a solid waste management unit, oversight will be transferred to Solid Waste Management.")

[46] *See* Tenn. Comp. Rules & Regs. 1200-01-07-.04(7).

groups asked TDEC to regulate the abandoned ash pond in 2012,[47] they were told that the current Clean Water Act permit for the plant exempted it from any landfill requirements, a statement that is plainly inconsistent with the law.[48]

[47] *See* Letter from Angela Garrone, Southern Alliance for Clean Energy, *et al.*, to Robert J. Martineau Jr., TDEC Commissioner (Sep. 10, 2012).
[48] *See id*; Letter from Pat Flood, Director of TDEC Division of Solid Waste Management, to Angela Garrone, Southern Alliance for Clean Energy (Dec. 6, 2012).

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Figure 2-1: Groundwater wells at Allen Fossil Plant (approximate locations)

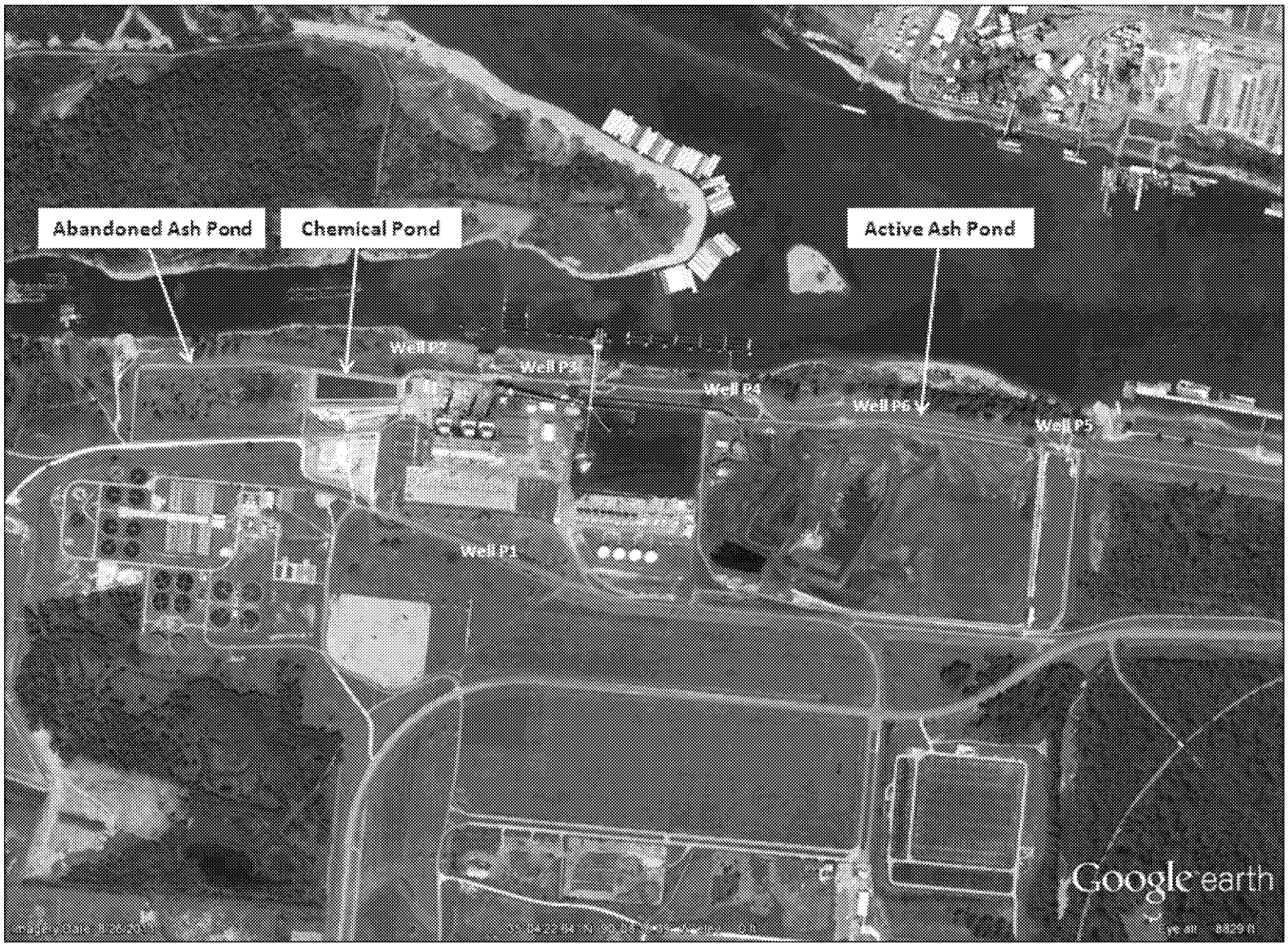

Table 2-1: Allen Fossil Plant, Well P1. Sampled 8 times between March 2004 and February 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<200	Limited data since 2008
Antimony	6	<3	
Arsenic	10	1.0 – 2.1	
Barium	2,000	450 – 600	
Beryllium	4	<2	
Boron	3,000	<200	Limited data since 2008
Cadmium	5	<0.5	
Chloride	250 mg/L	1.4 – 2.3 mg/L	Limited data since 2008
Chromium	100	<0.5 – 2.2	
Cobalt	4.7	<1	No data since 8/2011
Copper	1,300	<10	No data since 8/2011
Fluoride	4,000	180 – 300	
Lead	15	<1	
Lithium	31		No data
Manganese	300	590 – 780	Limited data since 2008
Mercury	2	<0.2	
Molybdenum	40	<20	Limited data since 2008
Nickel	100	<1 – 2.9	
Nitrate	10,000	<100	
Selenium	50	<1	
Silver	100	<10	
Strontium	9,300	471 – 620	Limited data since 2008
Sulfate	500 mg/L	5 – 43 mg/L	Limited data since 2008
TDS	500 mg/L	480 – 600 mg/L	Limited data since 2008
Thallium	2	<2	
Vanadium	63	<10	No data since 8/2011
Zinc	2,000	<10 – 23	No data since 8/2011

Table 2-2: Allen Fossil Plant, Well P2. Sampled 3 times between March 2004 and February 2008. No data since 2008.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<200	
Antimony	6	<3	
Arsenic	10	8.1 – 14	
Barium	2,000	160-320	
Beryllium	4	<2	
Boron	3,000	<200 – 500	
Cadmium	5	<0.5	
Chloride	250 mg/L	17 – 25 mg/L	
Chromium	100	<0.1 – 1.0	
Cobalt	4.7	<1	
Copper	1,300	<10	
Fluoride	4,000	180 – 220	
Lead	15	<1	
Lithium	31		No data
Manganese	300	560 – 930	
Mercury	2	<0.2	
Molybdenum	40	<20	
Nickel	100	<1 – 1.7	
Nitrate	10,000	<10 – 110	
Selenium	50	<1	
Silver	100	<10	
Strontium	9,300	240 -460	
Sulfate	500 mg/L	52 – 85 mg/L	
TDS	500 mg/L	340 – 620 mg/L	
Thallium	2	<2	
Vanadium	63	<10	
Zinc	2,000	<10	

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Table 2-3: Allen Fossil Plant, Well P3. Sampled 3 times between March 2004 and February 2008. No data since 2008.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<50 – 120	
Antimony	6	<3	
Arsenic	10	3.6 – 13	
Barium	2,000	190 – 500	
Beryllium	4	<2	
Boron	3,000	<200	
Cadmium	5	<0.5	
Chloride	250 mg/L	14 – 19 mg/L	
Chromium	100	<1	
Cobalt	4.7	<1	
Copper	1,300	<10	
Fluoride	4,000	110 – 190	
Lead	15	<1	
Lithium	31		No data
Manganese	300	370 – 1,400	
Mercury	2	<0.2	
Molybdenum	40	<20	
Nickel	100	<1 – 1.5	
Nitrate	10,000	<100	
Selenium	50	<1	
Silver	100	<10	
Strontium	9,300	<100	
Sulfate	500 mg/L	42 – 66 mg/L	
TDS	500 mg/L	245 – 450 mg/L	
Thallium	2	<2	
Vanadium	63	<10	
Zinc	2,000	<10	

Table 2-4: Allen Fossil Plant, Well P4. Sampled 8 times between March 2004 and February 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<200	Limited data since 2008
Antimony	6	<3	
Arsenic	10	1.8 – 5.7	
Barium	2,000	51 – 195	
Beryllium	4	<2	
Boron	3,000	<200 – 300	Limited data since 2008
Cadmium	5	<0.5	
Chloride	250 mg/L	8.6 – 61 mg/L	Limited data since 2008
Chromium	100	<1 – 4.2	
Cobalt	4.7	<1	No data since 8/2011
Copper	1,300	<10	No data since 8/2011
Fluoride	4,000	110 – 390	
Lead	15	<1	
Lithium	31		No data
Manganese	300	610 – 880	Limited data since 2008
Mercury	2	<0.2	
Molybdenum	40	<20	Limited data since 2008
Nickel	100	<1 – 4.1	
Nitrate	10,000	<10 – 260	
Selenium	50	<1	
Silver	100	<10	
Strontium	9,300	90 -160	Limited data since 2008
Sulfate	500 mg/L	28 – 58 mg/L	Limited data since 2008
TDS	500 mg/L	160 – 300 mg/L	Limited data since 2008
Thallium	2	<2	
Vanadium	63	<10	No data since 8/2011
Zinc	2,000	<10	No data since 8/2011

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Table 2-5: Allen Fossil Plant, Well P5. Sampled 8 times between March 2004 and February 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<200	Limited data since 2008
Antimony	6	<3	
Arsenic	10	2.7 – 4.5	
Barium	2,000	255 – 2,400[49]	
Beryllium	4	<2	
Boron	3,000	220 – 300	Limited data since 2008
Cadmium	5	<0.5	
Chloride	250 mg/L	15 – 23 mg/L	Limited data since 2008
Chromium	100	<1 – 8.9	
Cobalt	4.7	<1	No data since 8/2011
Copper	1,300	<10	No data since 8/2011
Fluoride	4,000	150 – 200	
Lead	15	<1	
Lithium	31		No data
Manganese	300	470 – 710	Limited data since 2008
Mercury	2	<0.2	
Molybdenum	40	<20	Limited data since 2008
Nickel	100	<1 – 9.9	
Nitrate	10,000	<100	
Selenium	50	<1	
Silver	100	<10	
Strontium	9,300	150 – 260	Limited data since 2008
Sulfate	500 mg/L	23 – 51 ug/L	Limited data since 2008
TDS	500 mg/L	200 – 305 mg/L	Limited data since 2008
Thallium	2	<2	
Vanadium	63	<10	No data since 8/2011
Zinc	2,000	<10 – 13	No data since 8/2011

[49] Although TVA reported a barium concentration of 2,400 mg/L in well P5 in February 2013, above the MCL of 2,000 mg/L, there are several reasons to suspect laboratory error. First, this is the only instance, at least in the data that we have on file, that barium in a TVA well has exceeded the MCL. Second, historical data for well P5 never exceeded 500 mg/L. Finally, data for the other pollutants measured in well P5 were consistent with historical data for that well.

Table 2-6: Allen Fossil Plant, Well P6. Sampled 6 times between February 2011 and February 2013.[50]

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 190	Limited data
Antimony	6	<1	
Arsenic	10	15 – 43	
Barium	2,000	220 – 490	
Beryllium	4	<2	
Boron	3,000	500 – 2,100	
Cadmium	5	<0.5	
Chloride	250 mg/L	13 – 14 mg/L	
Chromium	100	<1 – 4.4	
Cobalt	4.7	<1	
Copper	1,300	<1 – 1.1	
Fluoride	4,000	<100 – 330	
Lead	15	<1	
Lithium	31		No data
Manganese	300	580 – 870	
Mercury	2	<0.2	
Molybdenum	40	3.8 – 4.0	Limited data
Nickel	100	1.3 – 4.4	
Nitrate	10,000	<100 – 180	
Selenium	50	<1	
Silver	100	<0.5	
Strontium	9,300	270 – 620	Limited data
Sulfate	500 mg/L	44 – 89 mg/L	
TDS	500 mg/L	270 – 510 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	<10 – 24	

[50] Arsenic was measured 7 times: 2/2011, 4/2011, 8/2011, 11/2011, 1/2012, 8/2012, and 2/2013.

ED_002553_00025289-00049

3 Bull Run Fossil Plant

Background

The Bull Run Fossil Plant is located at the confluence of the Clinch River and Bull Run Creek outside of Oak Ridge, TN. TVA has been operating a single large unit at Bull Run since 1967. The original complex of ponds along the Clinch River has changed significantly over time. The area now known as Bottom Ash Area 1 was originally a fly ash pond; TVA filled it with bottom ash in 1985, and has been stacking bottom ash in the area since then.[51] Area 2A, Ash Pond 2, and the Stilling Pond were originally one large ash pond that TVA started using in 1971.[52] The stilling pond was separated from the rest of the pond in 1976. Area 2A was separated from the rest of the pond in 1981. TVA disposed of wet fly ash in Area 2A until 1989, then disposed of dry bottom ash there until 2004, and ultimately converted it to a gypsum disposal area in 2006-2008. Ash Pond 2 is now used as a fly ash settling pond, and also receives discharges from the coal yard runoff and metal cleaning ponds and overflow from the gypsum area (2A). The Dry Fly Ash Stack (landfill) has been in operation since 1982[53]. TVA used the East/West Dredge Cell for dredged fly ash disposal from 1981 to 1995; it is currently inactive.[54]

Monitoring

There are currently 12 wells monitoring groundwater at Bull Run. Four wells surround the Dry Fly Ash Landfill, five wells monitor the gypsum and ash landfills along the Clinch River, and three wells, installed in 2010 as part of the USWAG voluntary monitoring plan, are located along the edges of the ash ponds (see figure 3-6). Well 45R, a downgradient well at the Dry Fly Ash Landfill, replaced well 45 in 2009. Note that the upgradient well at the Dry Fly Ash Landfill is well "I" (eye), while the upgradient well at the gypsum/ash landfill is well "1." Our files include groundwater data from 2008-2012.

Wells around the Dry Fly Ash Landfill show a clear pattern of ash-related contamination. Since 2008, boron concentrations in downgradient well 45R have been much higher than the concentrations in upgradient well I (consistently <200 ug/L), higher than the Child Health Advisory of 300 ug/L (see Fig. 3-1), and increasing. The same pattern is evident with molybdenum (Fig. 3-2). Manganese and sulfate concentrations in wells 45 and 45R have also been higher than background and higher than upgradient concentrations. Despite the clear

[51] Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Tennessee, Appendix C, Bull Run Fossil Plant*, Bottom Ash Disposal Area, page 1 (June 24, 2009).
[52] *Id.* at Fly Ash pond Area 2, page 1.
[53] *Id.* at Dry Flay Ash Stack, page 1.
[54] *Id.* at East/West Dredge Cell, page 1.

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evidence of a problem, and despite the fact that boron and molybdenum concentrations were getting progressively worse in well 45R, all four of these pollutants were dropped from monitoring in 2010. TVA measured these pollutants again in May 2013, and results show that the levels of boron and molybdenum continue to increase.

Wells downgradient of the gypsum and ash landfills along the river (wells 47 – 50) also show evidence of contamination, including unsafe concentrations of cobalt, manganese, molybdenum, and sulfate. All wells have consistently shown unsafe levels of manganese. Manganese concentrations in upgradient well 1, however, are even higher than those in downgradient wells, suggesting a natural or man-made source other than the landfills. Cobalt concentrations in downgradient well 48 (see Fig. 3-3) were high enough to warrant an investigation by TVA in 2009. That investigation came to the unsatisfying conclusion that "ash and or gypsum leachate may not be the source or only source of cobalt in well 48."[55] In fact, it is quite likely that the ash landfill is the cause of the problem – downgradient wells have higher cobalt concentrations than the upgradient well, and the concentrations of cobalt in ash samples (mean of 64 mg/kg) were much higher than concentrations in soil samples (means of 9.0 – 12.7 mg/kg).[56] Although cobalt concentrations in wells 47 and 48 have declined since 2008, they remain unsafe.

Well 49 shows clear evidence of increasing contamination. TVA omitted manganese, strontium, sulfate, and TDS from monitoring in 2010-2012, but results from 2013 confirm they have all been increasing with a consistent pattern: Figure 3-4 plots the increase of each pollutant relative to its concentration in February 2008, and it shows that all of these pollutants have been increasing in parallel. Cobalt, which has been consistently monitored over this period, fits the same pattern. Other pollutants have not been increasing but nevertheless reflect ongoing contamination: Boron concentrations have been stable at concentrations (1.8 – 2.3 mg/L) much higher than background (<0.2 mg/L). Molybdenum concentrations in well 49 have been declining over this period, from 700 to 410 ug/L, but remain 10 times higher than the Lifetime Health Advisory of 40 ug/L.

Groundwater around the ash ponds has only recently been monitored, and not always for the full range of pollutants. The limited data show arsenic above the MCL in well 52 in addition to manganese concentrations slightly above the lifetime health advisory in wells 51 and 52.

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[55] TVA, *Bull Run Fossil Plant Gypsum/Coal-Ash Landfill Cobalt Investigation Report* (Oct. 2, 2009).

[56] *Id.* Cobalt concentrations from gypsum samples were nondetect (<0.5 mg/kg), suggesting that the ash, and not the gypsum, is the source of the cobalt.

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Figure 3-1: Boron concentrations (ug/L) in wells around the Bull Run Fossil Plant Dry Fly Ash Landfill (hollow data points are nondetect at <200 ug/L).

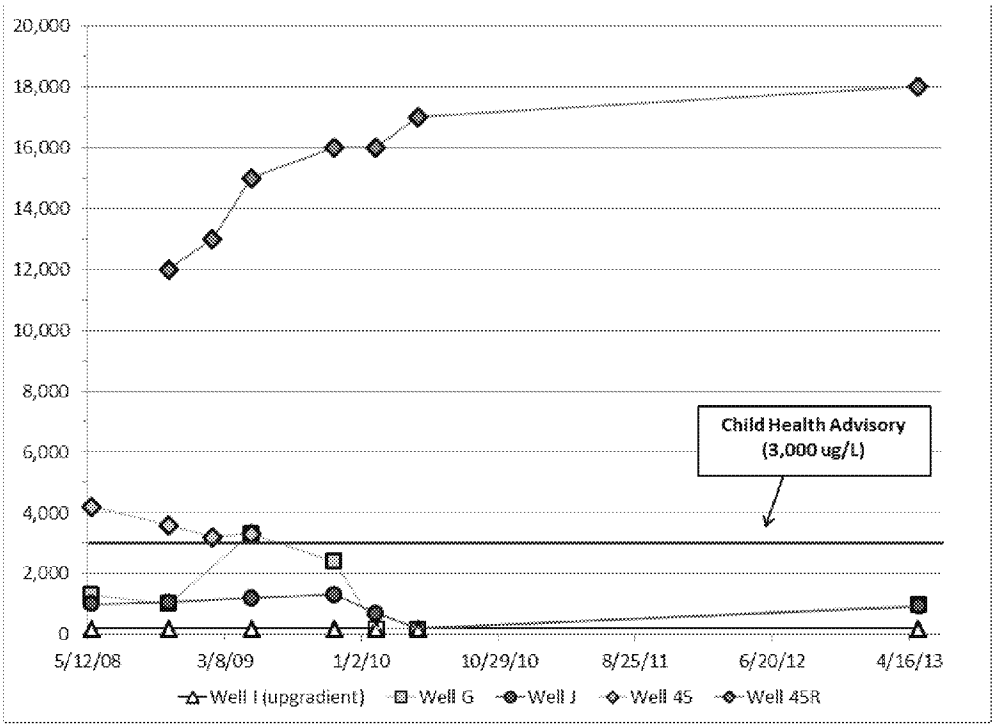


Figure 3-2: Molybdenum concentrations (ug/L) in wells around the Bull Run Fossil Plant Dry Fly Ash Landfill (hollow data points are nondetect at <2 or <5 ug/L).

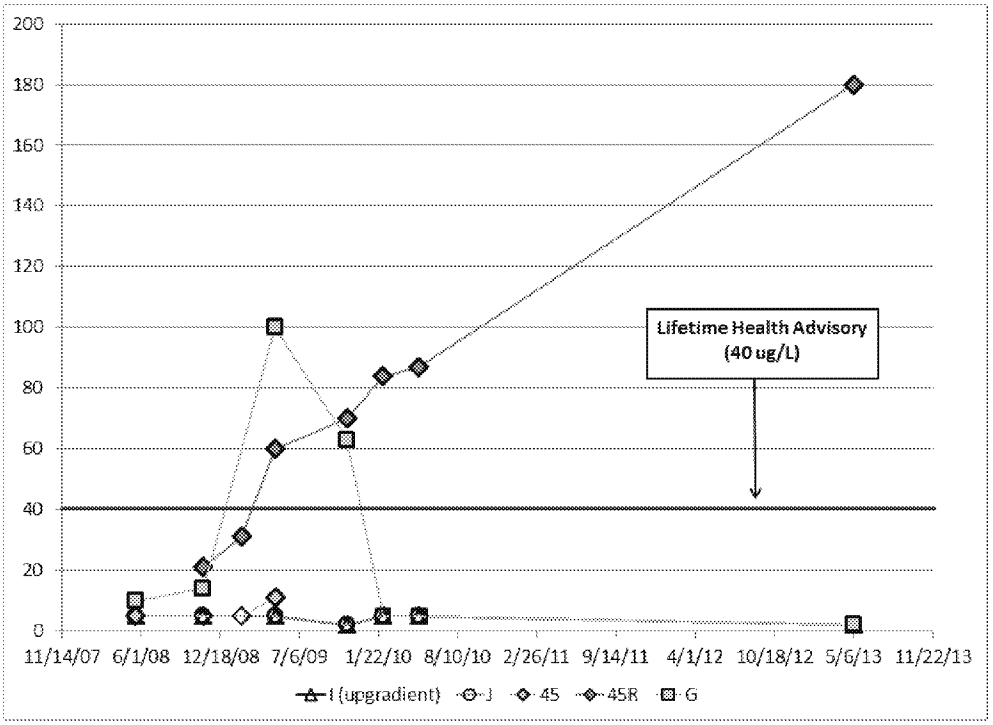


Figure 3-3: Cobalt concentrations (ug/L) in wells around the Bull Run Fossil Plant Gypsum and Fly Ash Landfill (hollow data points are nondetect at <1 or <10 ug/L).

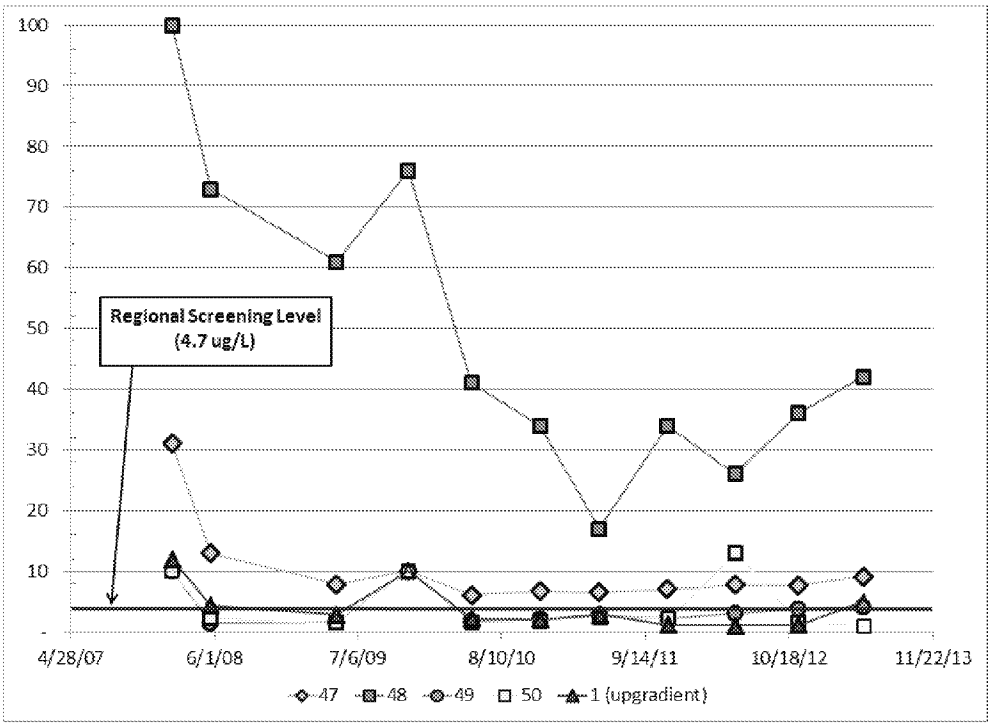
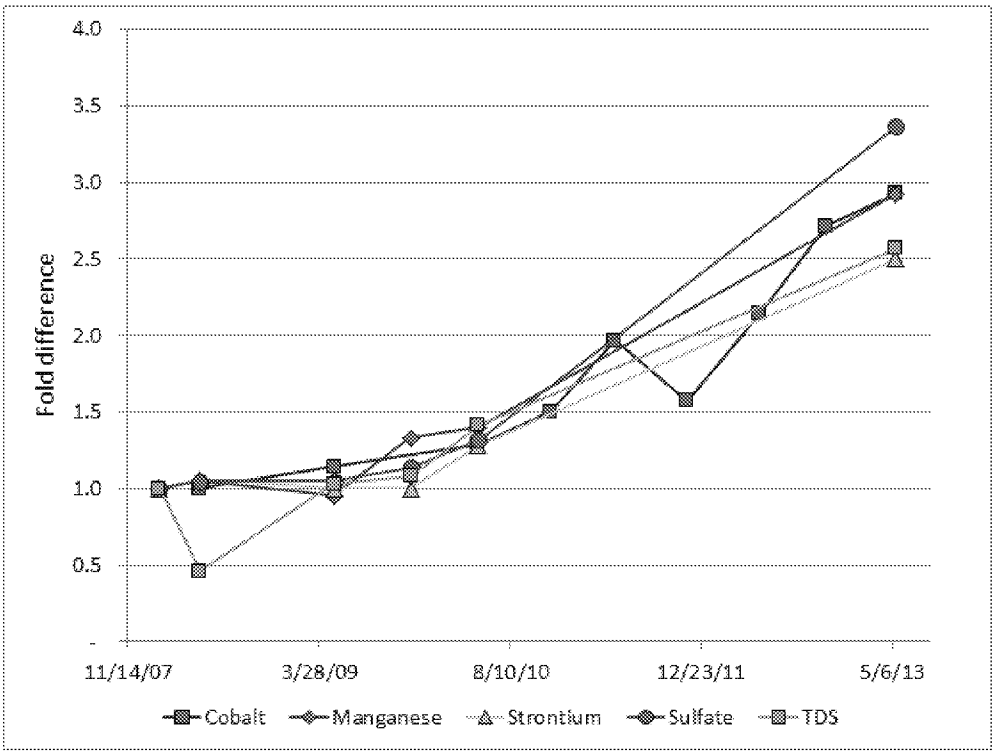


Figure 3-4: Increase of selected pollutants in Well 49. The Y axis reflects the ratio of the concentration of each pollutant on various dates to the same pollutant's concentration in February 2008. The figure shows that all of these pollutants roughly tripled in concentration between 2008 and 2013.



Data Gaps

1. Discontinued monitoring of coal ash indicators. TVA's groundwater reports suggest that TVA and TDEC deliberately dropped most coal ash indicators from monitoring in recent years.[57] Aluminum, boron, chloride, manganese, molybdenum, strontium, sulfate, and TDS were all dropped from site-wide monitoring after May 2010, aside from one initial round of sampling at two of the three ash pond wells in May 2011. TVA measured these pollutants again in 2013, but only in some wells. This lack of monitoring is troubling for two reasons; not only are these pollutants associated with coal ash leachate,[58] they are also found at high concentrations in downgradient wells at Bull Run, and in the case of boron and molybdenum in well 45R, have been steadily increasing.

2. Unmonitored areas. The East/West Dredge Cell is unmonitored. We do not have historical data for this area on file, and there is no way of knowing the extent of any contamination.

3. Shifting groundwater protection standards. Although not strictly a data gap, the inconsistent selection of Groundwater Protection Standards (GWPSs) for cobalt obscures the contamination at the gypsum landfill. Table 3-1, below, lists the various GWPSs that have been applied to the two Bull Run landfill areas along with the Upper Prediction Intervals (UPLs) used as the upper bound on assumed background concentrations. GWPSs have ranged from 4.7 to 55, they have been alternately health-based (Regional Screening Levels) and background-based (UPLs), and they have rarely been consistent between landfills. Moreover, they have not always been applied – TVA stopped comparing cobalt to any standards in 2011. This shifting benchmark means that cobalt, which has consistently exceeded the health-based Regional Screening Level in well 48, is not routinely flagged as an issue in the groundwater reports. TDEC has the authority to require TVA to apply a strict groundwater protection standard, and it has occasionally done so. It should, in the future, routinely require TVA to demonstrate compliance with the cobalt Regional Screening Level of 4.7 ug/L.

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[57] It may be the case that TVA is measuring more than they report; our conclusions are based on what was provided to us in public record requests.

[58] *See, e.g.*, U.S. EPA co-proposed Subtitle D coal ash regulations, which would have made boron, chloride, sulfate, and TDS, among others, "detection monitoring" parameters, and would have included aluminum, boron, chloride, manganese, molybdenum, sulfate, and TDS among the "assessment monitoring" parameters. 75 Fed. Reg. 35128, 35253 (June 21, 2010). *See also* TVA, *Groundwater Monitoring Report – Allen Fossil Plant – February 2008*, at 2 (Aug. 22, 2008) (identifying boron and sulfate as "ash leachate analytes."

Table 3-1: Regional Screening Levels (RSLs), Upper Prediction Limits (UPLs), and Groundwater Protection Standards (GWPSs) for cobalt at the two Bull Run landfills over time. Empty cells reflect groundwater reports that failed to identify RSLs, UPLs, or GWPSs.

Date	RSL	Dry fly ash landfill		Gypsum area 2A	
		UPL (ug/L)	**GWPS** (ug/L)	**UPL** (ug/L)	**GWPS** (ug/L)
Feb. 2008	-	*No report on file*		-	-
May 2008	-	22[59]	-	-	-
Nov. 2008	-	22	-	*No report on file*	
May 2009	-	22	-	37[60]	37
Nov. 2009	11	22	-	35	35
Feb. 2010	11	22	22	*No report on file*	
May 2010	11	22	22	55	55
Nov. 2010	11	10[61]	11	53	53
May 2011	11	10	11	28.5	11[62]
Nov. 2011	4.7	10	4.7	44.7	-
May 2012	-	-	-	-	-
Nov. 2012	-	10	-	*No report on file*	
May 2013	-	10	-	38.4	-

Failure to regulate

As described above, TVA and TDEC have routinely omitted coal ash indicators from groundwater monitoring, and have stopped comparing cobalt to any kind of regulatory standard. These could not have been arbitrary decisions. Boron, cobalt, manganese, molybdenum, and sulfate had all been observed at unsafe concentrations in one or more on-site wells. Rather than dealing with known contamination, however, TVA and TDEC chose to ignore the problem for two years and leave the source of the problem in place.

[59] Although this report generally used intrawell UPLs, TVA describes the cobalt UPL of 22 ug/L as the "assumed UPL equal to 90th percentile of TVA valley-wide groundwater measurements." TVA, *Bull Run Fossil Plant Dry Fly Ash Disposal Facility Groundwater Monitoring Report – May 2008*, 3 (June 25, 2008).

[60] Calculated on an interwell basis; this value represents the upper confidence limit on data from background well 1 between August 2006 and the date of each report.

[61] Based on data from background well I, June 2000 – date of report.

[62] Set at the RSL level "at the request of TDEC regulator over the site." TVA, *Bull Run Fossil Plant Gypsum/Coal Ash Landfill Groundwater Assessment Monitoring Report – May 2011*, 3 (June 24, 2011).

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Figure 3-6: Groundwater wells at Bull Run Fossil Plant (approximate locations)

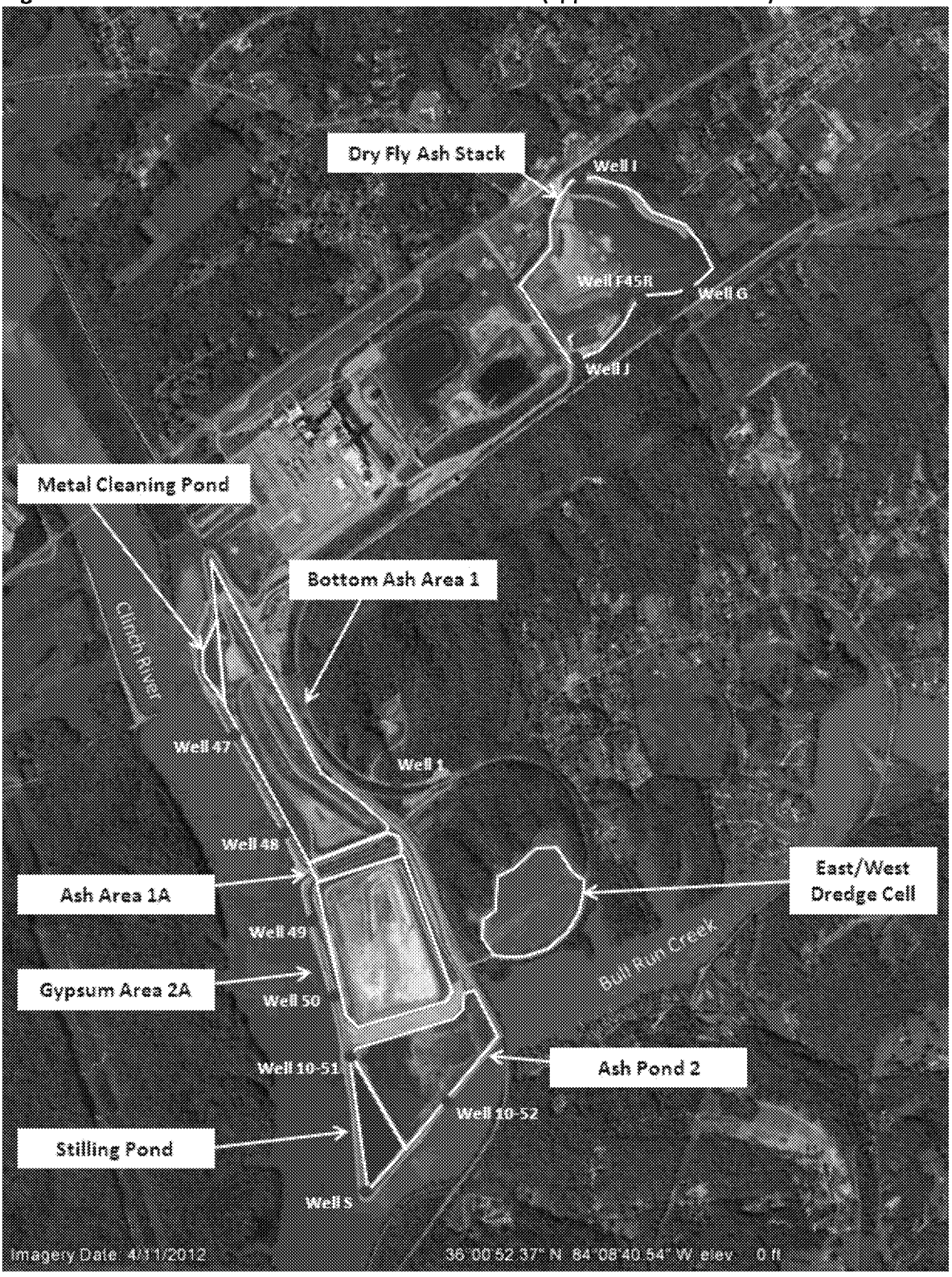

Table 3-2: Bull Run Fossil Plant, Well 10-51. Sampled 5 times between May 2011 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	2,000	No data since 5/2011
Antimony	6	<1	
Arsenic	10	<5	
Barium	2,000	69 – 81	
Beryllium	4	<1	
Boron	3,000	<200	No data since 5/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	3.3 mg/L	No data since 5/2011
Chromium	100	<2 – 4.4	
Cobalt	4.7	<1 – 1.5	No data since 5/2012
Copper	1,300	<2 – 2.4	No data since 5/2012
Fluoride	4,000	<100	No data prior to 5/2012
Lead	15	<1 – 1.6	
Lithium	31		No data
Manganese	300	400	No data since 5/2011
Mercury	2	<0.2	
Molybdenum	40	9	No data since 5/2011
Nickel	100	1.9 – 6.0	
Nitrate	10,000	<100	
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300	110	No data since 5/2011
Sulfate	500 mg/L	11 mg/L	No data since 5/2011
TDS	500 mg/L	310 mg/L	No data since 5/2011
Thallium	2	<1	
Vanadium	63	<2 – 4.4	No data since 11/2011
Zinc	2,000	<10 – 10	No data since 11/2011

Table 3-3: Bull Run Fossil Plant, Well 10-52. Sampled 5 times between May 2011 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	750	No data since 5/2011
Antimony	6	<1	
Arsenic	10	22 – 31	
Barium	2,000	27 –510	
Beryllium	4	<1 – 1.8	
Boron	3,000	<200	No data since 5/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	5 mg/L	No data since 5/2011
Chromium	100	<2 – 3.5	
Cobalt	4.7	1.6 – 2.8	No data since 5/2012
Copper	1,300	<2	No data since 5/2012
Fluoride	4,000	170	No data prior to 5/2012
Lead	15	<1 – 1.6	
Lithium	31		No data
Manganese	300	360	No data since 5/2011
Mercury	2	<0.2	
Molybdenum	40	9	No data since 5/2011
Nickel	100	1.7 – 4.2	
Nitrate	10,000	<100	
Selenium	50	<1 – 4.2	
Silver	100	<1 – 5.3	
Strontium	9,300	280	No data since 5/2011
Sulfate	500 mg/L	<5 mg/L	No data since 5/2011
TDS	500 mg/L	395 mg/L	No data since 5/2011
Thallium	2	<1	
Vanadium	63	2.2 – 2.5	No data since 11/2011
Zinc	2,000	<10 – 19	No data since 11/2011

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Table 3-4: Bull Run Fossil Plant, Well S. Sampled 4 times between November 2011 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	<5	
Barium	2,000	49 – 59	
Beryllium	4	<1	
Boron	3,000		No data
Cadmium	5	<0.5 – 0.6	
Chloride	250 mg/L		No data
Chromium	100	<2	
Cobalt	4.7	1.1	No data since 5/2012
Copper	1,300	<2	No data since 5/2012
Fluoride	4,000	<100	No data prior to 5/2012
Lead	15	<1	
Lithium	31		No data
Manganese	300		No data
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	3.1 – 4.5	
Nitrate	10,000	<100	No data prior to 5/2012
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300		No data
Sulfate	500 mg/L		No data
TDS	500 mg/L		No data
Thallium	2	<1	
Vanadium	63	<2	No data since 11/2011
Zinc	2,000	<10 – 19	No data since 11/2011

Table 3-5: Bull Run Fossil Plant, Gypsum/Bottom Ash landfills, Well BRF-1. Sampled 11 times between February 2008 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 3,800 (decreasing)	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	1.8 – 5.0	
Barium	2,000	<2 – 1,867[63]	
Beryllium	4	<2	
Boron	3,000	<200	No data 5/2010-11/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	3.2 – 4.8 mg/L	No data 5/2010-11/2012
Chromium	100	<10	
Cobalt	4.7	1.1 – 12 (decreasing)	No data 5/2010-11/2012
Copper	1,300	<10	No data 5/2010-11/2012
Fluoride	4,000	<100 – 240	
Lead	15	<5	
Lithium	31		No data
Manganese	300	19,000 – 22,000	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	<10	No data 5/2010-11/2012
Nickel	100	<5	
Nitrate	10,000	<100	
Selenium	50	<5	
Silver	100	<1 – 10	
Strontium	9,300	190 – 210	No data 5/2010-11/2012
Sulfate	500 mg/L	<5 – 15	No data 5/2010-11/2012
TDS	500 mg/L	220 – 260	No data 5/2010-11/2012
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 83	

[63] TVA reported barium concentrations of <0.002 mg/L in November 2010 and November 2011. These may have been typographical errors; aside from these two nondetects, data have ranged from 1.4 mg/L to 1.9 mg/L.

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Table 3-6: Bull Run Fossil Plant, Gypsum/Bottom Ash landfills, Well BRF-47. Sampled 11 times between February 2008 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	280 – 3,700 (decreasing)	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	1.7 – 6.1	
Barium	2,000	23 – 48	
Beryllium	4	<2	
Boron	3,000	1,750 – 2,600	No data 5/2010-11/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	3 – 12 mg/L	No data 5/2010-11/2012
Chromium	100	<10	
Cobalt	4.7	6 – 31	
Copper	1,300	<2 – 5	
Fluoride	4,000	<100 – 270	No data 5/2010-11/2012
Lead	15	<5	
Lithium	31		No data
Manganese	300	3,400 – 6,300 (decreasing)	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	22 – 50	No data 5/2010-11/2012
Nickel	100	3 – 16	
Nitrate	10,000	<100	No data 5/2010-11/2012
Selenium	50	<1 – 1.8	
Silver	100	<1 – 10	
Strontium	9,300	2.3 – 3.5	No data 5/2010-11/2012
Sulfate	500 mg/L	580 – 1,000 mg/L, decreasing	No data 5/2010-11/2012
TDS	500 mg/L	1,000 – 1,500 mg/L	No data 5/2010-11/2012
Thallium	2	<5	
Vanadium	63	<10	
Zinc	2,000	52 – 120	

Table 3-7: Bull Run Fossil Plant, Gypsum/Bottom Ash landfills, Well BRF-48. Sampled 11 times between February 2008 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	900 – 10,000	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	<1 – 2.9	
Barium	2,000	27 – 71	
Beryllium	4	<2	
Boron	3,000	1,200 – 2,100	No data 5/2010-11/2012
Cadmium	5	<0.5 – 1.1	
Chloride	250 mg/L	2.0 – 3.8 mg/L	No data 5/2010-11/2012
Chromium	100	<2 – 11	
Cobalt	4.7	17 – 100	
Copper	1,300	<2 – 7.4	
Fluoride	4,000	100 – 230	No data 5/2010-11/2012
Lead	15	<1 – 5.5	
Lithium	31		No data
Manganese	300	9,200 – 18,000	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	<5 – 6	No data 5/2010-11/2012
Nickel	100	17 – 43	
Nitrate	10,000	<100	No data 5/2010-11/2012
Selenium	50	<1 – 1.6	
Silver	100	<10	
Strontium	9,300	3.2 – 6.3	No data 5/2010-11/2012
Sulfate	500 mg/L	1,400 – 1,800 mg/L	No data 5/2010-11/2012
TDS	500 mg/L	2,000 – 2,600 mg/L	No data 5/2010-11/2012
Thallium	2	<1 – 1	
Vanadium	63	<2 – 18	
Zinc	2,000	<10 – 55	

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Table 3-8: Bull Run Fossil Plant, Gypsum/Bottom Ash landfills, Well BRF-49. Sampled 11 times between February 2008 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	110 – 400	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	1.4 – 6.1	
Barium	2,000	38 – 74	
Beryllium	4	<2	
Boron	3,000	1,800 – 2,300	No data 5/2010-11/2012
Cadmium	5	<0.5 – 2.0	
Chloride	250 mg/L	1.6 – 38 mg/L	No data 5/2010-11/2012
Chromium	100	<10	
Cobalt	4.7	<10 (increasing)[64]	
Copper	1,300	<2	
Fluoride	4,000	1,200 – 1,600	No data 5/2010-11/2012
Lead	15	<5	
Lithium	31		No data
Manganese	300	3,000 – 9,200	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	410 – 700	No data 5/2010-11/2012
Nickel	100	1.2 – 20	
Nitrate	10,000	<100	No data 5/2010-11/2012
Selenium	50	<1	
Silver	100	<10	
Strontium	9,300	1.8 – 4.5	No data 5/2010-11/2012
Sulfate	500 mg/L	220 – 740 mg/L	No data 5/2010-11/2012
TDS	500 mg/L	250 – 1,400 mg/L	No data 5/2010-11/2012
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 13	

Table 3-9: Bull Run Fossil Plant, Gypsum/Bottom Ash landfills, Well BRF-50. Sampled 11 times between February 2008 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 2,800 (decreasing)	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	2.4 – 4.4	
Barium	2,000	<2 – 360	
Beryllium	4	<2	
Boron	3,000	<200	No data 5/2010-11/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	2.3 – 5.3 mg/L	No data 5/2010-11/2012
Chromium	100	<10	
Cobalt	4.7	<1 – 13	
Copper	1,300	<2	
Fluoride	4,000	<100 – 170	No data 5/2010-11/2012
Lead	15	<5	
Lithium	31		No data
Manganese	300	2,700 – 4,700	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	<2 – 6	No data 5/2010-11/2012
Nickel	100	1.3 – 6.8	
Nitrate	10,000	<100	No data 5/2010-11/2012
Selenium	50	<1 – 9.9	
Silver	100	<10	
Strontium	9,300	170 – 350	No data 5/2010-11/2012
Sulfate	500 mg/L	21 – 35 mg/L	No data 5/2010-11/2012
TDS	500 mg/L	310 – 640 mg/L	No data 5/2010-11/2012
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<30	

[64] Cobalt was reported as nondetect at <10 ug/L in two sampling events in 2008 and 2009. Positive detections show an increasing trend, from 1.4 ug/L in May 2008 to 4.1 ug/L in May 2013.

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Table 3-10: Bull Run Fossil Plant, Dry Ash Disposal Facility, Well 45. Sampled 4 times between May 2008 and May 2009, then replaced by Well 45R (next page).

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 130	
Antimony	6	<1	
Arsenic	10	3.4 – 5.6	
Barium	2,000	43 – 62 (decreasing)	
Beryllium	4	<2	
Boron	3,000	3,200 – 4,200	
Cadmium	5	<0.5	
Chloride	250 mg/L	5.3 – 6.9 mg/L	
Chromium	100	<1 – 4.6	
Cobalt	4.7	2.0 -2.4	
Copper	1,300	<1 – 3.4	
Fluoride	4,000	<100 - 150	
Lead	15	<1	
Lithium	31		No data
Manganese	300	9,400 – 10,000	
Mercury	2	<0.2	
Molybdenum	40	<5 – 11	
Nickel	100	9.3 – 12.0 (decreasing)	
Nitrate	10,000	<100	
Selenium	50	<1 – 9.8	
Silver	100	<0.5	
Strontium	9,300	450 – 520	
Sulfate	500 mg/L	420 – 910 mg/L	
TDS	500 mg/L	1,600 – 1,700 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 13	

Table 3-11: Bull Run Fossil Plant, Dry Ash Disposal Facility, Well 45R. Sampled 12 times between November 2008 and May 2013. This well replaced Well 45 (previous page).

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 3,100 (decreasing)	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	4.1 – 8.9	
Barium	2,000	31 – 110	
Beryllium	4	<10[65]	
Boron	3,000	12,000 – 18,000 (increasing)	No data 5/2010-11/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	8.2 – 22 mg/L	
Chromium	100	<10	
Cobalt	4.7	<10[66]	
Copper	1,300	<2 – 13	
Fluoride	4,000	<100 – 160	No data since 5/2010
Lead	15	<1 – 2.7	
Lithium	31		No data
Manganese	300	5,300 – 7,800	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	21 – 180 (increasing)	No data 5/2010-11/2012
Nickel	100	1 – 17	
Nitrate	10,000	<100	No data 5/2010-11/2012
Selenium	50	<1 – 29	
Silver	100	<10	
Strontium	9,300	1,900 – 3,600 (increasing)	No data 5/2010-11/2012
Sulfate	500 mg/L	800 – 2,200 mg/L	No data 5/2010-11/2012
TDS	500 mg/L	2,600 – 3,500 mg/L	No data 5/2010-11/2012
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 19	

[65] Of the ten measurements on file, five were reported with a detection limit of 5 ug/L, and one with a detection limit of 10 ug/L. Since these are higher than the MCL for beryllium (4 ug/L), they are not sufficient to demonstrate the absence of an exceedance. On the other hand, beryllium has consistently been below detection, and half of the measurements that we have on file used detection limits of 1 or 2 ug/L.

[66] One of the ten measurements on file for this well reported that cobalt was undetected with a detection limit of 10 ug/L, which is not adequate to detect concentrations above the Regional Screening Level (RSL) of 4.7 ug/L. The nine remaining measurements were below the RSL, however, with an average of 2.3 ug/L, and so there is little evidence that cobalt levels in this well are unsafe.

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Table 3-12: Bull Run Fossil Plant, Dry Ash Disposal Facility, Well G. Sampled 12 times between May 2008 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	<1 – 1.0	
Barium	2,000	29 – 65	
Beryllium	4	<5[67]	
Boron	3,000	<200 – 3,300	No data 5/2010-11/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	7.4 – 9.4 mg/L	
Chromium	100	<10	
Cobalt	4.7	<10[68]	
Copper	1,300	<1 – 2.4	
Fluoride	4,000	<100 – 140	No data since 5/2010
Lead	15	<1	
Lithium	31		No data
Manganese	300	5 – 140	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	<2 – 100	No data 5/2010-11/2012
Nickel	100	1.4 – 47	
Nitrate	10,000	<100 – 100	No data 5/2010-11/2012
Selenium	50	<1 – 3.7	
Silver	100	<10	
Strontium	9,300	0.17 – 0.48	No data 5/2010-11/2012
Sulfate	500 mg/L	51 – 520 mg/L	No data 5/2010-11/2012
TDS	500 mg/L	275 – 1,000 mg/L	No data 5/2010-11/2012
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 12	

[67] Of the ten measurements on file, three were reported with a detection limit of 5 ug/L. Since this is higher than the MCL for beryllium (4 ug/L), it is not sufficient to demonstrate the absence of an exceedance. On the other hand, beryllium has consistently been undetected, and seven of the ten measurements had detection limits of 3 ug/L or less.

[68] One of the ten measurements on file for this well indicated that cobalt was undetected with a detection limit of 10 ug/L, which is not adequate to detect concentrations above the Regional Screening Level (RSL) of 4.7 ug/L. The nine remaining measurements were undetected at <1 ug/L, and so there is no evidence that cobalt levels in this well are unsafe.

Table 3-13: Bull Run Fossil Plant, Dry Ash Disposal Facility, Well I. Sampled 12 times between May 2008 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	165 – 2,500	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	59 – 69	
Beryllium	4	<5[69]	
Boron	3,000	<200	No data 5/2010-11/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	12 – 21 mg/L (increasing)	
Chromium	100	<10	
Cobalt	4.7	<10[70]	
Copper	1,300	<2	
Fluoride	4,000	<100 – 120	No data since 5/2010
Lead	15	<1	
Lithium	31		No data
Manganese	300	<10 – 27	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	<5	No data 5/2010-11/2012
Nickel	100	1.1 – 2.5	
Nitrate	10,000	<100 – 380	No data 5/2010-11/2012
Selenium	50	<1 – 1.2	
Silver	100	<10	
Strontium	9,300	0.17 – 0.20	No data 5/2010-11/2012
Sulfate	500 mg/L	<5 mg/L	No data 5/2010-11/2012
TDS	500 mg/L	280 – 325 mg/L	No data 5/2010-11/2012
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 36	

[69] Of the ten measurements on file, three were reported with a detection limit of 5 ug/L. Since this is higher than the MCL for beryllium (4 ug/L), it is not sufficient to demonstrate the absence of an exceedance. On the other hand, beryllium has consistently been undetected, and seven of the ten measurements had detection limits of 2 ug/L or less.

[70] One of the ten measurements on file for this well indicated that cobalt was undetected with a detection limit of 10 ug/L, which is not adequate to detect concentrations above the Regional Screening Level (RSL) of 4.7 ug/L. The nine remaining measurements were undetected at <1 ug/L, and so there is no evidence that cobalt levels in this well are unsafe.

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Table 3-14: Bull Run Fossil Plant, Dry Ash Disposal Facility, Well J. Sampled 12 times between May 2008 and May 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 810	No data 5/2010-11/2012
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	49 – 120	
Beryllium	4	<5[71]	
Boron	3,000	<200 – 1,300	No data 5/2010-11/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	3.8 – 17 mg/L	
Chromium	100	<10	
Cobalt	4.7	<10[72]	
Copper	1,300	<2	
Fluoride	4,000	<100 – 130	No data since 5/2010
Lead	15	<5	
Lithium	31		No data
Manganese	300	<2 – 140	No data 5/2010-11/2012
Mercury	2	<0.2	
Molybdenum	40	<5	No data 5/2010-11/2012
Nickel	100	1.8 – 5.5	
Nitrate	10,000	<100	No data 5/2010-11/2012
Selenium	50	<1 – 8	
Silver	100	<10	
Strontium	9,300	0.36 – 0.51	No data 5/2010-11/2012
Sulfate	500 mg/L	290 – 440 mg/L	No data 5/2010-11/2012
TDS	500 mg/L	320 – 870 mg/L	No data 5/2010-11/2012
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 12.5	

[71] Of the ten measurements on file, three were reported with a detection limit of 5 ug/L. Since this is higher than the MCL for beryllium (4 ug/L), it is not sufficient to demonstrate the absence of an exceedance. On the other hand, beryllium has consistently been undetected, and seven of the ten measurements had detection limits of 2 ug/L or less.

[72] One of the ten measurements on file for this well indicated that cobalt was undetected with a detection limit of 10 ug/L, which is not adequate to detect concentrations above the Regional Screening Level (RSL) of 4.7 ug/L. The nine remaining measurements were undetected at <1 ug/L, and so there is no evidence that cobalt levels in this well are unsafe.

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4 Colbert Fossil Plant

Background

The Colbert Fossil Plant is located outside of Muscle Shoals, Alabama on the Tennessee River. A small tributary, Cane Creek, runs northwest through the site before mixing with Colbert's cooling water discharge and eventually emptying into the river. TVA has been operating four units at the site since the 1950s, and added a fifth unit in the early 1960s. The original ash pond, Ash Pond 1, was located at the far northwest corner of the site. TVA stopped sluicing ash to the pond in 1975, but may have dry-stacked ash in the area during the 1980s.[73] Ash Pond 4 was built in 1972, and then raised by 20 feet in 1984. Ash Pond 5 was built in 1984; sinkholes formed shortly after TVA started filling the pond, so TVA abandoned the northwest part of the area and used the southeast part to dispose of ash dredged from Ash Pond 4. In 1990, TVA started dry-stacking ash in the southeast part of Ash Pond 5, which is now known as the Dry Fly Ash Landfill. The Metal Cleaning Pond was built in the early 1980s and used until 2007.[74] A chemical treatment pond just north of the Metal Cleaning Pond was closed in 1993.[75]

Colbert sits atop karst bedrock characterized by dissolved cavities. As described in one groundwater monitoring report, "[e]vidence of karst terrain is abundant with numerous sinkholes across the site and several caves along the river bluff."[76] This kind of terrain presents an ongoing risk that the coal ash disposal areas (or other areas) will suffer local collapses. TVA has long known about this risk: A 1982 memorandum regarding the future Ash Pond 5 noted that "[s]udden collapse of a small portion of the soil layer overlying the cavernous limestone could occur," but that it was "impossible to predict when or where they might occur."[77] Consultants recognized that Colbert posed a "moderate risk to water resources" as early as 1987.[78]

As predicted, Colbert has experienced a series of sinkhole-related accidents over the years:

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[73] Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Alabama, Appendix B – Colbert Fossil Plant* (June 24, 2009).
[74] TVA, *Pond Assessment Environmental Information: A Summary of Findings*, at 1 (Aug. 14, 2009); TVA, *Colbert Fossil Plant Groundwater Monitoring Report – October 2008*, at 8 (Jan. 20, 2009).
[75] TVA, *Colbert Fossil Plant Groundwater Assessment*, at 4 (Oct. 1994).
[76] TVA, *Colbert Fossil Plant Groundwater Monitoring Report – October 2008*, at 4 (Jan. 20, 2009).
[77] TVA, Memorandum from M. N. Sprouse to H. S. Fox, *Colbert Steam Plant – Additional Ash Disposal Area No. 5 – Engineering Report* (Dec. 21, 1982); *see also* TVA, *Geology of the Colbert Steam Plant*, at 10 (Nov. 1951) ("[T]he major structural features are the small faults and joints, with the solution accompanying these features being of more than passing interest.").
[78] TVA, *Colbert Fossil Plant Groundwater Assessment*, at 1 (Oct. 1994).

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- In October of 1984, as mentioned above, a "sinkhole complex" caused the new Ash Pond 5 to drain at a rate of 1 foot per hour;[79] this was part of a series of sinkholes in this area between 1983 and 1985.[80]
- TVA lined the coal yard drainage basin with clay in 1988 after "water level measurements in the [basin] indicated subsurface leakage."[81]
- In December of 1991, a meter-wide sinkhole caused the chemical treatment pond to lose 2 million liters of water.[82]
- In February of 2012, a sinkhole caused process water from the coal unloading area to drain into the river, causing a 150-foot plume.[83]

The Colbert ash disposal areas have also contaminated local groundwater: Monitoring during the 1980s and 1990s revealed that "[g]roundwater in both the bedrock and soil [was] impacted near the metal cleaning pond, coal yard drainage basin, and Ash Ponds 4 and 5."[84] A 1994 report suggested that there were three general areas or types of contamination: First, wells downgradient of the metal cleaning pond and Ash Pond 4 showed evidence of contamination that TVA attributed to multiple sources, including high levels of solids, boron, and molybdenum attributed to Ash Pond 4, and high pH and sulfate attributed to the chemical treatment pond.[85] Second, groundwater near the coal yard and coal yard drainage basin showed evidence of contamination from those sources, including low pH, high sulfate and dissolved solids, and "excessive levels of several heavy metals and cadmium."[86] Most of the wells around the coal yard drainage basin were abandoned in the late 1990s (see "data gaps" below). Finally, there was some evidence, though not as strong, of contamination from Ash Pond 5.[87] More recent data are discussed below.

Overview of recent monitoring

The groundwater quality database for Colbert is better than for most TVA sites, with data going back to 1982, over twenty actively monitored wells (Fig. 4-1), and a complete set of monitored parameters (4-2 to 4-26). Monitoring was originally required under both solid waste and NPDES permits. Alabama exempted coal ash from landfill regulations between 1982 and

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[79] TVA, *Colbert Steam Plant – Ash Pond 5 Engineering Report*, at 1 – 4 (Apr. 1985).
[80] Letter from TVA to ADEM, *Response to Groundwater Incident Number GW 93-6-4 and Notice of Violation (NOV)* (Oct. 6, 1993).
[81] TVA, *Colbert Fossil Plant Groundwater Assessment*, at 1 (Oct. 1994).
[82] *Id.* at 4.
[83] Letter from TVA to ADEM, *Tennessee Valley Authority (TVA) – Colbert Fossil Plant (COF) – NPDES Permit No. AL0003867 – Sinkhole Development* (Feb. 6, 2012).
[84] TVA, *Colbert Fossil Plant Groundwater Assessment*, at iii (Oct. 1994).
[85] *Id.* at 66.
[86] *Id.* at 66 – 70.
[87] *Id.* at 68 – 70.

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2011,[88] but the Alabama Department of Environmental Management (ADEM) continued to require monitoring pursuant to a 1993 Notice of Violation.[89]

In general, the same issues identified in the 1994 report (see preceding section) continue today.

- Wells MC1, MC4, MC5A, and MC5C are all west and downgradient of Ash Pond 4 and the metal cleaning pond, and they show consistently high levels of antimony, arsenic, boron, and molybdenum. Although the metal cleaning pond may have been partly responsible for the contamination, and was closed by TVA, the ash pond is likely to be the major cause. The groundwater flow in this area is to the west and southwest, away from the river and toward the boundary of TVA's property, raising concerns about offsite drinking water impacts.

- Wells 17A, 17B, 31A, and 30B are downgradient of Ash Pond 4 to the east and north. TVA recently noted that "[i]ron and manganese levels exceed historical range of background levels, and therefore likely indicate coal ash contamination at these wells."[90]

- Wells downgradient of Area 5, an area known to be susceptible to karst-related sinkholes, also show evidence of ash-related contamination.[91]

Ash Pond 4 is scheduled for final closure in 2020. The problems related to seeps and leaching are likely to continue in the meantime; whether the site continues to present a threat to groundwater after closure will depend on how TVA chooses to close the pond.

Data Gaps

- The monitoring well network at Colbert, which now consists of 25 wells, in the past included 41 or more wells.[92] Some of these were offsite private wells that were abandoned when the owners connected to public water supplies.[93] In 1999, ADEM approved the abandonment of five wells surrounding the coal yard drainage basin after TVA argued that the wells were redundant or were producing results that were

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[88] *See* 2011 Alabama Laws Act 2011-258 (H.B. 50); Ala. Code §§ 22-27-2 and 22-27-3.
[89] TVA, *Colbert Fossil Plant Groundwater Update – 1999*, at 9 (Oct. 1999).
[90] TVA, *Colbert Fossil Plant Groundwater Monitoring Report – April 2012*, at 8 (July 5, 2012).
[91] *See, e.g., id.* at 8 – 9.
[92] *See* TVA, *Colbert Fossil Plant Groundwater Update – 1999*, at 2 (Oct. 1999) (describing 37 on-site wells and 4 off-site wells).
[93] *See, e.g.*, Letter from TVA to ADEM, *Groundwater Assessment Update Report – Groundwater Incident 93-6-4* (Jan. 19, 2000). The two private wells approved for abandonment in this letter were offsite; one to the far northeast, and one just south of the Dry Fly Ash Landfill.

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"unremarkable/statistically insignificant."[94] In fact, as shown in Table 4-1, some of these wells showed clear evidence of contamination from the drainage basin including low pH, high sulfate and TDS, and high levels of some metals. These wells should not have been abandoned. Wells MC2 and MC3, which were located immediately south of the metal cleaning pond and showed high levels of antimony, arsenic, boron, and molybdenum, were abandoned in 2003 and replaced with wells MC5A and MC5B.[95] From what we have on file it is not clear why these wells were abandoned.

Table 4-1: Evidence of contamination from three wells around the coal yard drainage basin, all abandoned after 1999 (mean and range of data over stated period).[96]

Pollutant	**Threshold** (see Table 1-1)	**Well CA14** (6/17/1986-9/14/1993)	**Well CA18A** (6/18/1986-2/25/1997)	**Well CA24A** (9/27/1989-9/26/1991)
pH	6.5-8.5 (SMCL)	4.9 (4.1-5.7)	6.0 (5.4-6.4)	6.5 (6.1-6.9)
Sulfate (mg/L)	500 (DWA)	1,291 (130-1,900)	1,078 (580-1,900)	322 (160-610)
TDS (mg/L)	500 (SMCL)	2,087 (1,400-3,000)	1,751 (930-2,400)	694 (390-1,100)
Aluminum (mg/L)	16.0 (RSL)	19.8 (2.4-56.0)	0.36 (0.1-3.4)	10.1 (0.1-47.0)
Cadmium (ug/L)	5.0 (MCL)	46.8 (0.1-101)	5.4 (0.2-46)	2.3 (0.8-5.7)
Manganese (mg/L)	0.3 (LHA)	63.4 (27-99.4)	21.9 (0.0-34.0)	13.7 (8.7-22.0)

- Wells CA9R and CA29BR have not been monitored for key non-metal pollutants, including sulfate and chloride, since spring 2010.
- Many pollutants were not measured in any wells in April 2013 (see 4-2 to 4-26 below). It is not clear whether TVA intends to measure these pollutants less frequently or to stop measuring them altogether. For the most part, these were pollutants that have never been found at high concentrations at the plant. Cobalt, however, has been found at unsafe levels in several wells, and is a pollutant of concern in the coal ash context.[97] TVA should continue to monitor cobalt on a regular basis.

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[94] Letter from TVA to ADEM, *Groundwater Assessment Update Report – Groundwater Incident 93-6-4*, Enclosure A: Groundwater Well Summary (Mar. 6, 1998); Letter from ADEM to TVA, *Re: Groundwater Incident GW-93-4* (Mar. 9, 1999).

[95] Letter from TVA to ADEM, *Groundwater Assessment Monitoring Report* (Jan. 8, 2004).

[96] TVA, *Colbert Fossil Plant Groundwater Update – 1999*, at A13-A27 (Oct. 1999).

[97] *See, e.g.*, U.S. EPA, 75 Fed. Reg. 35128, 35145 (June 21, 2010) (identifying cobalt as one of the two "constituents with the highest estimated risks for surface impoundments.").

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Figure 4-1: Groundwater wells at Colbert Fossil Plant (approximate locations)

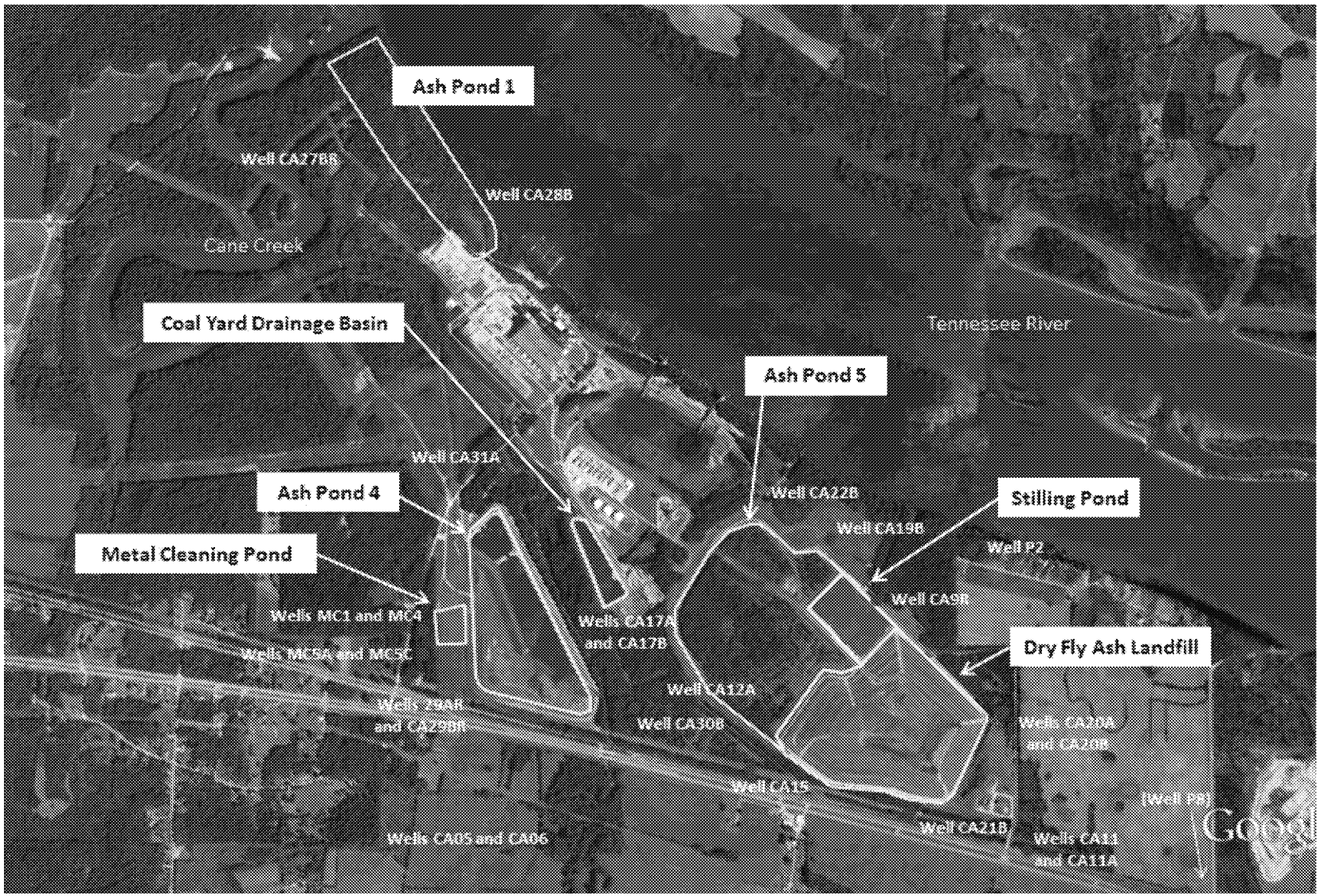

Table 4-2: Colbert Fossil Plant, Well CA19B. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 170	
Antimony	6	<1	
Arsenic	10	<1 – 3.3	
Barium	2,000	25 – 33	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200 – 240	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	14 – 20 mg/L	No data in 4/2013
Chromium	100	<2 – 9.8	
Cobalt	4.7	<1 – 7.2[98]	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	<100 – 160	No data in 4/2013
Lead	15	<1	
Lithium	31	<15	
Manganese	300	<10 – 61	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<5 – 18	
Nickel	100	3.0 – 9.0	No data in 4/2013
Nitrate	10,000	1,200 – 1,700	
Selenium	50	<1 – 2.3	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	290 – 360	
Sulfate	500 mg/L	190 – 240 mg/L	
TDS	500 mg/L	610 – 720 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 19	

Table 4-3: Colbert Fossil Plant, Well CA11. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 830	
Antimony	6	<1 – 1	
Arsenic	10	<1 – 3.3	
Barium	2,000	16 – 21	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	1.2 – 2.5	No data in 4/2013
Chromium	100	2.3 – 19.0	
Cobalt	4.7	<1 – 6.5	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	<100 – 130	No data in 4/2013
Lead	15	3.3 – 6.6	
Lithium	31	<15	
Manganese	300	<10 – 62	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 13	
Nickel	100	4.4 – 32.0	No data in 4/2013
Nitrate	10,000	360 – 600	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	140 – 200	
Sulfate	500 mg/L	<5 mg/L	
TDS	500 mg/L	290 – 390 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 31	

[98] The only positive cobalt reading was in October 2011; all other measurements were nondetect (<1 ug/L).

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Table 4-4: Colbert Fossil Plant, Well CA12A. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 1,900	
Antimony	6	<1 – 5.5	
Arsenic	10	<1 – 1.9	
Barium	2,000	32 – 56	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	1.4 – 3.6 mg/L	No data in 4/2013
Chromium	100	<2 – 6.6	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2 – 3.9	
Fluoride	4,000	120 – 1,200	No data in 4/2013
Lead	15	3 – 160	
Lithium	31	<15	
Manganese	300	<10 – 32	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 15	
Nickel	100	2.7 – 23.0	No data in 4/2013
Nitrate	10,000	<100 – 390	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	160 – 260	
Sulfate	500 mg/L	7.4 – 8.9 mg/L	
TDS	500 mg/L	190 – 280 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 66	

Table 4-5: Colbert Fossil Plant, Well CA16. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	
Antimony	6	<1	
Arsenic	10	<1 – 1.6	
Barium	2,000	22 – 37	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200 – 1,200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	4.4 – 7.6 mg/L	No data in 4/2013
Chromium	100	<2 – 4.7	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	<100	No data in 4/2013
Lead	15	<1	
Lithium	31	<15 – 19	
Manganese	300	<10	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 16	
Nickel	100	<1 – 5.6	No data in 4/2013
Nitrate	10,000	1,700 – 2,700	
Selenium	50	<1 – 3.2	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	120 – 200	
Sulfate	500 mg/L	11 – 120 mg/L	
TDS	500 mg/L	310 – 500 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 10	

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Table 4-6: Colbert Fossil Plant, Well CA17A. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 7,000	
Antimony	6	<1	
Arsenic	10	<1 – 3.4	
Barium	2,000	28 – 73	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	2.7 – 4.7 mg/L	No data in 4/2013
Chromium	100	<2 – 21	
Cobalt	4.7	<1 – 1.3	No data in 4/2013
Copper	1,300	<2 – 7.2	
Fluoride	4,000	<100	No data in 4/2013
Lead	15	<1 – 5.7	
Lithium	31	<15	
Manganese	300	<10 – 180	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 6	
Nickel	100	1.3 – 8.9	No data in 4/2013
Nitrate	10,000	<100 – 840	
Selenium	50	<1 – 1.4	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	29 – 97	
Sulfate	500 mg/L	9.1 – 14.0 mg/L	
TDS	500 mg/L	60 – 120 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2 – 18	
Zinc	2,000	<10 – 56	

Table 4-7: Colbert Fossil Plant, Well CA17B. Sampled 5 times between April 2011 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	
Antimony	6	<1	
Arsenic	10	1.0 – 9.2	
Barium	2,000	18 – 25	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	4.8 – 15 mg/L	No data in 4/2013
Chromium	100	<2 – 4.6	
Cobalt	4.7	6.1 – 19.0	No data in 4/2013
Copper	1,300	<2 – 2.7	
Fluoride	4,000	<100 – 290	No data in 4/2013
Lead	15	<1 – 6.2	
Lithium	31	<15 – 20	
Manganese	300	660 – 1,700	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 72	
Nickel	100	12 -24	No data in 4/2013
Nitrate	10,000	<100	
Selenium	50	<1 – 1.0	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	180 – 840	
Sulfate	500 mg/L	150 – 1,000 mg/L	
TDS	500 mg/L	500 – 1,800 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	12 – 48	

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Table 4-8: Colbert Fossil Plant, Well CA20A. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 40,000	
Antimony	6	<1	
Arsenic	10	<1 – 13	
Barium	2,000	25 – 110	No data in 4/2013
Beryllium	4	<2 – 3.6	No data in 4/2013
Boron	3,000	<200 – 440	
Cadmium	5	<0.5 – 0.76	No data in 4/2013
Chloride	250 mg/L	1.2 – 2.5 mg/L	No data in 4/2013
Chromium	100	<2 – 19	
Cobalt	4.7	<1 – 4.2	No data in 4/2013
Copper	1,300	<2 – 12	
Fluoride	4,000	<100	No data in 4/2013
Lead	15	<1 – 8.9	
Lithium	31	<15 – 32[99]	
Manganese	300	<10 – 420	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 14	
Nickel	100	3.1 – 36	No data in 4/2013
Nitrate	10,000	2,300 – 4,200	
Selenium	50	<1 – 2.0	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	89 – 140	
Sulfate	500 mg/L	11 – 20 mg/L	
TDS	500 mg/L	250 – 340 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2 – 28	
Zinc	2,000	<10 – 230	

[99] Lithium was measured at 32 ug/L in October 2010; all other measurements have been nondetect (<15 ug/L).

Table 4-9: Colbert Fossil Plant, Well CA20B. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	
Antimony	6	<1 – 1.6	
Arsenic	10	<1 – 3.3	
Barium	2,000	32 – 37	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	1.6 – 1.9 mg/L	No data in 4/2013
Chromium	100	3.1 – 5.2	
Cobalt	4.7	<1 – 4.2	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	<100 – 100	No data in 4/2013
Lead	15	<1	
Lithium	31	<15	
Manganese	300	<10	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<150[100]	
Nickel	100	3.2 – 8.4	No data in 4/2013
Nitrate	10,000	1,000 – 2,800	
Selenium	50	<1 – 6.2	No data in 4/2013
Silver	100	<1 – 1.3	No data in 4/2013
Strontium	9,300	170 – 190	
Sulfate	500 mg/L	16 – 18 mg/L	
TDS	500 mg/L	370 – 390 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 12	

[100] One of the five readings since April 2010 was reported as nondetect at <150 ug/L. This detection limit is inadequate to detect exceedances of the Lifetime Health Advisory for molybdenum (40 ug/L). In this case, however, the four earlier readings were all nondetect at <5 ug/L, the October 2012 reading was 8.2 ug/L, and the April 2013 reading was <2 ug/L, all well below the Lifetime Health Advisory.

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Table 4-10: Colbert Fossil Plant, Well CA21B. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 4,800	
Antimony	6	<1	
Arsenic	10	<1 – 19	
Barium	2,000	27 – 55	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200 – 9,300	
Cadmium	5	<0.5 – 4.4	No data in 4/2013
Chloride	250 mg/L	3.3 – 9.6 mg/L	No data in 4/2013
Chromium	100	2.2 – 27	
Cobalt	4.7	<1 – 13	No data in 4/2013
Copper	1,300	<2 – 12	
Fluoride	4,000	<100	No data in 4/2013
Lead	15	<1 – 15	
Lithium	31	<15 – 200	
Manganese	300	<10 – 82	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	7 – 180	
Nickel	100	1.8 – 43	No data in 4/2013
Nitrate	10,000	<100 – 1,700	
Selenium	50	<1 – 4.3	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	200 – 430	
Sulfate	500 mg/L	62 – 360	
TDS	500 mg/L	400 – 820	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2 – 26	
Zinc	2,000	<10 – 240	

Table 4-11: Colbert Fossil Plant, Well CA22B. Sampled 7 times between April 2010 and April.[101]

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 29,000 (see note)	
Antimony	6	<1	
Arsenic	10	<1 – 1.5	
Barium	2,000	50 – 52	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200 – 7,300 (see note)	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	2.4 – 13 mg/L	No data in 4/2013
Chromium	100	<2 – 9.3	
Cobalt	4.7	<1 – 10 (see note)	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	<100 – 130	No data in 4/2013
Lead	15	<1 – 1.8	
Lithium	31	<15 – 160 (see note)	
Manganese	300	<10 – 1,700 (see note)	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 88 (see note)	
Nickel	100	3.3 – 11	No data in 4/2013
Nitrate	10,000	<100	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	250 – 390	
Sulfate	500 mg/L	87 – 420 mg/L	
TDS	500 mg/L	400 – 430 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 16	

[101] Sampling results in October 2011 were noticeably different than other dates in that aluminum, boron, cobalt, lithium, manganese, and molybdenum all exceeded their respective thresholds on this date only; all other dates, including 2012 sampling, showed results for these contaminants that were well below their respective thresholds.

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Table 4-12: Colbert Fossil Plant, Well CA27BR. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 830	
Antimony	6	<2 – 24	
Arsenic	10	<1 – 3.0	
Barium	2,000	22 – 47	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	1.2 – 1.4 mg/L	No data in 4/2013
Chromium	100	<2 – 9.4	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2 – 8.6	
Fluoride	4,000	270 – 3,000	No data in 4/2013
Lead	15	<1 – 5.6	
Lithium	31	<15	
Manganese	300	<10 – 33	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 6	
Nickel	100	3.1 – 13	No data in 4/2013
Nitrate	10,000	<100	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	160 – 190	
Sulfate	500 mg/L	<5 – 6.1 mg/L	
TDS	500 mg/L	150 – 180 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2 – 3.1	
Zinc	2,000	<10 – 33	

Table 4-13: Colbert Fossil Plant, Well CA28B. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 220	
Antimony	6	<1 – 1.3	
Arsenic	10	<1 – 4.8	
Barium	2,000	130 – 160	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	16 – 17 mg/L	No data in 4/2013
Chromium	100	<2	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2 – 3.4	
Fluoride	4,000	<100 – 160	No data in 4/2013
Lead	15	<1 – 3	
Lithium	31	<15	
Manganese	300	540 – 680	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 13	
Nickel	100	<1 – 4.7	No data in 4/2013
Nitrate	10,000	<100 – 110	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	180 – 260	
Sulfate	500 mg/L	<5 mg/L	
TDS	500 mg/L	360 – 380 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 20	

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Table 4-14. Colbert Fossil Plant, Well CA29AR. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 2,200 (decreasing)	
Antimony	6	<1	
Arsenic	10	<1 – 4.6	
Barium	2,000	30 – 40	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	1,200 – 2,000	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	19 – 33 mg/L	No data in 4/2013
Chromium	100	<2 – 8.2	
Cobalt	4.7	<1 – 3.2	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	<100 – 110	No data in 4/2013
Lead	15	<1 – 1.5	
Lithium	31	<15	
Manganese	300	200 – 700	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	32 – 67	
Nickel	100	1.4 – 6.4	No data in 4/2013
Nitrate	10,000	<100 – 300	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	88 – 110	
Sulfate	500 mg/L	36 – 80 mg/L	
TDS	500 mg/L	190 – 250 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2 – 5.8	
Zinc	2,000	<10 – 15	

Table 4.15. Colbert Fossil Plant, Well CA29BR. Sampled 6 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 1,100 (decreasing)	
Antimony	6	<1 – 1.1	
Arsenic	10	<1 – 12	
Barium	2,000	68 – 78	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	690 – 1,100	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	14 mg/L	No data since 4/2010
Chromium	100	<2	
Cobalt	4.7	<1 – 1.8	No data in 4/2013
Copper	1,300	<2 – 36	
Fluoride	4,000	160	No data since 4/2010
Lead	15	<1 – 2.7	
Lithium	31	<15 – 15	
Manganese	300	10 – 200	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	48 – 65	
Nickel	100	3.2 – 6.8	No data in 4/2013
Nitrate	10,000	<100 – 120	No data since 10/2011
Selenium	50	<1 – 2.9	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	250 – 340	
Sulfate	500 mg/L	36 mg/L	No data since 4/2010
TDS	500 mg/L	250 mg/L	No data since 4/2010
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	15 – 93	

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Table 4-16: Colbert Fossil Plant, Well CA30B. Sampled 4 times between April 2011 and October 2012.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 200	
Antimony	6	<1	
Arsenic	10	<1 – 2.9	
Barium	2,000	42 – 96	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	2.5 – 4.2 mg/L	No data in 4/2013
Chromium	100	<2 – 280	
Cobalt	4.7	1.2 – 11.0	No data in 4/2013
Copper	1,300	<2 – 7.8	
Fluoride	4,000	<100 – 140	No data in 4/2013
Lead	15	<1	
Lithium	31	<15	
Manganese	300	810 – 1,700	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 47	
Nickel	100	10 – 220	No data in 4/2013
Nitrate	10,000	<100 – 140	
Selenium	50	<1	No data in 4/2013
Silver	100	<1 – 15	No data in 4/2013
Strontium	9,300	94 – 480	
Sulfate	500 mg/L	69 – 540 mg/L (decreasing)	
TDS	500 mg/L	17.3 – 530 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2 – 7.5	
Zinc	2,000	<10 – 12	

Table 4-17: Colbert Fossil Plant, Well CA31A. Sampled 5 times between April 2011 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	100 – 180	
Antimony	6	<1	
Arsenic	10	<1 – 6.9	
Barium	2,000	46 – 95	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	590 – 910	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	25 – 39 mg/L	No data in 4/2013
Chromium	100	<2	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2 – 12	
Fluoride	4,000	<100	No data in 4/2013
Lead	15	<1	
Lithium	31	<15	
Manganese	300	110 – 650	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	21 – 51	
Nickel	100	1.4 – 3.0	No data in 4/2013
Nitrate	10,000	<100 – 200	
Selenium	50	<1 – 1.2	No data in 4/2013
Silver	100	<1 – 14	No data in 4/2013
Strontium	9,300	140 – 220	
Sulfate	500 mg/L	44 – 92 mg/L	
TDS	500 mg/L	290 – 370 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2 – 4.2	
Zinc	2,000	<10 – 28	

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Table 4-18: Colbert Fossil Plant, Well CA5. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	180 – 8,000	
Antimony	6	<1	
Arsenic	10	<1 – 8.1	
Barium	2,000	36 – 160	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5 – 1.3	No data in 4/2013
Chloride	250 mg/L	1.6 – 2.4 mg/L	No data in 4/2013
Chromium	100	<2 – 18	
Cobalt	4.7	<5[102]	No data in 4/2013
Copper	1,300	<2 – 160	
Fluoride	4,000	<100 – 130	No data in 4/2013
Lead	15	<1 – 100[103]	
Lithium	31	<15	
Manganese	300	12 – 340	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 5.5	
Nickel	100	6 – 99	No data in 4/2013
Nitrate	10,000	<100	
Selenium	50	<1 – 2	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	44 – 260	
Sulfate	500 mg/L	<5 – 8.5 mg/L	
TDS	500 mg/L	47 – 200 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2 – 13	
Zinc	2,000	<10 – 170	

Table 4-19: Colbert Fossil Plant, Well CA6. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 800	
Antimony	6	<1	
Arsenic	10	<1 – 3	
Barium	2,000	340 – 390	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	480 – 650	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	13 – 15 mg/L	No data in 4/2013
Chromium	100	<2 – 4.7	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	240 – 2,600	No data in 4/2013
Lead	15	<1	
Lithium	31	57 – 71	
Manganese	300	<10 – 19	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 6.2	
Nickel	100	<1 – 4	No data in 4/2013
Nitrate	10,000	<100	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	3,400 – 3,800	
Sulfate	500 mg/L	5.2 – 31 mg/L	
TDS	500 mg/L	<10 – 340 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 19	

[102] Cobalt has consistently been below the level of detection at this well. The detection limit was 5 ug/L on one sampling date (10/20/2010), but cobalt was reported as <1 ug/L on all other sample dates.

[103] Lead was reportedly found at 100 ug/L on 10/20/2010. All other measurements have been below the Action Level of 15 ug/L.

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Table 4-20: Colbert Fossil Plant, Well CA9R. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 200	
Antimony	6	1.9 – 59 (increasing)	
Arsenic	10	<1 – 4.6	
Barium	2,000	47 – 62	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	2,000 – 2,800	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	3.6 mg/L	No data since 4/2010
Chromium	100	<2	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2 – 46	
Fluoride	4,000	1,100	No data since 4/2010
Lead	15	<1 – 1.2	
Lithium	31	18 – 53	
Manganese	300	<10 – 48	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	18 – 57	
Nickel	100	2.7 – 7.3	No data in 4/2013
Nitrate	10,000	<100	No data 10/2010-10/2012
Selenium	50	<1 – 8.8	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	550 – 670	
Sulfate	500 mg/L	110 – 130 mg/L	No data 10/2010-10/2012
TDS	500 mg/L	370 – 390 mg/L	Rarely measured[104]
Thallium	2	<1	No data in 4/2013
Vanadium	63	3.4 – 6.3	
Zinc	2,000	<10 – 24	

[104] TVA measured TDS in well CA94 in April 2010 and April 2012, but not in the 5 other monitoring events represented by this table.

Table 4-21: Colbert Fossil Plant, Well MC1. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	1,300 – 1,600	
Antimony	6	12 – 15	
Arsenic	10	62 – 76[105]	
Barium	2,000	12 – 14	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	3,100 – 3,700	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	42 – 53 mg/L	No data in 4/2013
Chromium	100	<2	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	<100 – 120	No data in 4/2013
Lead	15	<1	
Lithium	31	<15 – 35	
Manganese	300	<10 – 13	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	150 – 180	
Nickel	100	<1.4 – 3.9	No data in 4/2013
Nitrate	10,000	<100	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	230 – 260	
Sulfate	500 mg/L	110 – 160 mg/L	
TDS	500 mg/L	280 – 320 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	50 – 69	
Zinc	2,000	<10	

[105] The April 2012 report lists the arsenic result for this well as <1 ug/L. This is so unlikely to be true that I did not include the result in the table.

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Table 4-22: Colbert Fossil Plant, Well MC4. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	500 – 955	
Antimony	6	5.1 – 11	
Arsenic	10	38 – 65[106]	
Barium	2,000	9.2 – 15	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	3,100 – 3,600	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	41 – 52 mg/L	No data in 4/2013
Chromium	100	<2	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2	
Fluoride	4,000	<100 – 110	No data in 4/2013
Lead	15	<1	
Lithium	31	<15 – 26	
Manganese	300	<10 – 15	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	140 – 180	
Nickel	100	<1 – 4.4	No data in 4/2013
Nitrate	10,000	<100 – 350	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	210 – 240	
Sulfate	500 mg/L	100 – 120 mg/L	
TDS	500 mg/L	280 – 300 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	4.9 – 19.5	
Zinc	2,000	<10	

[106] The April 2012 report lists the arsenic result for this well as <1 ug/L. This is so unlikely to be true that I did not include the result in the table.

Table 4-23: Colbert Fossil Plant, Well MC5A. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	450 – 5,500 (decreasing)	
Antimony	6	6.5 – 11	
Arsenic	10	15 – 72[107]	
Barium	2,000	14 – 43	
Beryllium	4	<2	
Boron	3,000	1,800 – 3,500	
Cadmium	5	<0.5	
Chloride	250 mg/L	32 – 52 mg/L	
Chromium	100	<2 – 11	
Cobalt	4.7	<1 – 2.2	
Copper	1,300	<2 – 2.4	
Fluoride	4,000	<100 – 115	
Lead	15	<1 – 2.3	
Lithium	31	<15 – 30	
Manganese	300	30 – 310	
Mercury	2	<0.2	
Molybdenum	40	70 – 170	
Nickel	100	2.4 – 9.0	
Nitrate	10,000	<100 – 110	
Selenium	50	<1 – 1.6	
Silver	100	<1	
Strontium	9,300	190 – 260	
Sulfate	500 mg/L	60 – 120 mg/L	
TDS	500 mg/L	240 – 300 mg/L	
Thallium	2	<1	
Vanadium	63	14 – 120	
Zinc	2,000	<10 – 19	

[107] The April 2012 report lists the arsenic result for this well as <1 ug/L. This is so unlikely to be true that I did not include the result in the table.

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Table 4-24: Colbert Fossil Plant, Well MC5C. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 160	
Antimony	6	<1	
Arsenic	10	<1 – 1.7	
Barium	2,000	140 – 150	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	1,100 – 1,300	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	20 – 23 mg/L	No data in 4/2013
Chromium	100	<2 – 10	
Cobalt	4.7	<1 – 1.9	No data in 4/2013
Copper	1,300	<2 – 2.1	
Fluoride	4,000	<100 – 1,900	No data in 4/2013
Lead	15	<1	
Lithium	31	<15 – 84	
Manganese	300	19 – 110	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	38 – 54	
Nickel	100	<2 – 15	No data in 4/2013
Nitrate	10,000	<100	
Selenium	50	<1	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	1,200 – 1,500	
Sulfate	500 mg/L	51 – 62 mg/L	
TDS	500 mg/L	220 – 250 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	<10 – 19	

Table 4-25: Colbert Fossil Plant, Well P2. Sampled 7 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	1,300 – 14,000	
Antimony	6	<1	
Arsenic	10	<1 – 8.0	
Barium	2,000	34 – 69	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	340 – 930	
Cadmium	5	<0.5	No data in 4/2013
Chloride	250 mg/L	14 – 57 mg/L	No data in 4/2013
Chromium	100	2.6 – 21	
Cobalt	4.7	<1 – 2.2	No data in 4/2013
Copper	1,300	<2 – 48	
Fluoride	4,000	120 – 200	No data in 4/2013
Lead	15	1.3 – 6.3	
Lithium	31	<15 – 25	
Manganese	300	31 – 220	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 11	
Nickel	100	13 – 26	No data in 4/2013
Nitrate	10,000	240 – 610	
Selenium	50	<1 – 2.9	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	130 – 255	
Sulfate	500 mg/L	31 – 74 mg/L	
TDS	500 mg/L	350 – 440 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	2.6 – 20	
Zinc	2,000	38 – 350	

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Table 4-26: Colbert Fossil Plant, Well P8. Sampled 6 times between April 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	
Antimony	6	<1	
Arsenic	10	<1 – 3.7	
Barium	2,000	30 – 47	No data in 4/2013
Beryllium	4	<2	No data in 4/2013
Boron	3,000	<200	
Cadmium	5	<0.5 – 0.75	No data in 4/2013
Chloride	250 mg/L	2.6 – 6.0 mg/L	No data in 4/2013
Chromium	100	<2	
Cobalt	4.7	<1	No data in 4/2013
Copper	1,300	<2 – 7.7	
Fluoride	4,000	140 – 420	No data in 4/2013
Lead	15	<1 – 18	
Lithium	31	<15 – 23	
Manganese	300	<10 – 14	
Mercury	2	<0.2	No data in 4/2013
Molybdenum	40	<2 – 8.4	
Nickel	100	3.5 – 7.0	No data in 4/2013
Nitrate	10,000	<100 – 530	
Selenium	50	<1 – 5.0	No data in 4/2013
Silver	100	<1	No data in 4/2013
Strontium	9,300	110 – 230	
Sulfate	500 mg/L	6.7 – 9.3 mg/L	
TDS	500 mg/L	220 – 260 mg/L	No data in 4/2013
Thallium	2	<1	No data in 4/2013
Vanadium	63	<2	
Zinc	2,000	140 – 2,700	

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5 Cumberland Fossil Plant

Background

The Cumberland Fossil Plant is located on the Cumberland River near Nashville, TN. TVA has been operating two coal units at the site since the early 1970s. Cumberland's ash disposal area was originally one large ash pond. TVA installed sulfur dioxide scrubbers in 1994, and in 1995-1996 separated the area into the current configuration: The ash pond receives wet-sluiced bottom ash, which is dredged and stacked in the dry fly ash disposal area, and fly ash is dry-handled and stacked in the dry fly ash disposal area. Gypsum is wet-sluiced to the gypsum disposal area or directly routed to a neighboring gypsum processing plant. The dry fly ash and gypsum disposal areas are therefore built over an unknown amount of sluiced bottom and fly ash that was left in the original ash pond.[108] TVA has had ongoing problems with seepage along the west perimeter dike, along the bank of Wells Creek.[109] Groundwater under the site is in contact with ash and, in some places, gypsum.[110]

Overview of monitoring

TVA currently monitors and reports on groundwater quality in six downgradient wells. TVA also monitors two surface water locations, including one spring, and uses them as upgradient reference points. The tables below also include well 93-2, which TVA removed from monitoring in 2011.

Monitoring shows that coal ash has affected groundwater quality across the site, as shown in tables 5-2 to 5-10. Table 5-1, below, summarizes results for four coal ash indicator pollutants. Wells 93-2 and 93-2R, in particular, show that very high concentrations of these pollutants are migrating from the ash disposal area to Wells Creek.

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[108] *See* Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Tennessee*, Cumberland Fossil Plant Dry Ash Stack, 2 (June 24, 2009) ("It is unknown how much sluiced ash is beneath the [dry ash] stack.").
[109] *Id*. at 5; Stantec Consulting Services, Inc., *Dry Fly Ash Stack and Gypsum Disposal Complex*, at 8 – 10 (June, 2010) (identifying seepage studies from 2005 and 2008), *id*. at 29 (describing seepage in 1973 – 1974), and *id*. at Appendix A (identifying historical documents, some of which concern seepage over the 1973 – 2005 period).
[110] *See, e.g.*, *id*. at 44, Appendix B, and Appendix C.

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Table 5-1: Mean concentrations of selected coal ash indicators in Cumberland monitoring network, October 2009-April 2013. All units mg/L.

Well or sampling point	Boron	Chloride	Manganese	Sulfate
Upgradient				
Rye Spring	0.3	9	0.2	54
Wells Creek	0.2	6	0.02	7
Downgradient				
93-1	0.6	417	9.3	192
93-2	34.9	1,386	3.8	1,957
93-2R	14.0	1,158	13.5	1,313
93-3	6.0	47	1.2	189
93-4	5.6	390	0.2	840
10-1	0.2	17	4.2	70
10-2	0.2	51	16.5	111

TVA is not required to report boron, chloride, manganese, or sulfate results to TDEC for compliance monitoring purposes, and TDEC does not apply Groundwater Protection Standards (GWPSs) for these pollutants at Cumberland. However, high concentrations of selenium in well 93-2 led TDEC to place Cumberland in assessment monitoring in early 2009.[111] Since that time, TVA has reported intermittent exceedances of Tennessee GWPSs for arsenic, selenium, and vanadium. TVA found unusually high arsenic levels in January 2013. In response, they had the wells retested; the second round of results was lower, and TVA reported these lower results to TDEC. Figure 5-1 below includes both original and retest results for each well for that date. It does appear that initial results from January 2013 were erroneous.

[111] *See* TVA, *Cumberland Fossil Plant Dry Ash and Gypsum Disposal Areas Groundwater Assessment Monitoring Report – April 2009*, at 1 (May 20, 2009). TDEC regulations require quarterly assessment monitoring whenever semi-annual detection monitoring shows a significant increase in any detection monitoring pollutants. Tenn. Comp. R. & Regs. 0400-11-01-.04(7)6.

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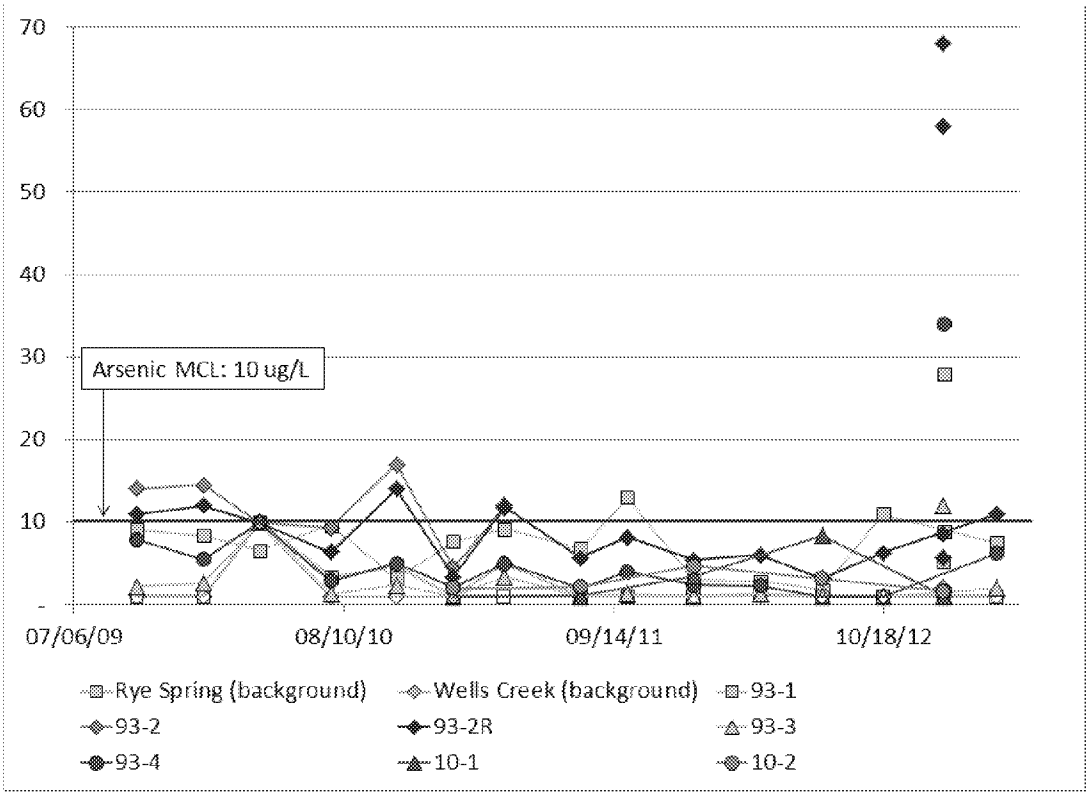
Figure 5-1: Arsenic in Cumberland wells. Hollow data points were undetected at the detection limit shown. Lines do not intersect January 2013 data, some of which may have been in error.



TVA also discovered very high concentrations of cobalt in USWAG well 10-2, at 130-150 ug/L, observing that "[t]he value of cobalt at well 10-2 is exceptionally high, higher than any in the fleet."[112] TVA's response to this dramatic problem was to dismiss it and then ignore it. TVA claimed that they had "no MCL or UPL in place that this value is exceeding,"[113] flatly ignoring the use of RSLs or Preliminary Remediation Goals for cobalt at Bull Run, Gallatin, and John Sevier. TVA stopped measuring cobalt in this well after 2011.

Data Gaps

TVA stopped reporting results from well 93-2 in 2011 despite the fact that it was showing unsafe concentrations of several pollutants. TVA describes well 93-2R, which was installed in the same location sometime prior to 2008, as a replacement well. This is misleading, however, because the two wells are screened in different strata: Well 93-2 was screened in a layer of gravel roughly parallel to neighboring Wells Creek, while well 93-2R, the deepest onsite well, is

[112] TVA, *Cumberland Fossil Plant USWAG Groundwater Monitoring Report – July 2011*. In fact, higher concentrations of cobalt have been seen at the Gallatin and Paradise plants.
[113] *Id*.

screened roughly 5 meters deeper, in bedrock.[114] As might be expected, the water quality in the two wells is not the same: Well 93-2 shows higher concentrations of boron, chloride, molybdenum, selenium, strontium, and sulfate, while well 93-2R shows higher concentrations of aluminum, barium, cadmium, and manganese. Because these wells provide evidence for different kinds of contamination in different groundwater strata, TDEC should require TVA to continue monitoring both wells.

Wells 10-1 and 10-2 are being monitored as part of TVA's voluntary impoundment monitoring program. In 2011, TVA stopped reporting results from these wells for key coal ash indicators including boron, chloride, cobalt, manganese, molybdenum, and sulfate. Without these data, TVA, TDEC, and the public do not have a clear sense of how the Cumberland ash pond is affecting local groundwater; TVA should continue to measure and report a full suite of pollutants at all wells.

Finally, TVA maintains very few wells at Cumberland and may not be able to adequately characterize the site. For example, the western edge of the site, and the western edge of the ash pond in particular, is effectively unmonitored. TVA should install additional wells at Cumberland to create a more comprehensive database.

Failure to Regulate

Despite the evidence of contamination described above, including reported exceedances of state GWPSs and unsafe concentrations of other pollutants for which TDEC has not established GWPSs, TDEC has not required TVA to remediate the site. TVA's Office of the Inspector General made the following observation about Cumberland (and Gallatin):

> TDEC's Guidance states that Phase III assessment requires the development of a Groundwater Quality Assessment Plan, which should be submitted no later than 45 days after a constituent exceeds the groundwater protection standard. Also, an assessment of corrective measures is to be initiated within 90 days. The policy also states that TDEC will issue a Notice of Violation at the time the assessment is initiated. However, TDEC personnel noted that the above policy has room for discretion and that it would be impossible to meet the 45- and 90-day requirements. <u>TDEC personnel also noted that they were not required to</u>

[114] Groundwater well screen depths are provided in Appendix A to each groundwater monitoring report. Well 93-2 is screened at a depth of 10.6-13.6 meters; well 93-2R is screened at a depth of 19-22 meters. Although we were not able to review well development logs for these wells, soil boring B-21, located a short distance away from these monitoring wells, shows bedrock at a depth of roughly 14 meters. Stantec Consulting Services, Inc., *Report of Geotechnical Exploration, Dry Fly Ash Stack and Gypsum Disposal Complex, Cumberland Fossil Plant, Appendix B* (June, 2010).

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issue a Notice of Violation and chose not to as long as TVA was cooperative and working toward making a quality plan.[115]

There is no evidence that the problems at Cumberland will improve without TDEC intervention. Instead of turning a blind eye to an obvious source of contamination, TDEC and TVA should jointly investigate the possibility of removing the ash from Cumberland's waste disposal area and transferring it to a dry, lined, monitored disposal site.

[115] TVA Office of the Inspector General, *TVA's Groundwater Monitoring at Coal Combustion Products Disposal Areas*, at 7 (June 21, 2011) (emphasis added).

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Figure 5-2: Groundwater wells at Cumberland Run Fossil Plant (approximate locations)

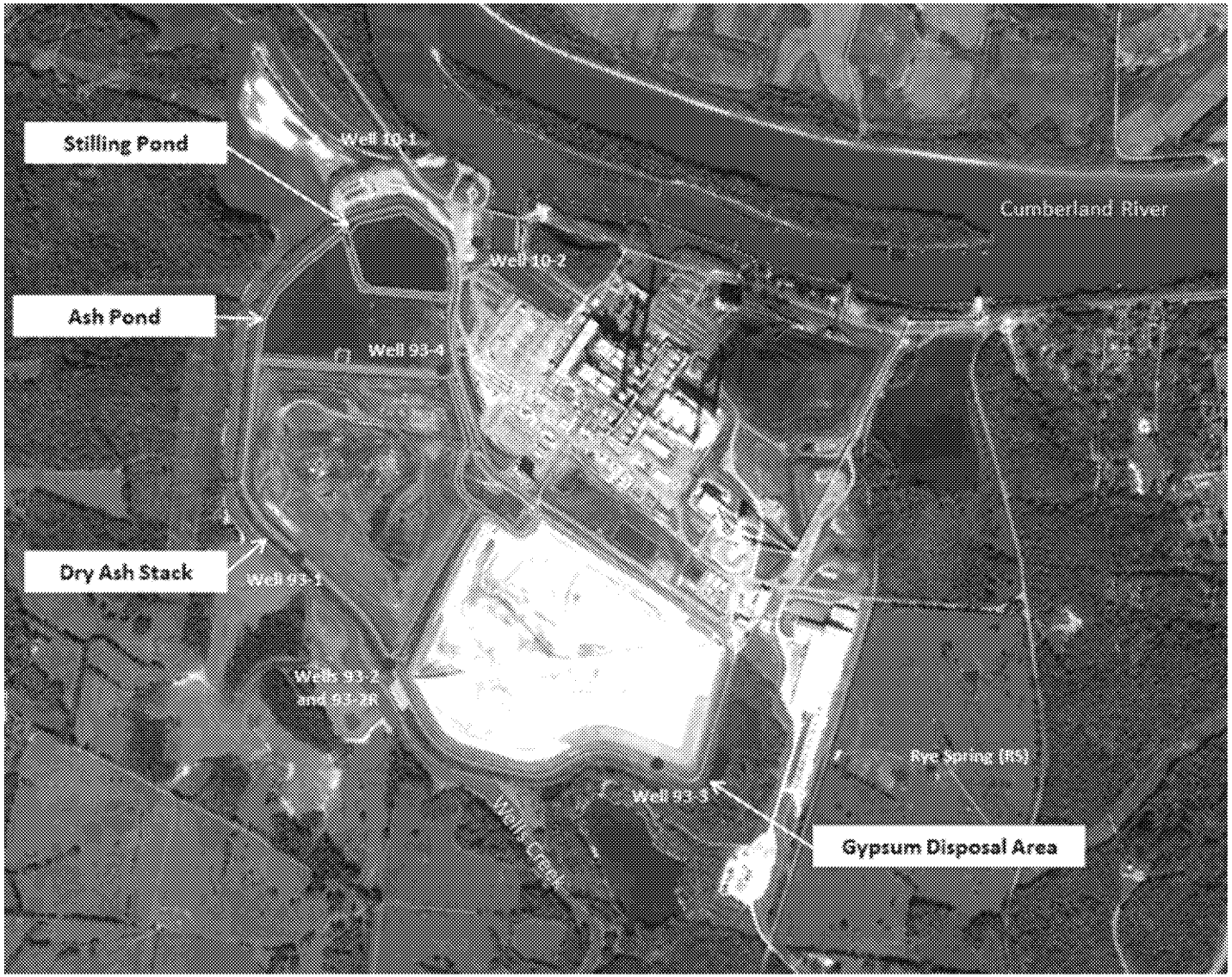

Table 5-2: Cumberland Fossil Plant, Well 10-1. Sampled 5 times between January 2011 and January 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	120 – 350	No data since 7/2011
Antimony	6	<1	
Arsenic	10	<1 – 8.4	
Barium	2,000	55 – 69	
Beryllium	4	<2	
Boron	3,000	<200	No data since 7/2011
Cadmium	5	<0.5 – 1.5	
Chloride	250 mg/L	17 mg/L	No data since 7/2011
Chromium	100	<2 – 2.5	
Cobalt	4.7	6.4 – 7.4	No data since 7/2011
Copper	1,300	<2	No data since 7/2011
Fluoride	4,000	260 – 360	No data since 1/2012
Lead	15	<1	
Lithium	31		No data
Manganese	300	4,000 – 4,300	No data since 7/2011
Mercury	2	<0.2	
Molybdenum	40	<0.5 – 5.7	No data since 7/2011
Nickel	100	6 – 30	
Nitrate	10,000	<100	
Selenium	50	<1 – 1.3	
Silver	100	<1 – 1.5	
Strontium	9,300	120 – 130	No data since 7/2011
Sulfate	500 mg/L	69 – 70 mg/L	No data since 7/2011
TDS	500 mg/L	290 – 330 mg/L	No data since 7/2011
Thallium	2	<1	
Vanadium	63	<2	No data since 7/2011
Zinc	2,000	<10 – 10	No data since 7/2011

Table 5-3: Cumberland Fossil Plant, Well 10-2. Sampled 5 times between January 2011 and January 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	No data since 7/2011
Antimony	6	<1	
Arsenic	10	1.7 – 4.7	
Barium	2,000	69 – 80	
Beryllium	4	<2	
Boron	3,000	<200 – 210	No data since 7/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	49 – 52 mg/L	No data since 7/2011
Chromium	100	<2 – 2.3	
Cobalt	4.7	130 – 150	No data since 7/2011
Copper	1,300	<2	No data since 7/2011
Fluoride	4,000	<100	No data since 1/2012
Lead	15	<1	
Lithium	31		No data
Manganese	300	16,000 – 17,000	No data since 7/2011
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 7/2011
Nickel	100	11 – 18	
Nitrate	10,000	<100 – 140	
Selenium	50	<1 – 1	
Silver	100	<1	
Strontium	9,300	220	No data since 7/2011
Sulfate	500 mg/L	110 – 111 mg/L	No data since 7/2011
TDS	500 mg/L	290 – 320 mg/L	No data since 7/2011
Thallium	2	<1	
Vanadium	63	<2	No data since 7/2011
Zinc	2,000	20 – 24	No data since 7/2011

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Table 5-4: Cumberland Fossil Plant, Well 93-1. Sampled 15 times between October 2010 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 600	Not always measured[116]
Antimony	6	<1 – 3.5	
Arsenic	10	1.8 – 28[117]	
Barium	2,000	170 – 330	
Beryllium	4	<2	
Boron	3,000	480 – 1,100	See note
Cadmium	5	<0.5 – 2.0	
Chloride	250 mg/L	250 – 540 mg/L	See note
Chromium	100	<2 – 16	
Cobalt	4.7	1.0 – 10.0	
Copper	1,300	<2 – 18	
Fluoride	4,000	<100 – 190	
Lead	15	<1 – 1.6	
Lithium	31		No data
Manganese	300	1,000 – 32,000	See note
Mercury	2	<0.2	
Molybdenum	40	<5 – 21	See note
Nickel	100	2.1 – 28	
Nitrate	10,000	<100	See note
Selenium	50	<5	
Silver	100	<1 – 3.3	
Strontium	9,300	1,000 – 3,000	See note
Sulfate	500 mg/L	120 – 250 mg/L	See note
TDS	500 mg/L	1,200 – 2,000 mg/L	See note
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 27	

Table 5-5: Cumberland Fossil Plant, Well 93-2. Sampled 7 times between October 2009 and April 2011.[118]

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 - 200	
Antimony	6	<1 – 2.3	
Arsenic	10	4.5 – 17	
Barium	2,000	27 – 41	
Beryllium	4	<2	
Boron	3,000	33,500 – 38,000	
Cadmium	5	<2.5	
Chloride	250 mg/L	1,300 – 1,500 mg/L	
Chromium	100	<10	
Cobalt	4.7	3.4 – 9.4	
Copper	1,300	<10	
Fluoride	4,000	440 – 800	
Lead	15	<1	
Lithium	31		No data
Manganese	300	2,700 – 4,900	
Mercury	2	<1	
Molybdenum	40	420 – 540	
Nickel	100	<1 – 63	
Nitrate	10,000	550 – 1,600	
Selenium	50	13 – 49.5	
Silver	100	<1	
Strontium	9,300	3,000 – 3,400	
Sulfate	500 mg/L	1,800 – 2,100 mg/L	
TDS	500 mg/L	4,850 – 6,600 mg/L	
Thallium	2	<1	
Vanadium	63	<10 – 18	
Zinc	2,000	<50	

[116] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were not measured in April 2012, July 2012, or January 2013.

[117] TVA measured arsenic at 28 ug/L in January 2013, then retested and obtained a result of 8.8 ug/L. See text for further details.

[118] This well was abandoned in 2011. TVA continues to monitor a replacement well located nearby (Well 93-2R).

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Table 5-6: Cumberland Fossil Plant, Well 93-2R. Sampled 15 times between October 2009 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	120 – 700	Not always measured[119]
Antimony	6	<1	
Arsenic	10	3.2 – 68[120]	
Barium	2,000	46 – 63	
Beryllium	4	<2	
Boron	3,000	12,000 – 16,000	See note
Cadmium	5	1.2 – 3.6	
Chloride	250 mg/L	1,100 – 1,200 mg/L	See note
Chromium	100	<2 – 16	
Cobalt	4.7	1.1 – 9.0	
Copper	1,300	<10	
Fluoride	4,000	<100 – 240	
Lead	15	<1	
Lithium	31		No data
Manganese	300	11,000 – 18,000	See note
Mercury	2	<1	
Molybdenum	40	<5 – 13	See note
Nickel	100	<1 – 74	
Nitrate	10,000	<0.1	See note
Selenium	50	<1 – 15.5	
Silver	100	<1 – 1.1	
Strontium	9,300	1,300 – 1,500	See note
Sulfate	500 mg/L	1,250 – 1,400 mg/L	See note
TDS	500 mg/L	2,800 – 5,100 mg/L	See note
Thallium	2	<2	
Vanadium	63	<10	
Zinc	2,000	<50	

[119] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were not measured in April 2012, July 2012, or January 2013.

[120] When TVA measured high arsenic in January 2013 (58 ug/L and 68 ug/L in duplicate samples), they retested the well, again in duplicate, and measured 8.6 and 5.7 ug/L. See text for further details.

Table 5-7: Cumberland Fossil Plant, Well 93-3. Sampled 15 times between October 2009 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 7,600	Not always measured[121]
Antimony	6	<1 – 1.9	
Arsenic	10	<1 – 12[122]	
Barium	2,000	140 – 180	
Beryllium	4	<2	
Boron	3,000	5,700 – 6,500	See note
Cadmium	5	<0.5	
Chloride	250 mg/L	37 – 62 mg/L	See note
Chromium	100	<2 – 14	
Cobalt	4.7	<1 – 4.4	
Copper	1,300	<2 – 4.9	
Fluoride	4,000	320 – 510	
Lead	15	<1 – 4.2	
Lithium	31		No data
Manganese	300	930 – 1,600	See note
Mercury	2	<1	
Molybdenum	40	24 – 36	See note
Nickel	100	<1 – 20	
Nitrate	10,000	<0.1 – 0.6	See note
Selenium	50	<1 – 3.0	
Silver	100	<1	
Strontium	9,300	820 – 970	See note
Sulfate	500 mg/L	160 – 210	See note
TDS	500 mg/L	770 – 1,700	See note
Thallium	2	<1	
Vanadium	63	<2 – 20	
Zinc	2,000	<10 – 25	

[121] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were not measured in April 2012, July 2012, or January 2013.

[122] TVA measured arsenic at 12 ug/L in January 2013, then retested and obtained a result of <1 ug/L. See text for further details.

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Table 5-8: Cumberland Fossil Plant, Well 93-4. Sampled 13 times between October 2009 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	200 – 1,200	Not always measured[123]
Antimony	6	<1 – 2	
Arsenic	10	<1 – 34[124]	
Barium	2,000	77 – 110	
Beryllium	4	<2	
Boron	3,000	3,800 – 8,100	See note
Cadmium	5	<0.5 – 3.2	
Chloride	250 mg/L	220 – 470 mg/L	See note
Chromium	100	<2 – 3.7	
Cobalt	4.7	<1 – 1.9	
Copper	1,300	<2 – 12	
Fluoride	4,000	<100 – 230	
Lead	15	<1 – 1.1	
Lithium	31		No data
Manganese	300	31 – 510	See note
Mercury	2	<0.2	
Molybdenum	40	<5 – 10	See note
Nickel	100	<1 – 39	
Nitrate	10,000	<0.1	See note
Selenium	50	<1 – 5.7[125]	
Silver	100	<1	
Strontium	9,300	1,200 – 1,600	See note
Sulfate	500 mg/L	390 – 1,100 mg/L	See note
TDS	500 mg/L	1,700 – 2,900 mg/L	See note
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 38	

[123] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were not measured in April 2012, July 2012, or January 2013.

[124] TVA measured arsenic at 34 ug/L in January 2013, then retested and obtained a result of 1.7 ug/L. See text for further details.

[125] TVA has been using two labs to test for selenium, one with higher results (shown here) and one that typically reports <1 ug/L.

Table 5-9: Cumberland Fossil Plant, Rye Spring.[126] Sampled 15 times between October 2009 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 38,000	Not always measured[127]
Antimony	6	<1	
Arsenic	10	<10	
Barium	2,000	31 – 300	
Beryllium	4	<2	
Boron	3,000	<200 – 970	See note
Cadmium	5	<0.5	
Chloride	250 mg/L	6.5 – 15 mg/L	See note
Chromium	100	<2 – 24	
Cobalt	4.7	<1 – 10	
Copper	1,300	<2 – 24	
Fluoride	4,000	190 – 360	
Lead	15	<1 – 23	
Lithium	31		No data
Manganese	300	17 – 710	See note
Mercury	2	<0.2	
Molybdenum	40	<5 – 6	See note
Nickel	100	<1 – 25	
Nitrate	10,000	2,800 – 8,900	See note
Selenium	50	<1 – 4	
Silver	100	<1	
Strontium	9,300	360 – 570	See note
Sulfate	500 mg/L	48 – 68 mg/L	See note
TDS	500 mg/L	360 – 1,400 mg/L	See note
Thallium	2	<2	
Vanadium	63	<2 – 26	
Zinc	2,000	<10 – 120	

[126] Rye Spring and Wells Creek surface water sampling locations are included here because TVA uses them as upgradient comparisons for Cumberland groundwater.

[127] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were not measured in April 2012, July 2012, or January 2013.

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Table 5-10: Cumberland Fossil Plant, Wells Creek.[128] Sampled 13 times between October 2009 and October 2012.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	Not always measured[129]
Antimony	6	<1	
Arsenic	10	<10	
Barium	2,000	26 – 38	
Beryllium	4	<2	
Boron	3,000	<200	See note
Cadmium	5	<0.5	
Chloride	250 mg/L	4.7 – 6.15 mg/L	See note
Chromium	100	<2	
Cobalt	4.7	<1	
Copper	1,300	<2 – 24	
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	<10 – 20	See note
Mercury	2	<0.2	
Molybdenum	40	<5	See note
Nickel	100	<1 – 4	
Nitrate	10,000	350 – 720	See note
Selenium	50	<1 – 4	
Silver	100	<1 – 5.05	
Strontium	9,300	120 – 180	See note
Sulfate	500 mg/L	5.6 – 7.9 mg/L	See note
TDS	500 mg/L	160 – 2,530 mg/L	See note
Thallium	2	<2	
Vanadium	63	<10	
Zinc	2,000	<10	

[128] Rye Spring and Wells Creek surface water sampling locations are included here because TVA uses them as upgradient comparisons for Cumberland groundwater.

[129] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were not measured in April 2012, July 2012, or January 2013.

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6 Gallatin Fossil Plant

Background

The Gallatin Fossil Plant is located on the Cumberland River in Gallatin, TN. TVA has been operating four coal units at the site since the 1950s. The original ash pond was located immediately west of the site; TVA abandoned this pond in 1970 when it built the existing ash pond complex to the north of the site. Within the active ash pond complex, the active fly ash pond receives 185,000 dry tons of fly ash each year, and the bottom ash pond receives roughly 45,000 dry tons of bottom ash.

In its Phase I engineering assessment for Gallatin, Stantec Consulting Services observed that "karst bedrock and sinkhole activity is present plant-wide and is a concern."[130] In response to the identified karst-related risk, Stantec recommended that TVA "install[] lining systems beneath all ponds or convert[] to dry disposal operation."[131] The risk of sinkholes is not a merely conjectural concern; many sinkholes have formed at Gallatin in the past: From 1970-1978, all of the water put into the currently active ash pond complex drained through sinkholes – up to 111 of them – and the pond never reached the level of the permitted outfall.[132] Although TVA filled enough sinkholes to bring the pond up to the level of the outfall, it is not clear how many sinkholes were left unrepaired, or how much ash pond leachate has drained through existing or new sinkholes since then.[133] More recently, sinkholes were identified during the 2006 expansion of the fly ash pond, and another sinkhole was discovered in 2010.[134] Sinkholes can affect groundwater, and groundwater monitoring just north of Gallatin's active ash pond in the late 1980s found evidence that leachate from the ash ponds had affected a cluster of wells, including residential wells, causing elevated concentrations of boron, manganese, and other pollutants.[135]

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[130] Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Tennessee, Appendix E – Gallatin Fossil Plant*, Bottom Ash Pond A pages 5-6 of 6, Fly Ash Pond E page 6, Stilling Ponds B, C and D pages 5-6 (June 24, 2009).

[131] *Id.*

[132] *See* TVA memorandum, *Gallatin Steam Plant – Ash Disposal Pond – Leakage Problems* (Jan. 25, 1979); *see also* TVA, *Magnitude of Ash Disposal Pond Leakage Problem – Gallatin Steam Plant* (Apr. 1977).

[133] *See* TVA, *Magnitude of Ash Disposal Pond Leakage Problem – Gallatin Steam Plant*, 3 (Apr. 1977) ("If the present leaks from the pond were plugged and the water level in the pond rose to the elevation of the outfall weir, one or more of another 52 sinkholes could begin to leak. In addition, sink holes which are not presently leaking could begin to leak because of increased hydrostatic pressure. . . . [P]lugging the presently leaking sinkholes would give no assurance that other sinkholes would not begin to leak.").

[134] Stantec Consulting Services, Inc., *Report of Geotechnical Exploration and Slope Stability Evaluation: Ash Pond / Stilling Pond Complex, Gallatin Fossil Plant* 8 (May 27, 2010).

[135] TVA, *An Evaluation of the Impacts of the Gallatin Fly Ash Pond to Groundwater Resources* (Aug. 1989).

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It is clear that status quo waste disposal operations at Gallatin will continue to be accompanied by the risk of sinkholes and groundwater contamination. New operations, including the possible construction of a Flue Gas Desulfurization (FGD) waste disposal facility, will increase this risk.

Monitoring

Figure 6-2 shows the approximate locations of the groundwater wells discussed in this report. The oldest wells are those along the edge of the abandoned ash pond, wells 19-R and 20, and well 21, which is between the plant's coal pile and the cooling water discharge channel. Well 21 is upgradient of the abandoned ash pond and the other two wells, so it was originally used as a background well. When it became apparent that well 21 was contaminated (see below), TVA installed a new background well, well 22, on the other side of the discharge channel.[136] In 2010, as part of the USWAG voluntary monitoring plan, TVA installed wells 23, 24, and 25 to the west and north of the ash pond complex. TVA also started monitoring well 17, a pre-existing well located on the southwest corner of the ash pond complex, as part of the USWAG program.[137] Wells 26 and 27, which are bedrock wells located near wells 19R and 20, were installed in 2012.[138]

All of the groundwater beneath the Gallatin plant ultimately discharges to the river, either directly, as in the case of groundwater monitored by wells adjacent to the river, or through underlying bedrock.[139]

The data that we have on file cover the period February 2008 through April 2013, and they reveal three distinct areas of concern.

First, the abandoned ash pond is leaching pollutants into the local groundwater and surface water (see Figs. 1-1 to 1-3 in the Introduction). Wells 19-R and 20 have both shown unsafe concentrations of boron, cobalt, manganese, and sulfate in recent years. One of these two wells, 19-R, has also shown unsafe concentrations of aluminum, beryllium, cadmium, and

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[136] Well 22 was installed in 2009 (*see* TVA, *Gallatin Fossil Plant Abandoned Ash Disposal Area Groundwater Assessment Monitoring Report – October 2009*, Dec. 4 2009), but was not approved for use as a background well until 2011 (*see* TVA, *Gallatin Fossil Plant Abandoned Ash Disposal Area Groundwater Assessment Monitoring Report – April 2011*, June 7, 2011).

[137] It is not clear when well 17 was installed or how often it was sampled between installation and the beginning of the USWAG monitoring program, but TVA's ash pond closure plan for Gallatin describes well 17 as "existing" when wells 23, 24 and 25 were installed. URS, *TVA Gallatin Fossil Plant – Preliminary Ash Pond Closure Plan (Revision 0) – Prepared for TVA*, Appendix B page 4 (Sep. 25, 2012).

[138] *See* TVA, *Gallatin Fossil Plant Abandoned Ash Disposal Area Groundwater Assessment Monitoring Report – July 2012*, 1 (Sep. 6, 2012).

[139] URS, *supra* note 137, at Appendix B page 3 ("A raised area of groundwater in and around the Ash Pond Complex causes flow to generally radiate outward until it either discharges to the adjacent river or reaches the underlying bedrock. . . [B]edrock groundwater eventually discharges to the river.").

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nickel. Vanadium concentrations in well 19-R have historically been higher than in other on-site wells, but below the current EPA Regional Screening Level used to define exceedances in this report.[140] Wells 26 and 27, deeper wells near wells 19-R and 20, have only recently been installed and sampled, but have also shown unsafe levels of boron, cobalt, manganese, and sulfate. Arsenic in several wells exceeded the MCL of 10 ug/L in 2013. Since arsenic had not been elevated in earlier monitoring, TVA had samples from each well retested by additional labs. All downgradient wells exceeded the MCL at least once in 2013. Taken together, 2013 results have ranged from <1 to 140 ug/L in well 19R, from 1.1 to 79 ug/L in well 20, from <1 to 22 ug/L in well 26, and from <1 to 15 ug/L in well 27. Since groundwater flow in this area is toward the river, and since the strip of land between the inactive ash pond and the river is very narrow, the practical reality is that these pollutants are leaching directly into the river.

Cobalt concentrations in certain wells have been extremely high in recent monitoring (see Fig. 6-1 below), and this is consistent with historical trends. Three wells, 19-R, 20, and 21, routinely show concentrations greater than 100 ug/L, more than 20 times higher than the RSL of 4.7 ug/L; well 26 also exceeds the RSL. In 2011, TVA asked TDEC to consider the high cobalt to be naturally occurring based on the following evidence. First, soil cobalt concentrations around well 21 were much higher than cobalt concentrations in coal ash produced onsite. Second, groundwater concentrations were historically higher upgradient of the ash pond than downgradient. Finally, well drilling had revealed manganese "nodules," which may have suggested a natural source of cobalt (manganese and iron deposits).[141] On the other hand, there is good evidence that the cobalt may be related to coal ash or other TVA operations: First, concentrations in background well 22 have been consistently lower than the RSL of 4.7 ug/L, and have been undetected at <1 ug/L since 2011. Second, recent monitoring shows cobalt concentrations in downgradient well 19R that are as high as they ever were in well 21. Despite the mixed evidence and the dangerously high cobalt concentrations, TDEC accepted the idea that cobalt was naturally occurring in 2003,[142] and stopped requiring cobalt monitoring and reporting in 2011.[143]

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[140] Between April 2009 and October 2011, TVA groundwater reports compared vanadium concentrations to the Regional Screening Level, which at the time was 5 ug/L, and identified well 19-R as exceeding that standard.

[141] Letter from Gordon G. Park, TVA, to Alfred Majors, Tennessee Division of Solid Waste Management, re: Evaluation of Naturally-Occurring Cobalt (Dec. 19, 2001).

[142] Letter from Al Majors and Alan D. Spear, Tennessee Division of Solid Waste Management, to Gordon G. Park, TVA, re: Natural Background Cobalt in Soils and Water (Feb. 10, 2003).

[143] *See, e.g.*, TVA, *Gallatin Fossil Plant Abandoned Ash Disposal Area Groundwater Assessment Monitoring Report – April 2011*, 2 (June 7, 2011) ("Naturally-occurring cobalt, associated [with] concretionary mineral deposits in the alluvial sediments in the AADA vicinity, has been shown to be a likely source of elevated cobalt concentrations observed in GAF-19R, GAF-20, and in former background well GAF-21 (12/19/2001 letter from G.G. Park to A. Majors of TDEC).").

Well 21, which was once used an upgradient background well and has since been dropped from monitoring, had unsafe concentrations of cadmium, cobalt, manganese, mercury, strontium and sulfate. In 2011, TVA acknowledged that well 21 was contaminated.[144] This well is upgradient of the abandoned ash pond and has a different contamination profile than wells 19-R and 20, so the contamination may be from another source.

Well 17, which was installed or reactivated in 2010, is at the southwest corner of the active ash pond complex. This well has had high concentrations of cobalt and manganese since 2010.

Data gaps

1. Suspended cobalt monitoring. Cobalt has long been a problem at Gallatin. TVA has argued that the cobalt is naturally occurring. Even if the cobalt is naturally occurring, it is an environmental risk that TDEC should be keeping track of. Instead, however, TDEC suspended cobalt monitoring and reporting requirements in 2011.[145] Although TVA continues to collect cobalt data, it no longer includes these results in the main body their groundwater reports.

2. Suspended monitoring of well 21. Well 21 is clearly contaminated, with unsafe concentrations of cadmium, cobalt, manganese, mercury, strontium, and sulfate. According to Tennessee's Assessment Monitoring regulations, the high concentrations of cadmium and mercury, and perhaps cobalt, should have triggered corrective action.[146] Instead of requiring TVA to address the problem, however, TDEC allowed it to suspend monitoring.[147]

3. Incomplete well network. The USWAG well network around the ash pond complex is incomplete, with two wells at the northwest corner, one well at the southwest corner, but no wells in the center of the western edge of the complex, and no wells south, east, or north of the complex (aside from upgradient well 25 to the north). As explained in the 2012 ash pond closure plan,

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[144] *See* TVA, *Gallatin Fossil Plant Abandoned Ash Disposal Area Groundwater Assessment Monitoring Report – February 2011*, 4 (Mar. 11, 2011) ("GAF-21 is now believed to be contaminated.").

[145] See TVA, *Gallatin Fossil Plant Abandoned Ash Disposal Area Groundwater Assessment Monitoring Report – October 2011*, 2 (Mar. 11, 2011) ("TDEC recently suspended requirements to monitor and report cobalt data from the AADA site (personal communication, A.D. Spear to R.L. Hooper, 11/21/2011)."). TVA has continued to include cobalt in its lab analyses but is no longer listing cobalt results in its groundwater reports.

[146] *See* Tenn. Comp. Rules & Regs. 1200-01-07-.04(7); URS, *supra* note 137 at Appendix B page 14; TVA Office of the Inspector General (OIG), *TVA's Groundwater Monitoring at Coal Combustion Products Disposal Areas*, at 7 (June 21, 2011).

[147] Well 21 results were left out of groundwater reports beginning in January 2010, but the well was still sampled and results were available in lab analyses appended to the groundwater reports. In the July 2011 groundwater report, TVA stated that well 21 would only be used for groundwater level measurements, and would no longer be sampled. TVA, *Gallatin Fossil Plant Abandoned Ash Disposal Area Groundwater Assessment Monitoring Report – July 2011*, 4 (Aug. 30, 2011)

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> Originally, all three downgradient wells were intended to be placed between the Ash Pond Complex and the Cumberland River; due to safety concerns of drilling too close to high power transmission lines, one of the downgradient wells was moved to the northern edge of the Ash Pond Complex. As a result, two wells were installed near the northwestern corner of the facility, with one (GAF-23) installed into overburden and the other (GAF-24) installed into the Carters Limestone, both being screened in the first water encountered at those locations.[148]

This is unlikely to be sufficient. TVA identified an area of leachate migration to the north in 1989, and at the time had four wells in that area in addition to residential wells.[149] TVA is currently monitoring just one well in that area (Well 25). Migration to the west, and particularly to the east, is also unlikely to be identified by the existing wells. There should be wells in these areas because, as TVA has observed, "[t]he true flows from the [ash pond complex] would be expected to radiate out laterally from each side of the ash pond, since impounded waters would likely mound up over ambient water levels."[150]

Failure to regulate

Because of the known on-site contamination, TDEC placed Gallatin in phase III assessment monitoring in 2009.[151] Documented exceedances of groundwater protection standards since that time should, according to Tennessee law, require corrective action.[152] Specifically, TDEC should have required TVA to remediate the leaking abandoned ash pond and to identify and remediate the source of the contamination in Well 21. But so far TDEC has failed to impose any corrective action requirements at all.[153] As described above, TDEC's only real response to the problem has been to allow TVA to discontinue monitoring at well 21 and to discontinue cobalt monitoring. Instead of dealing with the problem, TDEC has chosen to ignore the problem and allow the site to bleed mercury, cobalt, and other pollutants into the Cumberland River indefinitely.

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[148] URS, *supra* note 137, at Appendix B page 4.
[149] TVA, *An Evaluation of the Impacts of the Gallatin Fly Ash Pond to Groundwater Resources* (Aug. 1989).
[150] TVA, *Gallatin Fossil Plant Ash Impoundment Groundwater Monitoring Report, July 2011*.
[151] TVA Office of the Inspector General, *TVA's Groundwater Monitoring at Coal Combustion Products Disposal Areas*, 7 (June 21, 2011).
[152] *See* Tenn. Comp. Rules & Regs. 1200-01-07-.04(7); URS, *supra* note 137 at Appendix B page 14; TVA OIG, *supra* note 146 at 7.
[153] TVA OIG, *supra* note 146 at 7 ("TDEC personnel also noted that they were not required to issue a Notice of Violation and chose not to as long as TVA was cooperative and working toward making a quality plan.").

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Figure 6-1: Cobalt (ug/L) in wells near the Abandoned Ash Pond, February 2008 through April 2013. Hollow data points were undetected at the detection limit shown.

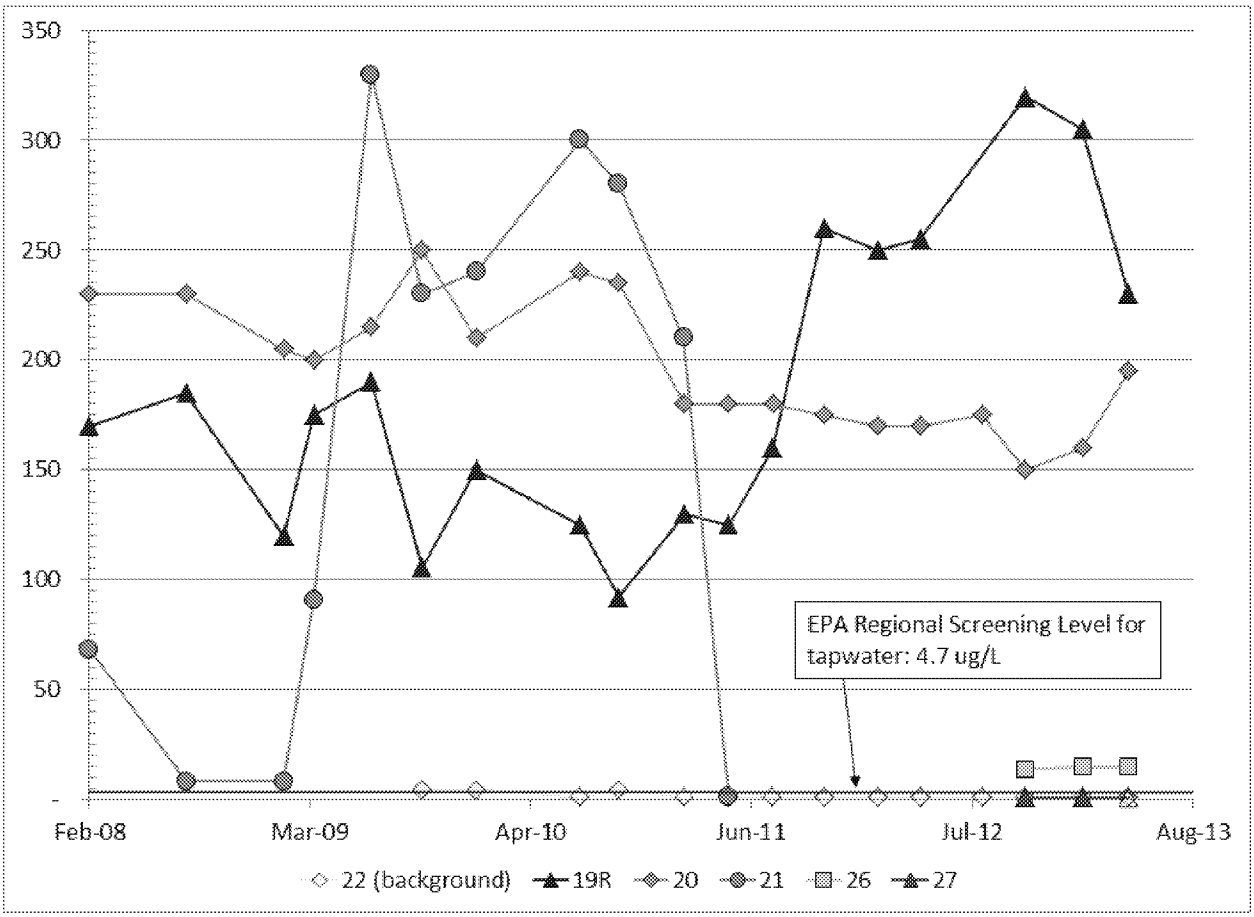

Figure 6-2: Groundwater wells at Gallatin Fossil Plant (approximate locations)

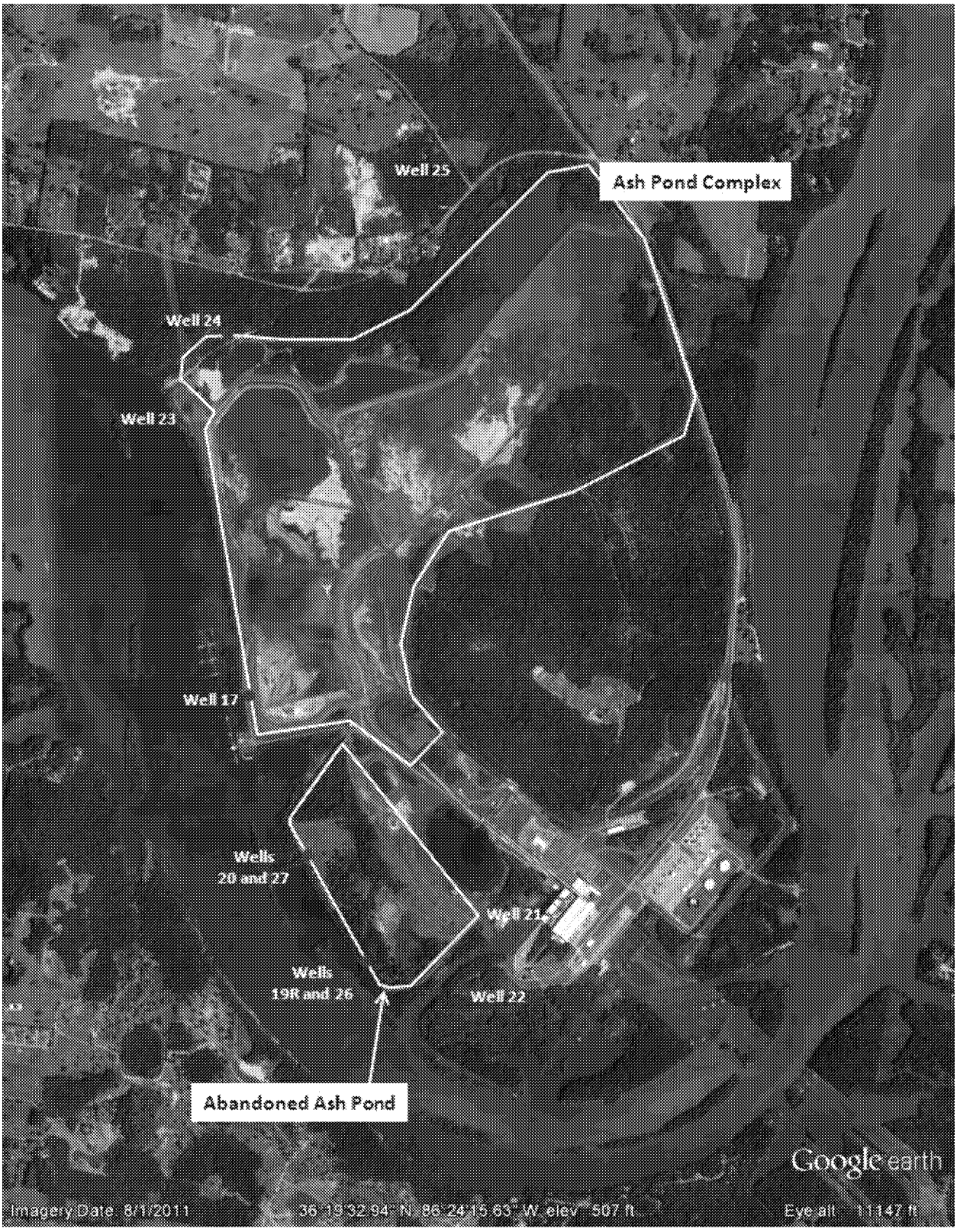

Table 6-1: Gallatin Fossil Plant, Well 17. Sampled 4 times between February 2011 and January 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 640	No data since 1/2012
Antimony	6	<1	
Arsenic	10	<1 – 2.0	
Barium	2,000	36 – 100	
Beryllium	4	<2	
Boron	3,000	1,200 – 2,100	
Cadmium	5	<0.5 – 0.64	
Chloride	250 mg/L	10 – 11 mg/L	No data since 1/2012
Chromium	100	<2 – 6.3	
Cobalt	4.7	3.0 – 7.8	No data since 1/2012
Copper	1,300	<2 – 6.2	No data since 1/2012
Fluoride	4,000	990 – 1,000	
Lead	15	<1 – 2.2	
Lithium	31		No data
Manganese	300	260 – 1,500	No data since 1/2012
Mercury	2	<0.2	
Molybdenum	40	7.0 – 7.9	No data since 1/2012
Nickel	100	5.1 – 27.0	
Nitrate	10,000	<100	
Selenium	50	<1 – 1.3	
Silver	100	<1	
Strontium	9,300	0.62 – 0.65	No data since 1/2012
Sulfate	500 mg/L	230 – 240	No data since 1/2012
TDS	500 mg/L	620 – 630	No data since 1/2012
Thallium	2	<1	
Vanadium	63	<2 - 2.4	No data since 1/2012
Zinc	2,000	<10 – 42	No data since 1/2012

Table 6-2: Gallatin Fossil Plant, Well 19-R. Sampled 19 times between February 2008 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	69,000 – 125,000	
Antimony	6	<1	
Arsenic	10	<1 – 135[154]	
Barium	2,000	<5 – 110	
Beryllium	4	11 – 24.5	
Boron	3,000	2,950 – 4,500	
Cadmium	5	2.65 – 7.9	
Chloride	250 mg/L	2.1 – 7.4 mg/L	
Chromium	100	<40	
Cobalt	4.7	92 – 320[155]	
Copper	1,300	<2 – 51	
Fluoride	4,000	<100 – 755	
Lead	15	<1 – 7.5	
Lithium	31		No data
Manganese	300	11,000 – 33,000	
Mercury	2	<0.2	
Molybdenum	40	<50[156]	
Nickel	100	120 – 250	
Nitrate	10,000		No data
Selenium	50	<1 – 18.8	
Silver	100	<0.5 – 16.7	
Strontium	9,300	1,150 – 1,500	
Sulfate	500 mg/L	2,950 – 6,300 mg/L	
TDS	500 mg/L	3,750 – 6,700 mg/L	
Thallium	2	<1	
Vanadium	63	<2 – 66	
Zinc	2,000	495 – 1,000[157]	

[154] This well started showing arsenic levels above the MCL in 2013 (see report text).

[155] Cobalt in this well was reported as <1 ug/L in July 2012, but that result is presumed to be inaccurate given that cobalt results immediately before and after July 2012 were over 200 ug/L.

[156] There have been no positive detections of molybdenum above 40 ug/L, and results are generally nondetect at <5 or <25 ug/L.

[157] Zinc in this well was reported as 30 ug/L in July 2012. This is likely to be inaccurate given that all other values, before and after July 2012, have been above 400 ug/L.

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Table 6-3: Gallatin Fossil Plant, Well 20. Sampled 19 times between February 2008 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 1,600	
Antimony	6	<1	
Arsenic	10	<1 – 78[158]	
Barium	2,000	12 – 30	
Beryllium	4	<2	
Boron	3,000	5,300 – 5,800	
Cadmium	5	<0.5 – 0.97	
Chloride	250 mg/L	2.8 – 5.4 mg/L	
Chromium	100	<1 – 3.3	
Cobalt	4.7	150 – 250	
Copper	1,300	<10	
Fluoride	4,000	<100 – 230	
Lead	15	<1	
Lithium	31		No data
Manganese	300	16,000 – 22,000	
Mercury	2	<0.2	
Molybdenum	40	<5 – 23	
Nickel	100	33 – 63	
Nitrate	10,000		No data
Selenium	50	<1 – 1.6	
Silver	100	<1	
Strontium	9,300	1,200 – 1,400	
Sulfate	500 mg/L	1,400 – 2,050 mg/L	
TDS	500 mg/L	1,900 – 2,300 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<50	

Table 6-4: Gallatin Fossil Plant, Well 21. Sampled 11 times between February 2008 and April 2011. No data since April 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	510 – 10,000	
Antimony	6	<1	
Arsenic	10	<1 – 2.2	
Barium	2,000	21 – 200	
Beryllium	4	<1 – 3.0	
Boron	3,000	<200	
Cadmium	5	<0.5 – 5.8	
Chloride	250 mg/L	59 – 100 mg/L	
Chromium	100	2.1 – 27	
Cobalt	4.7	1.3 – 330	
Copper	1,300	3.2 – 7.7	
Fluoride	4,000	<100 – 1,900	
Lead	15	<1 – 2.1	
Lithium	31		No data
Manganese	300	300 – 18,000	
Mercury	2	<0.2 – 3	
Molybdenum	40	<5 – 8.3	
Nickel	100	13 – 110	
Nitrate	10,000		No data
Selenium	50	<1 – 10	
Silver	100	<0.5 – 20	
Strontium	9,300	<10 – 10,000	
Sulfate	500 mg/L	340 – 1,800 mg/L	
TDS	500 mg/L	960 – 1,900 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	13 – 280	

[158] This well started showing arsenic levels above the MCL in 2013 (see report text).

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Table 6-5: Gallatin Fossil Plant, Well 22. Sampled 14 times between October 2009 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	100 – 6,000	
Antimony	6	<1	
Arsenic	10	<1 – 3.4	
Barium	2,000	9.5 – 73	
Beryllium	4	<5	
Boron	3,000	<200 – 260	
Cadmium	5	<0.5 – 0.52	
Chloride	250 mg/L	<1 – 2.3 mg/L	
Chromium	100	<1 – 43	
Cobalt	4.7	<1 – 4.6	
Copper	1,300	<2 – 8.5	
Fluoride	4,000	<100 – 180	
Lead	15	<1 – 5.8	
Lithium	31		No data
Manganese	300	<10 – 370	
Mercury	2	<0.2	
Molybdenum	40	<5 – 11	
Nickel	100	<1 – 39	
Nitrate	10,000		No data
Selenium	50	<1 – 5	
Silver	100	<1	
Strontium	9,300	57 – 140	
Sulfate	500 mg/L	<5 – 32 mg/L	
TDS	500 mg/L	<10 – 320	
Thallium	2	<1	
Vanadium	63	<2 – 14	
Zinc	2,000	<10 – 39	

Table 6-6: Gallatin Fossil Plant, Well 23. Sampled 5 times between January 2011 and January 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	810 – 1,300	No data since 1/2012
Antimony	6	<1	
Arsenic	10	<1 – 1.1	
Barium	2,000	55 – 68	
Beryllium	4	<2	
Boron	3,000	290 – 410	No data since 1/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	5.8 – 6.8 mg/L	No data since 1/2012
Chromium	100	<2	
Cobalt	4.7	<1 – 2.2	No data since 1/2012
Copper	1,300	<2	No data since 1/2012
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	35 – 300	No data since 1/2012
Mercury	2	<0.2	
Molybdenum	40	<5 – 9.1	No data since 1/2012
Nickel	100	<1 – 8.2	
Nitrate	10,000	0.66 – 0.67	No data prior to 7/2012
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300	220 – 260	No data since 1/2012
Sulfate	500 mg/L	250 – 260 mg/L	No data since 1/2012
TDS	500 mg/L	640 – 740 mg/L	
Thallium	2	<1	
Vanadium	63	<2 – 2.3	No data since 1/2012
Zinc	2,000	<10 – 11	No data since 1/2012

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Table 6-7: Gallatin Fossil Plant, Well 24. Sampled 5 times between February 2011 and January 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 200	No data since 1/2012
Antimony	6	<1	
Arsenic	10	<1 – 1.3	
Barium	2,000	23 – 34	
Beryllium	4	<2	
Boron	3,000	<200	No data since 1/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	1.0 – 1.2 mg/L	No data since 1/2012
Chromium	100	<2	
Cobalt	4.7	<1	No data since 1/2012
Copper	1,300	<2	No data since 1/2012
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	32 – 68	No data since 1/2012
Mercury	2	<0.2	
Molybdenum	40	<5 – 11	No data since 1/2012
Nickel	100	1.2 – 8.7	
Nitrate	10,000	<0.1	No data prior to 7/2012
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300	210 – 230	No data since 1/2012
Sulfate	500 mg/L	230 – 240 mg/L	No data since 1/2012
TDS	500 mg/L	710 – 760 mg/L	
Thallium	2	<1	
Vanadium	63	<2	No data since 1/2012
Zinc	2,000	<10	No data since 1/2012

Table 6-8: Gallatin Fossil Plant, Well 25. Sampled 5 times between January 2011 and January 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 280	No data since 1/2012
Antimony	6	<1 – 1.2	
Arsenic	10	<1 – 1.9	
Barium	2,000	86 – 100	
Beryllium	4	<2	
Boron	3,000	<200	No data since 1/2012
Cadmium	5	<0.5	
Chloride	250 mg/L	42 – 66 mg/L	No data since 1/2012
Chromium	100	<2	
Cobalt	4.7	<1 – 2.5	No data since 1/2012
Copper	1,300	<2	No data since 1/2012
Fluoride	4,000	<100 – 120	
Lead	15	<1	
Lithium	31		No data
Manganese	300	140 – 210	No data since 1/2012
Mercury	2	<0.2	
Molybdenum	40	5.1 – 7.2	No data since 1/2012
Nickel	100	<1 – 2.6	
Nitrate	10,000	<0.1	No data prior to 7/2012
Selenium	50	<1 – 1.7	
Silver	100	<1	
Strontium	9,300	260 – 270	No data since 1/2012
Sulfate	500 mg/L	32 – 46 mg/L	No data since 1/2012
TDS	500 mg/L	420 – 440 mg/L	
Thallium	2	<1	
Vanadium	63	<2	No data since 1/2012
Zinc	2,000	<10	No data since 1/2012

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Table 6-9: Gallatin Fossil Plant, Well 26. Sampled 4 times between July 2012 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	330 – 740	
Antimony	6	<1	
Arsenic	10	1.5 – 22	
Barium	2,000	<2 – 51	
Beryllium	4	<2	
Boron	3,000	5,500 – 5,900	
Cadmium	5	<0.5	
Chloride	250 mg/L	3.6 – 8.9 mg/L	
Chromium	100	<1 – 4.4	
Cobalt	4.7	14 - 15	
Copper	1,300	<2	
Fluoride	4,000	<100 – 200	
Lead	15	<1	
Lithium	31		No data
Manganese	300	8,700 – 9,400	
Mercury	2	<0.2	
Molybdenum	40	7 – 14	
Nickel	100	<1 – 18	
Nitrate	10,000		No data
Selenium	50	<1 – 2	
Silver	100	<1	
Strontium	9,300	99 – 1,100	
Sulfate	500 mg/L	880 – 1,000 mg/L	October 2012 only
TDS	500 mg/L	1,500 – 1,600 mg/L	October 2012 only
Thallium	2	<1	
Vanadium	63	<2 – 2	
Zinc	2,000	<10	

Table 6-10: Gallatin Fossil Plant, Well 27. Sampled 4 times between July 2012 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 180	
Antimony	6	<1	
Arsenic	10	<1 – 15	
Barium	2,000	52 – 100	
Beryllium	4	<2	
Boron	3,000	4,800 – 5,400	
Cadmium	5	<0.5 – 2.4	
Chloride	250 mg/L	4.2 – 4.6 mg/L	
Chromium	100	<2	
Cobalt	4.7	<1 – 1.1	
Copper	1,300	1.5 – 5.5	
Fluoride	4,000	160 – 400	
Lead	15	<1	
Lithium	31		No data
Manganese	300	170 – 600	
Mercury	2	<0.2	
Molybdenum	40	<5 – 19	
Nickel	100	9 – 13	
Nitrate	10,000		No data
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300	1,200 – 1,300	
Sulfate	500 mg/L	840 – 920 mg/L	
TDS	500 mg/L	1,400 – 1,600 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	<10 – 14	

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7 John Sevier Fossil Plant

Background

John Sevier Fossil Plant includes four coal units on the Holston River near Rogersville, TN. The plant went online in 1955, and TVA idled the coal units in 2012. TVA originally disposed of the ash from John Sevier in a series of ponds located along the Holston River, in the area now covered by the dry fly ash disposal area and the sediment pond. In 1979, TVA started using Area 2 as a bottom ash pond and started disposing of dry fly ash on top of the fly ash and bottom ash in the old ash ponds. Ash Disposal Area J had a shorter lifespan - TVA started using Area J as a fly ash settling pond in 1982, converted to dry stacking in 1988, and closed the area in 1999.

John Sevier does not appear to have the same karst bedrock as many of the TVA plants, and therefore has less natural vulnerability to sinkholes and related groundwater contamination. Other, anthropogenic sources of vulnerability do exist, however, including the fact that the dikes around the original ash ponds, now the dry fly ash disposal area, were poorly built. After a section of the northern dike collapsed in 1973, TVA observed that:

> A large percent of ash was used as material to raise the dikes. DED had recommended that ash not be used in dike building at John Sevier since the ash there is not suitable for this purpose because a significant portion is not stable when wet and it erodes easily.[159]

The dikes were also too steep to be structurally sound; the same memo went on to observe that "the entire dike system at John Sevier has the same inadequacies."[160] As a result of this poor construction, John Sevier has had a history of dike failures, sloughing, and seepage.[161]

Monitoring

TVA currently monitors eight wells at John Sevier, mainly around the dry fly ash disposal area. Wells along the north dike of the dry fly ash disposal area show unsafe concentrations of boron, manganese, and sulfate, and in some cases cobalt (wells W28 and W30). Well W31 also showed very high concentrations of molybdenum in April 2008, but molybdenum has not been

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[159] TVA, *John Sevier Steam Plant – Inspection of Ash Disposal Pond Dikes*, memo to file from R. J. Bowman, Principal Civil Engineer (June 8, 1973) (reproduced in Stantec Consulting Services Inc., *Report of Geotechnical Exploration – John Sevier Fossil Plant*, Appendix A – historical documents, Feb. 8, 2010).
[160] *Id.*
[161] *See generally* Stantec Consulting Services Inc., *Report of Phase 1 Facility Assessment, Tennessee, Appendix F – John Sevier Fossil Plant*, Dry Fly Ash Area pages 2 – 6 and Sediment Pond West page 2; Parsons Energy and Chemicals Group Inc., *Fly Ash Pond Dike Slope Stability Evaluation – Phase One Report* (Dec. 9, 1999).

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measured since then (see Data Gaps section below). When compared to upgradient background water quality, all of the wells around the dry fly ash disposal area have shown significantly elevated concentrations of boron, sulfate, and many other contaminants in recent years.[162] Although results for well W31 suggest cadmium contamination, TVA tested water from that well at three different labs in 2011, and only one of the three has reported such high concentrations.[163] TVA suggested that the high readings at one lab were caused by interference from elevated molybdenum levels.[164] This explanation seems plausible, but it raises another issue – if there is elevated molybdenum in this well, then TVA should be regularly measuring and reporting molybdenum concentrations.

Monitoring around the bottom ash disposal pond, Area 2, has been recent and limited; concentrations of most pollutants were below health-based thresholds. Manganese, which was only measured in April 2011, was higher than the Lifetime Health Advisory and higher than upgradient concentrations.

Data gaps

There are gaps at each of John Sevier's three ash disposal areas:

- There are no groundwater wells upgradient or downgradient of ash disposal Area J, so we have no information about the extent to which that abandoned ash pond is leaching pollutants into groundwater and the Holston River.
- The bottom ash disposal area (Area 2) is currently monitored with one upgradient well (W1) and two downgradient wells (10-36 and 10-37). The downgradient wells, however, were only recently installed. Moreover, TVA does not regularly monitor these wells for many pollutants of concern, including boron, chloride, manganese, and sulfate. TVA once monitored an additional well south of Area 2 and west of well W1; it is not clear why this well was removed.[165]
- The dry fly ash disposal area is the best-monitored of the three areas. However, it has a history of dike failures, sloughing, and seeping along the north dike. The 1973 dike failure occurred in the area between wells W30 and W31 (see Figure 7-1 below), and

[162] For example, the April 2012 groundwater report noted that there were exceedances (significant departures from upgradient water quality) for the following analytes in the following downgradient wells: Alkalinity (all wells), aluminum (W31 and W32), ammonia (W29), boron (all wells), fluoride (W30 and W31), manganese (W28- W30), pH (all wells), sodium (W28-W31), specific conductivity (all wells), strontium (wells W28-W31), and sulfate (all wells). TVA, *John Sevier Fossil Plant Dry Fly Ash Landfill Groundwater Assessment Monitoring Report – April 2012*, 6 (May 28, 2012).
[163] TVA, *John Sevier Fossil Plant Dry Fly Ash Landfill Groundwater Assessment Monitoring Report – April 2011*, 7-9 (June 15, 2011).
[164] *Id.*
[165] Meeting Minutes, John Sevier Fossil Plant Ash Disposal – Tennessee Solid Waste Permit (Mar. 3, 1987) (showing two wells south of Area 2 – W1 and W2).

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both of these wells show clear evidence of contamination. The distance between these two wells is roughly 0.4 miles. An additional well in this area would provide important information about the rate of leaching in parts of the dike that have a history of weakness and instability.

As a site-wide matter, molybdenum is essentially unmonitored at John Sevier. The only data that we have on file for wells W1 – W32 are from a single round of results in April 2008; molybdenum has apparently not been measured at all in wells 10-36 and 10-37. Yet there are several reasons why molybdenum should be a pollutant of concern at John Sevier: First, according to a U.S. EPA risk assessment, molybdenum is a coal ash pollutant that may pose a health risk near coal ash impoundments and landfills.[166] Second, molybdenum is elevated in groundwater at other TVA coal plants. Third, molybdenum concentrations in well W31 have been as high as 2,200 ug/L, over 50 times higher than the concentration that is safe to drink. Finally, molybdenum has been blamed for causing artificially high cadmium results in the same well (see Monitoring section above). TDEC clearly should require TVA to regularly measure molybdenum concentrations across the site.

Failure to regulate

Recent data show clear evidence of coal ash leachate migrating from the dry fly ash disposal area to the Holston River via the local groundwater. Specifically, concentrations of boron, manganese, strontium, sulfate and other pollutants are much higher than background in wells along the thin strip of land between the disposal area and the river. The source of the contamination is likely to be the ash that was sluiced to the ponds beneath the current dry disposal area and left in place, though the dry fly ash stacks may be contributing as well. As far as we know, TDEC is not requiring TVA to do anything about this legacy waste issue, and has decided to allow the problem to persist indefinitely.

[166] *See, e.g.*, U.S. EPA, Draft *Human and Ecological Risk Assessment of Coal Combustion Wastes*, 2-4 (Apr. 2010) (listing molybdenum as a coal ash constituent of potential concern); id. at ES-6 – ES-7 (showing significant 90th percentile risks for molybdenum through the groundwater-to-drinking water pathway for landfills and surface impoundments); U.S. EPA co-proposed Subtitle D coal ash regulations, 75 Fed. Reg. 35128, 35253 (June 21, 2010) (listing molybdenum as an assessment monitoring constituent).

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Figure 7-1: Groundwater wells at John Sevier Fossil Plant (approximate locations).

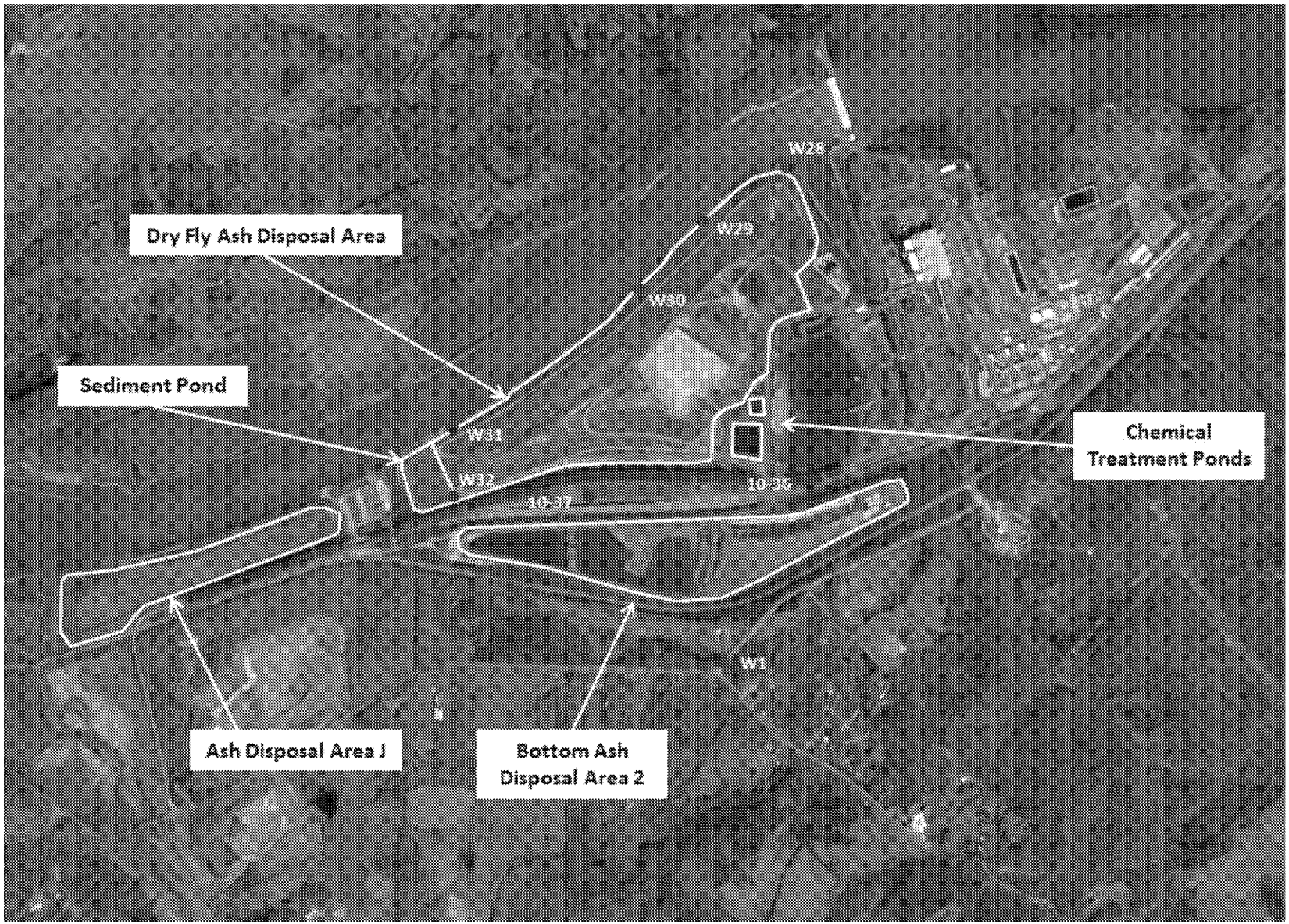

Table 7-1: John Sevier Fossil Plant, Well W1. Sampled 11 times between April 2008 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 140	
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	190 – 230	
Beryllium	4	<2	
Boron	3,000	<0.2	
Cadmium	5	<0.5	
Chloride	250 mg/L	8.9 – 11.0 mg/L	
Chromium	100	<1 – 4	
Cobalt	4.7	<1	
Copper	1,300	<2	
Fluoride	4,000	<100 – 100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	<10 – 39	
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 4/2008
Nickel	100	<1 – 3.3	
Nitrate	10,000	<100 – 530	
Selenium	50	<1 – 1.4	
Silver	100	<1	
Strontium	9,300	590 – 800	
Sulfate	500 mg/L	24.5 – 27.0 mg/L	
TDS	500 mg/L	260 – 320 mg/L	No data 4/2012 or 4/2013
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 95.5	

Table 7-2: John Sevier Fossil Plant, Well W28. Sampled 11 times between April 2008 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 3,100	
Antimony	6	<1	
Arsenic	10	<1 – 2.3	
Barium	2,000	16 – 53	
Beryllium	4	<2	
Boron	3,000	2,600 – 3,100	
Cadmium	5	<0.5	
Chloride	250 mg/L	12 – 14 mg/L	
Chromium	100	<1 – 7.6	
Cobalt	4.7	<1 – 6.4	
Copper	1,300	<1 – 3.3	
Fluoride	4,000	<100 – 120	
Lead	15	<1 – 2.4	
Lithium	31		No data
Manganese	300	960 – 4,000	
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 4/2008
Nickel	100	5.1 – 21.0	
Nitrate	10,000	<100 – 280	
Selenium	50	<1 – 2.1	
Silver	100	<1	
Strontium	9,300	870 – 1,000	
Sulfate	500 mg/L	750 – 890 mg/L	
TDS	500 mg/L	1,400 – 1,600 mg/L	No data 4/2012 or 4/2013
Thallium	2	<1	
Vanadium	63	<2 – 10	
Zinc	2,000	<10 – 18	

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Table 7-3: John Sevier Fossil Plant, Well W29. Sampled 11 times between April 2008 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 760	
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	15 – 32	
Beryllium	4	<2	
Boron	3,000	850 – 1,800	
Cadmium	5	<0.5	
Chloride	250 mg/L	3.2 – 9.5 mg/L	
Chromium	100	<1 – 4.3	
Cobalt	4.7	<1 – 2.4	
Copper	1,300	<1 – 2	
Fluoride	4,000	100 – 220	
Lead	15	<1	
Lithium	31		No data
Manganese	300	1,040 – 8,300	
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 4/2008
Nickel	100	2.4 – 7.6	
Nitrate	10,000	<100 – 3,200	
Selenium	50	<1 – 4	
Silver	100	<1	
Strontium	9,300	640 – 1,200	
Sulfate	500 mg/L	150 – 390	
TDS	500 mg/L	640 – 860	No data 4/2012 or 4/2013
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 21	

Table 7-4: John Sevier Fossil Plant, Well W30. Sampled 11 times between April 2008 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 110	
Antimony	6	<1	
Arsenic	10	<1 – 7.3	
Barium	2,000	16 – 27	
Beryllium	4	<2	
Boron	3,000	4,100 – 5,650	
Cadmium	5	<0.5	
Chloride	250 mg/L	15 – 18 mg/L	
Chromium	100	<1 – 2.9	
Cobalt	4.7	1.2 – 5.0	
Copper	1,300	<1 – 3.1	
Fluoride	4,000	310 – 420	
Lead	15	<1	
Lithium	31		No data
Manganese	300	1,200 – 3,800	
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 4/2008
Nickel	100	7.2 – 33.0	
Nitrate	10,000	<100 – 100	
Selenium	50	<1 – 2.1	
Silver	100	<1	
Strontium	9,300	3,200 – 5,050	
Sulfate	500 mg/L	960 – 1,100 mg/L	
TDS	500 mg/L	1,750 – 2,000 mg/L	No data 4/2012 or 4/2013
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10	

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Table 7-5: John Sevier Fossil Plant, Well W31. Sampled 11 times between April 2008 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 880	
Antimony	6	<1	
Arsenic	10	<1 – 2.2	
Barium	2,000	23.5 – 46	
Beryllium	4	<1	
Boron	3,000	9,000 – 18,000	
Cadmium	5	<0.5 – 8.2	
Chloride	250 mg/L	8.1 – 14 mg/L	
Chromium	100	<1 – 2.7	
Cobalt	4.7	<1	
Copper	1,300	<1 – 9.7	
Fluoride	4,000	170 – 380	
Lead	15	<1 – 1.25	
Lithium	31		No data
Manganese	300	<50	
Mercury	2	<0.2	
Molybdenum	40	2,200	No data since 4/2008
Nickel	100	6.8 – 19.0	
Nitrate	10,000	<100 – 3,000	
Selenium	50	<1 – 4.1	
Silver	100	<1	
Strontium	9,300	3,000 – 6,300	
Sulfate	500 mg/L	860 – 1,800 mg/L	
TDS	500 mg/L	1,600 – 2,800 mg/L	No data 4/2012 or 4/2013
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 16	

Table 7-6: John Sevier Fossil Plant, Well W32. Sampled 11 times between April 2008 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 1,000	
Antimony	6	<1	
Arsenic	10	<1 – 1.1	
Barium	2,000	52 – 65	
Beryllium	4	<2	
Boron	3,000	<200 – 440	
Cadmium	5	<0.5	
Chloride	250 mg/L	9.7 – 12.0 mg/L	
Chromium	100	<1 – 2.7	
Cobalt	4.7	<1	
Copper	1,300	<2	
Fluoride	4,000	<100 – 120	
Lead	15	<1	
Lithium	31		No data
Manganese	300	4 – 12	
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 4/2008
Nickel	100	1.8 – 5.7	
Nitrate	10,000	<100 – 960	
Selenium	50	<1 – 1	
Silver	100	<1	
Strontium	9,300	260 – 340	
Sulfate	500 mg/L	47 – 54	
TDS	500 mg/L	370 – 460	No data 4/2012 or 4/2013
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 15	

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Table 7-7: John Sevier Fossil Plant, Well 10-36. Sampled 5 times between April 2011 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	No data since 4/2011
Antimony	6	<1	
Arsenic	10	1.3 – 2.5	
Barium	2,000	47 – 60	
Beryllium	4	<1	
Boron	3,000	<200	No data since 4/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	9.75 mg/L	No data since 4/2011
Chromium	100	<2	
Cobalt	4.7	3.30 – 3.35	No data since 10/2011
Copper	1,300	<2	No data since 10/2011
Fluoride	4,000	<100 – 120	
Lead	15	<1	
Lithium	31		No data
Manganese	300	1,850	No data since 4/2011
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	3.3 – 7.55	
Nitrate	10,000	<100	
Selenium	50	<1 – 2.3	
Silver	100	<1	
Strontium	9,300	850	No data since 4/2011
Sulfate	500 mg/L	120 mg/L	No data since 4/2011
TDS	500 mg/L	625 mg/L	No data since 4/2011
Thallium	2	<1	
Vanadium	63	<2	No data since 10/2011
Zinc	2,000	<10	No data since 10/2011

Table 7-8: John Sevier Fossil Plant, Well 10-37. Sampled 5 times between April 2011 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	No data since 4/2011
Antimony	6	<1	
Arsenic	10	<1 – 3.7	
Barium	2,000	33.5 – 59	
Beryllium	4	<1	
Boron	3,000	<200	No data since 4/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	7.7 mg/L	No data since 4/2011
Chromium	100	<2	
Cobalt	4.7	<1	No data since 10/2011
Copper	1,300	<2	No data since 10/2011
Fluoride	4,000	<100 – 150	
Lead	15	<1	
Lithium	31		No data
Manganese	300	750	No data since 4/2011
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	<1 – 2.4	
Nitrate	10,000	<100 – 340	
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300	210	No data since 4/2011
Sulfate	500 mg/L	65 mg/L	No data since 4/2011
TDS	500 mg/L	350 mg/L	No data since 4/2011
Thallium	2	<1	
Vanadium	63	<2	No data since 10/2011
Zinc	2,000	<10	No data since 10/2011

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8 Johnsonville Fossil Plant

Background

The 10-unit Johnsonville plant, on the Tennessee River in New Johnsonville TN, is TVA's oldest coal plant. Construction began in 1949 and the first unit went online in 1951.[167] TVA idled four units in 2012. The plant will permanently close between 2015 and 2017.

The ash disposal facilities at Johnsonville are shown in Figure 8-1. The original ash disposal pond for the plant was in Area 1. DuPont, which operates a titanium dioxide facility north of the coal plant and east of Area 1, has used and controlled the northern part of Area 1 since the early 1970s.[168] TVA closed the ash disposal areas in the southern half of Area 1 in 1975-1976. The area is presumably unlined, and although it was covered with soil upon closure, erosion "throughout the majority" of the exterior slopes of the area has since exposed the ash.[169] The western dike along the Tennessee River has also experienced significant seepage.

TVA built Areas 2 & 3 on an artificial island in the late 1960s, and raised the dikes twice during the 1970s.[170] Fly ash from the ponds on the island is now being dredged and transported to a private landfill across the river.[171] Groundwater within the Area 2 & 3 dikes drains into the Tennessee River.[172] TVA plans to close this area between 2015 and 2017 by removing most of the ash,[173] grading the dikes and remaining ash, and installing either a geosynthetic or compacted soil cap.[174]

The South Railroad Loop Area was built in the early 1980s, and originally included two dredge cells, a dry disposal area, and stilling ponds. Ash was dry-stacked over the dredge cells to a maximum height of 70-80 feet before the area was closed in 2000. Geotechnical engineering

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[167] TVA, Johnsonville Fossil Plant, http://www.tva.com/sites/johnsonville.htm.
[168] Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Tennessee, Appendix G: Johnsonville Fossil Plant*, North Abandoned Ash Disposal Area 1, pages 1-2 (June 24, 2009).
[169] *Id*. at 4.
[170] *Id*. at Active Ash Disposal Areas 2 & 3, 1-2.
[171] The private landfill has had its own groundwater quality problems. *See* EIP and Earthjustice, OUT OF CONTROL, *supra* note 5 at 102-105.
[172] *See, e.g.*, TVA, *Johnsonville Fossil Plant Ash Impoundment Groundwater Monitoring Report – September 2011* (showing groundwater "flowing out radially, including north towards the Kentucky Reservoir / Tennessee River.").
[173] The closure plan calls for removing 5 million cubic yards of ash. TVA estimated that this would be all of the ash on the island and all of the ash that will be sluiced to the island between 2009 and plant closure. TVA, *Active Ash Pond Preliminary Closure Plan*, 2 (May 24, 2011). However, the closure plan also describes grading and capping of the remaining ash, suggesting that not all ash will be removed. *Id*. at 6. TVA has estimated the total storage capacity of "Area 2" to be 4.36 million cubic yards. Letter from Anda Ray, TVA, to Richard Kinch, U.S. EPA, responding to EPA's request for information (Mar. 25, 2009). It is not clear whether this volume represents all of the ash on the island, or only the ash within the footprint of what TVA defines as Area 2.
[174] TVA, *Active Ash Pond Preliminary Closure Plan*, 6 (May 24, 2011).

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consultants noted ongoing erosion around the area, due in part to the "erosive nature of the materials used to construct the disposal area and final cover."[175] The extent to which TVA lined the site prior to using it as an ash disposal area is unclear.[176]

TVA constructed the DuPont Road Dredge Cell in the late 1980s or early 1990s. Ash was dry stacked in the area from the late 1990s through the early 2000s, when the area was closed. Although TVA built the cell with a clay liner, they did not install a cap to prevent water from percolating through the ash, instead opting for an "evapotranspiration plan" that consisted of trees planted along the crest of the area. Although the liner appears to have worked, the evapotranspiration plan has not, and so the area has filled with water, creating a "bathtub effect" and seepage that "appears to have completely surrounded the cell."[177]

Monitoring

Figure 8-1 shows the approximate locations of the groundwater wells discussed in this report.

Area 1. EIP has not received any recent data from the original ash pond area (Area 1), but we do have data from 1990-1994 for six wells numbered C1 through C6. EIP obtained these data from TVA through a Freedom of Information Act request in 2010.[178] Unfortunately, the data came in the form of a spreadsheet, without details about how the wells were installed, what kind of material they were screened in, or precisely where the wells were located.[179] The spreadsheet included results for aluminum, arsenic, boron, cadmium, chromium, iron, lead, manganese, molybdenum, sulfate, and TDS. As shown in Tables 8-1 through 8-6, concentrations of all pollutants were very high, frequently more than an order of magnitude greater than the health-based thresholds used in this paper. This area is known to be deteriorating (see Background section above), and has apparently caused severe groundwater contamination,[180] yet neither TVA nor TDEC appear to have conducted any groundwater monitoring since 1994, much less remediate the source of the contamination.

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[175] Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Tennessee, Appendix G: Johnsonville Fossil Plant*, South Railroad Loop Ash Disposal Area 4 page 6 (June 24, 2009).

[176] See *id.*, Photos, Concerns/Photo Log, page a (photograph caption describing "erosion exposing liner along toe of eastern stack area.").

[177] *Id.*, Dredge Pond East of Gas Turbines Area 5, pages 2-6.

[178] TVA, Groundwater monitoring data for the active ash disposal area and abandoned ash disposal area (Area A) in response to April 28, 2010 Freedom of Information Act Request (2010).

[179] Two unrelated maps indicate that they were in the southern part of Area 1, which is consistent with the fact that DuPont controls all of Area 1 north of the TVA property line. Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Tennessee, Appendix G: Johnsonville Fossil Plant*, North Abandoned Ash Disposal Area 1, pages 1-2 (June 24, 2009).

[180] Even if these six wells were screened directly in saturated ash, the primitive state of ash disposal in the 1950s-1970s suggests a high likelihood of groundwater contamination beyond the footprint of the abandoned ash pond.

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Areas 2 & 3. EIP has two sets of data from the ash disposal island, Areas 2 &3. The first set of data, from 1986-1997, was obtained in the same 2010 FOIA request described above, and comes with the same limitations. The exact locations of these wells, in particular, remain uncertain. The results from these wells are shown in Tables 8-7 through 8-9. The data show very high concentrations of the measured pollutants, again frequently more than an order of magnitude greater than "safe" concentrations. We are not aware of any groundwater data collected by TVA between 1997 and 2011. In 2011, as part of the USWAG voluntary monitoring program, TVA installed 3 new wells around the perimeter of the island in 2010, shown in Figure 8-1 as 10-AP1 through 10-AP3. These wells show much lower concentrations of some metals, like arsenic and cadmium, but continue to show clear evidence of coal ash contamination, including high concentrations of boron, cobalt, manganese, and sulfate (see Tables 8-10 through 8-12). Well 10-AP1, for example, showed 6.3 mg/L of boron, 11-21 ug/L of cobalt, and 3.5 mg/L of manganese in 2011, all much higher than background and higher than health-based guidelines.[181] Despite the clearly elevated concentrations of these three pollutants, TVA stopped measuring them in 2012.

South Rail Loop area. There are currently six wells around the South Rail Loop Area. Three wells are screened in alluvial soils: B9 (upgradient), B6R, and B8R. The other three wells are screened in a deeper geologic layer of Chattanooga Shale: B30 (upgradient), B6, and B8. Wells B6R, B8R, and B30 are new or recently reactivated wells, as described below.

Until recently, TVA maintained three wells around the South Rail Loop Area: Wells B6, B8, and upgradient well B9. Wells B6 and B8 consistently showed evidence of contamination, including high concentrations of boron, manganese, sulfate, and in the case of well B8, cobalt. Limited data from the 1992-1993 suggest that the same pattern was evident 20 years ago.[182] TVA speculated that the contamination might have been naturally occurring since Chattanooga Shale can release the same pollutants typically associated with coal ash.[183] TVA could not conduct a proper upgradient-downgradient analysis at the time because the upgradient well, B9, was screened in alluvial soils. In March 2013, in order to build the database for a better analysis, TVA started monitoring well B30, which is upgradient of the South Rail Loop area and also screened in the Chattanooga shale.[184] Although TVA has only measured this well once, there are clear differences between well B30 and wells B6 and B8. Boron, in particular, is below detection at <0.2 mg/L in well B30, but above the Child Health Advisory in wells B6 (1.3-6.5

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[181] Background well B9 has had maximum boron, cobalt, and manganese concentrations of 0.33 mg/L, 1 ug/L, and 0.06 mg/L, respectively, since 2006.

[182] *See* TVA, *Rail Loop Disposal Area – Revised Closure Plan – Appendix F: Background Groundwater Monitoring Report* (Feb. 2, 1998).

[183] Letter from Cynthia M. Anderson, TVA, to Alan Spear, TDEC (Nov. 15, 2012).

[184] TVA, *Johnsonville Fossil Plant South Rail Loop Ash Disposal Area Groundwater Monitoring Report- March 2013*, 1, 4 (May 15, 2013).

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mg/L) and B8 (9.2-10.5 mg/L). Similar differences between wells B30 and B8 can be seen for cobalt (5.1 ug/L in well B30, 47-65 ug/L in well B8), manganese (1.0 mg/L in well B30, 2.5-2.9 mg/L in well B8), and sulfate (13 mg/L in well B30, 120-1,200 mg/L in well B8). These results suggest that the contamination in wells B6 and B8 is not naturally occurring, and is instead due to the coal ash in the South Rail Loop area.

In 2012, on the grounds that contamination in wells B6 and B8 might have been naturally occurring (and before results from well B30 were collected), TVA and TDEC agreed to replace these wells with new wells screened in alluvial soils above the shale layer.[185] The new wells, B6R and B8R, were installed in December 2012 and first monitored in March 2013. The initial results suggest that the groundwater in the alluvial soil, like the groundwater in the Chattanooga shale, has been contaminated by the ash in the South Rail Loop area. Boron in wells B6R and B8R was 7.2 and 1.0 mg/L, respectively. Upgradient well B9, by comparison, ranges between <0.2 and 0.3 mg/L. Manganese in wells B6R and B8R was 1.5 and 1.1 mg/L, much higher than the 0.003-0.06 mg/L seen in well B9.

To summarize, the ash in the South Rail Loop area has contaminated groundwater in the alluvial soil and in the Chattanooga Shale beneath it; this groundwater is now unsafe to drink, with high concentrations of boron, cobalt, manganese, and sulfate.

DuPont Road Dredge Cell. The closed DuPont Road Dredge Cell, as described above, has a clay liner that may be effectively preventing leachate from seeping into local groundwater. The four wells around that area show little evidence of contamination.

Data gaps

1. The groundwater around the southern part of abandoned ash disposal Area 1 has apparently not been monitored over the past twenty years (since 1994). As described above, TVA measured extremely high levels of groundwater contamination here in the early 1990s. TVA and TDEC should resume monitoring this area and, if the groundwater contamination has persisted, remediate the area.

2. Although TVA found clear evidence of groundwater contamination around Areas 2 & 3 in the early 1990s with no discernible downward trend, it suspended monitoring between 1994/1997 (depending on the well) and 2011. When TVA resumed monitoring, this time at different wells, concentrations of some pollutants (for example, aluminum, arsenic and cadmium) were dramatically lower. Concentrations of boron, on the other hand, were roughly consistent with historical data. TVA and TDEC should investigate whether these changes are an

[185] Letter from Cynthia M. Anderson, TVA, to Alan Spear, TDEC (May 17, 2012).

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artifact of where the wells are installed or screened, or whether they represent changes that can be generalized to the perimeter of the island.

3. TVA resumed monitoring groundwater around Areas 2 & 3 in 2011 as part of its USWAG voluntary monitoring plan. However, TVA only conducted one or two rounds of monitoring for many pollutants, including key coal ash indicators. Specifically, aluminum, boron, chloride, manganese, molybdenum, strontium, sulfate, and TDS were measured in the first round of sampling, but not measured during the next four sampling events. Cobalt, copper, vanadium, and zinc were measured twice in 2011 but not at all in 2012 or 2013. All of these pollutants should be routinely measured. The failure to routinely measure boron, cobalt, and manganese when initial sampling showed elevated and unsafe concentrations is particularly irresponsible. Manganese, for example, was more than ten times the Lifetime Health Advisory in all three wells when TVA stopped measuring it.

4. Finally, TVA and TDEC agreed to abandon contaminated wells B6 and B8 on the grounds that these wells may be showing the effect of the natural shale bedrock. However, as described above, the new upgradient shale-screened well, well B30, shows much lower concentrations of boron, manganese, and sulfate than the downgradient wells, suggesting that the contamination in wells B6 and B8 is not in fact naturally occurring. TVA and TDEC should not abandon these wells, but should instead begin corrective action planning to remediate the contamination.

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Figure 8-1: Groundwater wells at Johnsonville Fossil Plant (approximate locations). Orange wells are no longer monitored and their locations are only roughly known.

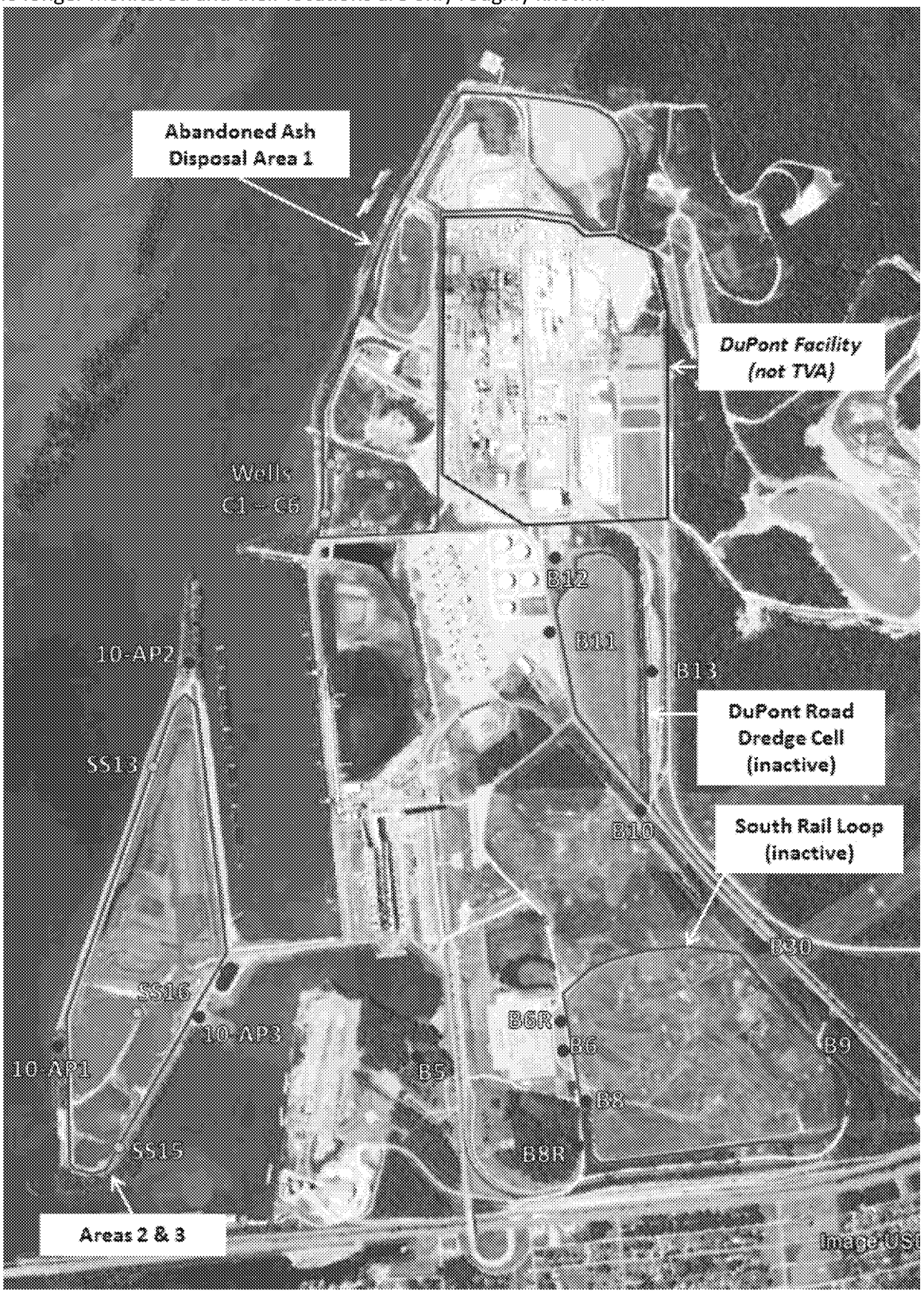

Table 8-1: Johnsonville Fossil Plant, Well C1. Sampled 14 times, March 1990 - September 1994.

Chemical	Threshold	Data
Aluminum	16,000	1,200 – 49,000
Arsenic	10	130 – 390
Boron	3,000	7,900 – 48,000
Cadmium	5	<0.1 – 37
Chromium	100	<1 – 49
Lead	15	<1 – 38
Manganese	300	1,900 – 6,700
Molybdenum	40	<20 – 320
Sulfate	500 mg/L	160 – 2,000 mg/L
TDS	500 mg/L	2,000 – 3,300 mg/L

Table 8-2: Johnsonville Fossil Plant, Well C2. Sampled 14 times, March 1990 - September 1994.

Chemical	Threshold	Data
Aluminum	16,000	1,400 – 28,000
Arsenic	10	35 – 110
Boron	3,000	6,300 – 18,000
Cadmium	5	0.2 – 20
Chromium	100	1 – 47
Lead	15	<1 – 43
Manganese	300	<5 – 410
Molybdenum	40	<20 – 350
Sulfate	500 mg/L	43 – 1,500 mg/L
TDS	500 mg/L	1,600 – 2,400 mg/L

Table 8-3: Johnsonville Fossil Plant, Well C3. Sampled 12 times, March 1990 - September 1994.

Chemical	Threshold	Data
Aluminum	16,000	370 – 42,000
Arsenic	10	37 – 160
Boron	3,000	8,000 – 24,000
Cadmium	5	0.1 – 18
Chromium	100	<1 – 68
Lead	15	<1 – 53
Manganese	300	<5 – 720
Molybdenum	40	140 – 320
Sulfate	500 mg/L	240 – 950 mg/L
TDS	500 mg/L	550 – 1,900 mg/L

Table 8-4: Johnsonville Fossil Plant, Well C4. Sampled 12 times, March 1990 - September 1994.

Chemical	Threshold	Data
Aluminum	16,000	1,800 – 270,000
Arsenic	10	6 – 61
Boron	3,000	1,800 – 5,700
Cadmium	5	0.2 – 35
Chromium	100	1 – 230
Lead	15	2 – 200
Manganese	300	3,800 – 8,900
Molybdenum	40	<20 – 160
Sulfate	500 mg/L	60 – 250 mg/L
TDS	500 mg/L	<10 – 310 mg/L

Table 8-5: Johnsonville Fossil Plant, Well C5. Sampled 12 times, March 1990 - September 1994.

Chemical	Threshold	Data
Aluminum	16,000	2,000 – 470,000
Arsenic	10	32 – 300
Boron	3,000	3,500 – 18,000
Cadmium	5	0.2 – 240
Chromium	100	1 – 620
Lead	15	5 – 240
Manganese	300	38 – 10,000
Molybdenum	40	<20 – 420
Sulfate	500 mg/L	77 – 600 mg/L
TDS	500 mg/L	300 – 920 mg/L

Table 8-6: Johnsonville Fossil Plant, Well C6. Sampled 15 times, March 1990 - September 1994.

Chemical	Threshold	Data
Aluminum	16,000	5,700 – 340,000
Arsenic	10	12 – 570
Boron	3,000	3,300 – 17,000
Cadmium	5	0.3 – 31
Chromium	100	7 – 520
Lead	15	11 – 390
Manganese	300	240 – 6,800
Molybdenum	40	<20 – 310
Sulfate	500 mg/L	47 – 1,400
TDS	500 mg/L	210 – 1,200

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Table 8-7: Johnsonville Fossil Plant, Well SS13. Sampled 14 times, April 1986 - September 1994.

Chemical	Threshold	Data
Aluminum	16,000	38 – 130,000
Arsenic	10	3 – 65
Boron	3,000	<500 – 16,000
Cadmium	5	0.4 – 86
Chromium	100	2 – 110
Lead	15	2 – 120
Manganese	300	410 – 9,000
Molybdenum	40	<20 – 130
Sulfate	500 mg/L	<1 – 1,400
TDS	500 mg/L	80 – 310

Table 8-8: Johnsonville Fossil Plant, Well SS15. Sampled 18 times, April 1986 - September 1997.

Chemical	Threshold	Data
Aluminum	16,000	1,300 – 46,000
Arsenic	10	<1 – 10
Boron	3,000	1,900 – 4,200
Cadmium	5	0.8 – 25
Chromium	100	<1 – 48
Lead	15	<1 – 32
Manganese	300	3,110 – 14,000
Molybdenum	40	<20
Sulfate	500 mg/L	88 – 220
TDS	500 mg/L	230 – 400

Table 8-9: Johnsonville Fossil Plant, Well SS16. Sampled 15 times, April 1986 - September 1994.

Chemical	Threshold	Data
Aluminum	16,000	130 – 1,100,000
Arsenic	10	6 – 520
Boron	3,000	2,100 – 8,400
Cadmium	5	0.5 – 260
Chromium	100	<1 – 160
Lead	15	<1 – 100
Manganese	300	4,100 – 16,000
Molybdenum	40	150 – 1,200
Sulfate	500 mg/L	140 – 1,500
TDS	500 mg/L	1,200 – 2,300

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Table 8-10: Johnsonville Fossil Plant, Well 10-AP1. Sampled 5 times between March 2011 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	420	No data since 3/2011
Antimony	6	<1	
Arsenic	10	2.4 – 4.8	
Barium	2,000	35 – 44	
Beryllium	4	<2	
Boron	3,000	6,300	No data since 3/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	21 mg/L	No data since 3/2011
Chromium	100	<2	
Cobalt	4.7	11 – 21	No data since 9/2011
Copper	1,300	<2	No data since 9/2011
Fluoride	4,000	130 – 180	
Lead	15	<1	
Lithium	31		No data
Manganese	300	3,500	No data since 3/2011
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 3/2011
Nickel	100	29 – 36	
Nitrate	10,000	<100	No data prior to 9/2012
Selenium	50	<1 – 2.8	
Silver	100	<1	
Strontium	9,300	360	No data since 3/2011
Sulfate	500 mg/L	300 mg/L	No data since 3/2011
TDS	500 mg/L	1,200 mg/L	No data since 3/2011
Thallium	2	<1	
Vanadium	63	<10	No data since 9/2011
Zinc	2,000	15 – 21	No data since 9/2011

Table 8-11: Johnsonville Fossil Plant, Well 10-AP2. Sampled 5 times between March 2011 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	230	No data since 3/2011
Antimony	6	<1	
Arsenic	10	1.8 – 4.9	
Barium	2,000	31 – 71	
Beryllium	4	<2	
Boron	3,000	<200	No data since 3/2011
Cadmium	5	<0.5 – 2.8	
Chloride	250 mg/L	23 mg/L	No data since 3/2011
Chromium	100	<2 – 14	
Cobalt	4.7	34 – 58	No data since 9/2011
Copper	1,300	<2	No data since 9/2011
Fluoride	4,000	120 – 170	
Lead	15	<1	
Lithium	31		No data
Manganese	300	13,000	No data since 3/2011
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 3/2011
Nickel	100	35 – 52	
Nitrate	10,000	<100	No data prior to 9/2012
Selenium	50	<1 – 1	
Silver	100	<1	
Strontium	9,300	280	No data since 3/2011
Sulfate	500 mg/L	820 mg/L	No data since 3/2011
TDS	500 mg/L	810 mg/L	No data since 3/2011
Thallium	2	<1	
Vanadium	63	<10	No data since 9/2011
Zinc	2,000	16 – 18	No data since 9/2011

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Table 8-12: Johnsonville Fossil Plant, Well 10-AP3. Sampled 5 times between March 2011 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	1,300	No data since 3/2011
Antimony	6	<1	
Arsenic	10	<1 – 1.6	
Barium	2,000	20 – 26	
Beryllium	4	<2	
Boron	3,000	5,300	No data since 3/2011
Cadmium	5	3.7 – 5.8	
Chloride	250 mg/L	36 mg/L	No data since 3/2011
Chromium	100	<2	
Cobalt	4.7	47 – 55	No data since 9/2011
Copper	1,300	<2 – 3	No data since 9/2011
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	20,000	No data since 3/2011
Mercury	2	<0.2	
Molybdenum	40	<5	No data since 3/2011
Nickel	100	84 – 120[186]	
Nitrate	10,000	<100	No data prior to 9/2012
Selenium	50	<1 – 1.2	
Silver	100	<1	
Strontium	9,300	630	No data since 3/2011
Sulfate	500 mg/L	780 mg/L	No data since 3/2011
TDS	500 mg/L	560 mg/L	No data since 3/2011
Thallium	2	<1	
Vanadium	63	<10	No data since 9/2011
Zinc	2,000	68 – 75	No data since 9/2011

[186] Nickel was measured 7 times over this period.

Table 8-13: Johnsonville Fossil Plant, Well B5. Sampled 9 times between March 2009 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	360 – 2,000	
Antimony	6	<1	
Arsenic	10	<1 – 3.4	
Barium	2,000	<5 – 20	
Beryllium	4	<2	
Boron	3,000	<200	
Cadmium	5	0.6 – 1.6	
Chloride	250 mg/L	32 – 36 mg/L	
Chromium	100	<2 – 2.9	
Cobalt	4.7	<10[187]	
Copper	1,300	7.4 – 13	
Fluoride	4,000	310 – 560	
Lead	15	<1 – 3	
Lithium	31		No data
Manganese	300	53 - 87	
Mercury	2	0.22 – 0.66	
Molybdenum	40	<5	
Nickel	100	61 – 76	
Nitrate	10,000	560	No data prior to 3/2013
Selenium	50	<1 – 6.1	
Silver	100	<1	
Strontium	9,300	<10 – 23	
Sulfate	500 mg/L	66 – 72 mg/L	
TDS	500 mg/L	180 – 200 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	160 – 220	

[187] Cobalt in this well has historically been reported as "<10 ug/L." Results for September 2012 and March 2013 were <1 and 1 ug/L.

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Table 8-14: Johnsonville Fossil Plant, Well B6. Sampled 9 times between March 2009 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 135	
Antimony	6	<1	
Arsenic	10	1.1 – 3	
Barium	2,000	6.9 – 21	
Beryllium	4	<2	
Boron	3,000	1,300 – 6,500	
Cadmium	5	<0.5	
Chloride	250 mg/L	2.5 – 17 mg/L	
Chromium	100	<2	
Cobalt	4.7	<10[188]	
Copper	1,300	<2	
Fluoride	4,000	<100 – 150	
Lead	15	<1	
Lithium	31		No data
Manganese	300	150 – 390	
Mercury	2	<0.2	
Molybdenum	40	3 – 7	
Nickel	100	4.6 – 10	
Nitrate	10,000	520	No data prior to 3/2013
Selenium	50	<1 – 3.6	
Silver	100	<1	
Strontium	9,300	80 – 300	
Sulfate	500 mg/L	120 – 310 mg/L	
TDS	500 mg/L	205 – 560 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	12 – 24	

Table 8-15: Johnsonville Fossil Plant, Well B8. Sampled 9 times between March 2009 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	780 – 2,900	
Antimony	6	<1	
Arsenic	10	<1 – 2.8	
Barium	2,000	22 – 40	
Beryllium	4	<10	
Boron	3,000	9,200 – 10,500	
Cadmium	5	<0.5 – 1	
Chloride	250 mg/L	6.8 – 10 mg/L	
Chromium	100	<2 – 12	
Cobalt	4.7	47 – 65	
Copper	1,300	<2 – 4.9	
Fluoride	4,000	140 – 445	
Lead	15	<1 – 2.2	
Lithium	31		No data
Manganese	300	2,500 – 2,850	
Mercury	2	<0.2 – 1.4	
Molybdenum	40	<2 – 11	
Nickel	100	18.5 – 34	
Nitrate	10,000	<100	No data prior to 3/2013
Selenium	50	<1 – 6	
Silver	100	<1	
Strontium	9,300	950 – 1,200	
Sulfate	500 mg/L	120 – 1,200 mg/L	
TDS	500 mg/L	1,400 – 1,800 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 55	

[188] Cobalt in this well has historically been reported as "<10 ug/L." Results for September 2012 and March 2013 were <1 and 2.3ug/L.

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Table 8-16: Johnsonville Fossil Plant, Well B9. Sampled 9 times between March 2009 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 5,100	
Antimony	6	<1	
Arsenic	10	<1 – 1	
Barium	2,000	6.8 – 53	
Beryllium	4	<2	
Boron	3,000	<200 – 330	
Cadmium	5	<0.5	
Chloride	250 mg/L	3.1 – 4.7	
Chromium	100	<2 – 12	
Cobalt	4.7	<10[189]	
Copper	1,300	<2 – 4	
Fluoride	4,000	<100	
Lead	15	<1 – 1.5	
Lithium	31		No data
Manganese	300	3 – 62	
Mercury	2	<0.2	
Molybdenum	40	<5	
Nickel	100	<1 – 7.7	
Nitrate	10,000	<100	No data prior to 9/2012
Selenium	50	<1 – 1.4	
Silver	100	<1	
Strontium	9,300	<10 – 21	
Sulfate	500 mg/L	<5	
TDS	500 mg/L	38 – 90	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 15	

[189] Cobalt in this well has historically been reported as "<10 ug/L." Results for September 2012 and March 2013 were both <1 ug/L.

Table 8-17: Johnsonville Fossil Plant, Well B10. Sampled 9 times between March 2009 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	100 – 1,500	
Antimony	6	<1	
Arsenic	10	<1 – 1	
Barium	2,000	9 – 19	
Beryllium	4	<2	
Boron	3,000	<200	
Cadmium	5	<0.5	
Chloride	250 mg/L	11 – 18 mg/L	
Chromium	100	<2 – 4.6	
Cobalt	4.7	<10[190]	
Copper	1,300	<2	
Fluoride	4,000	<100 – 100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	6 – 15	
Mercury	2	<0.2	
Molybdenum	40	<5	
Nickel	100	2.7 – 6.1	
Nitrate	10,000	180	No data prior to 3/2013
Selenium	50	<1 – 1.3	
Silver	100	<1	
Strontium	9,300	<10 – 12	
Sulfate	500 mg/L	<5 – 5.6 mg/L	
TDS	500 mg/L	46 – 93 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<10 – 12	

[190] Cobalt in this well has historically been reported as "<10 ug/L." Results for September 2012 and March 2013 were <1 and 1.1 ug/L.

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Table 8-18: Johnsonville Fossil Plant, Well B11. Sampled 9 times between March 2009 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 3,500	
Antimony	6	<1	
Arsenic	10	<1 – 1.5	
Barium	2,000	255 – 530	
Beryllium	4	<2	
Boron	3,000	270 – 540	
Cadmium	5	<0.5 – 0.7	
Chloride	250 mg/L	230 – 400 mg/L	
Chromium	100	<2 – 9.7	
Cobalt	4.7	<10[191]	
Copper	1,300	<2 – 2.4	
Fluoride	4,000	<100	
Lead	15	<1 – 3	
Lithium	31		No data
Manganese	300	380 – 780	
Mercury	2	<0.2	
Molybdenum	40	<5	
Nickel	100	7 – 14	
Nitrate	10,000	660	No data prior to 3/2013
Selenium	50	<1 – 2.7	
Silver	100	<1	
Strontium	9,300	195 – 330	
Sulfate	500 mg/L	20 – 34 mg/L	
TDS	500 mg/L	470 – 870 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	13 – 39	

[191] Cobalt in this well has historically been reported as "<10 ug/L." Results for September 2012 and March 2013 were <1 and 1.3 ug/L.

Table 8-19: Johnsonville Fossil Plant, Well B12. Sampled 9 times between March 2009 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 590	
Antimony	6	<1	
Arsenic	10	<1 – 1.4	
Barium	2,000	360 – 750	
Beryllium	4	<2	
Boron	3,000	<200	
Cadmium	5	<0.5 – 0.9	
Chloride	250 mg/L	660 – 1,200 mg/L	
Chromium	100	<2 – 2.8	
Cobalt	4.7	<10[192]	
Copper	1,300	<2	
Fluoride	4,000	<100	
Lead	15	<1 – 3	
Lithium	31	No data	No data
Manganese	300	1,000 – 2,200	
Mercury	2	<0.2	
Molybdenum	40	<5	
Nickel	100	11 – 23	
Nitrate	10,000	1,600	No data prior to 3/2013
Selenium	50	1.3 – 4.9	
Silver	100	<1	
Strontium	9,300	320 – 620	
Sulfate	500 mg/L	20 – 28 mg/L	
TDS	500 mg/L	1,100 – 2,200 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	16 – 51	

[192] Cobalt in this well has historically been reported as "<10 ug/L." Results for September 2012 and March 2013 were 1 and 1.9 ug/L.

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Table 8-20: Johnsonville Fossil Plant, Well B13. Sampled 9 times between March 2009 and March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	280 – 2,600	
Antimony	6	<1	
Arsenic	10	<1 – 1.5	
Barium	2,000	780 – 1,000	
Beryllium	4	<2	
Boron	3,000	<200	
Cadmium	5	1.1 – 2	
Chloride	250 mg/L	820 – 1,200 mg/L	
Chromium	100	<2 – 5.7	
Cobalt	4.7	<10[193]	
Copper	1,300	<2 – 2.3	
Fluoride	4,000	<100 – 120	
Lead	15	<1 – 1.9	
Lithium	31	No data	No data
Manganese	300	135 – 460	
Mercury	2	<0.2 – 0.3	
Molybdenum	40	<2 – 11	
Nickel	100	23 – 43	
Nitrate	10,000	500	No data prior to 3/2013
Selenium	50	1.9 – 6.0	
Silver	100	<1	
Strontium	9,300	660 – 1,100	
Sulfate	500 mg/L	<5 – 37 mg/L	
TDS	500 mg/L	1,800 – 2,800 mg/L	
Thallium	2	<1	
Vanadium	63	4 – 11	
Zinc	2,000	36 – 75	

Table 8-21: Johnsonville Fossil Plant, Well B6R. First sampled in March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	160	
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	28	
Beryllium	4	<1	
Boron	3,000	7,200	
Cadmium	5	<0.5	
Chloride	250 mg/L	18 mg/L	
Chromium	100	<2	
Cobalt	4.7	<1	
Copper	1,300	<2	
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	1,500	
Mercury	2	<0.2	
Molybdenum	40	<2	
Nickel	100	18	
Nitrate	10,000	490	
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300	370	
Sulfate	500 mg/L	340 mg/L	
TDS	500 mg/L	540 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	26	

[193] Cobalt in this well has historically been reported as "<10 ug/L." Results for September 2012 and March 2013 were 2.6 and 6.0 ug/L.

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Table 8-22: Johnsonville Fossil Plant, Well B8R. First sampled in March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	25	
Beryllium	4	<1	
Boron	3,000	990	
Cadmium	5	<0.5	
Chloride	250 mg/L	10 mg/L	
Chromium	100	<2	
Cobalt	4.7	2.4	
Copper	1,300	<2	
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	1,100	
Mercury	2	<0.2	
Molybdenum	40	<2	
Nickel	100	12	
Nitrate	10,000	240	
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300	140	
Sulfate	500 mg/L	87 mg/L	
TDS	500 mg/L	160 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	19	

Table 8-23: Johnsonville Fossil Plant, Well B30. First sampled in March 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	
Antimony	6	<1	
Arsenic	10	2.9	
Barium	2,000	7.5	
Beryllium	4	<1	
Boron	3,000	<200	
Cadmium	5	<0.5	
Chloride	250 mg/L	4.8 mg/L	
Chromium	100	3.4	
Cobalt	4.7	5.1	
Copper	1,300	<2	
Fluoride	4,000	480	
Lead	15	<1	
Lithium	31		No data
Manganese	300	960	
Mercury	2	<0.2	
Molybdenum	40	6	
Nickel	100	5.9	
Nitrate	10,000	<100	
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300	11	
Sulfate	500 mg/L	13 mg/L	
TDS	500 mg/L	74 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	<10	

9 Kingston Fossil Plant

Background

The Kingston fossil plant is located outside of Kingston, TN, at the confluence of the Clinch and Emory Rivers. The nine coal units at Kingston were built in the 1950s; at the time it was the largest coal plant in the world.[194] Kingston is notorious as the site of the largest coal ash spill in U.S. history:[195] On December 22, 2008, the ash dredge cell at the Kingston plant collapsed, spilling 5.4 million cubic yards of ash into local waterways and over 300 acres of land.[196] Although much could be, and has been, said about the engineering and regulatory failures that led to the spill, this report is focused on groundwater. For more information on the spill, see EPA, TDEC, and TVA websites with archived data and reports.[197]

Current ash disposal areas are shown in Figure 9-3. Prior to the ash spill, TVA was disposing of ash in a complex that included, from northwest to southeast in Figure 9-2, a dredge cell, a settling pond, and a stilling pond. TVA has used this area for ash disposal since 1958.[198] Since the spill, TVA has switched to dry ash disposal at Kingston, but continues to use the reconstructed ash complex area, including the original stilling pond. The Ash Processing Area was built in 2009 as a place to dewater and temporarily store ash dredged from the Emory and Clinch Rivers during cleanup and recovery from the spill. This area was built over an abandoned section of the ash disposal area, including 7.4 – 16.2 meters of ash fill, and an abandoned metal cleaning pond.[199]

TVA built the gypsum disposal area (variously described as a pond[200] and a landfill[201]) to store the waste from Kingston's sulfur dioxide scrubber. Initial construction took place between

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[194] TVA, Kingston Fossil Plant, http://www.tva.gov/sites/kingston.htm
[195] *See, e.g.*, New York Times, Tennessee Ash Flood Larger than Initial Estimate (Dec. 26, 2008).
[196] *See, e.g.*, U.S. EPA, In the Matter of TVA Kingston Fossil Fuel Plant Release Site, Administrative Order and Agreement on Consent (May 11, 2009).
[197] U.S. EPA, TVA Kingston Fossil Fuel Plant Release Site: http://www.epakingstontva.com/default.aspx, TDEC, Ash Slide at TVA Kingston Fossil Plant: http://www.tn.gov/environment/kingston/archive/, TVA, Kingston Recovery: http://www.tva.gov/kingston/index.htm,
[198] *See* U.S. EPA, *supra* note 196.
[199] *See, e.g.*, TVA, *Kingston Fossil Plant Ash Processing area Groundwater Monitoring Report – June 2009* (Aug. 24, 2009).
[200] *See, e.g.*, letter from Anda Ray, TVA, to Paul Sloan, TDEC, transmitting corrective action plan for the "Gypsum Disposal Pond" (Mar. 4, 2011).
[201] *See, e.g.*, TVA, *Kingston Fossil Plant Gypsum Landfill Groundwater Monitoring Report – March 2008* (May 23, 2008).

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2008 and 2010.[202] Although 10 sinkholes were discovered and repaired during that time,[203] the facility was constructed with only a clay liner. Gypsum was first sluiced to the area in June 2010.[204] In December 2010, TVA discovered that liquid was draining through a sinkhole near the southern edge of the disposal area, causing dramatically elevated selenium concentrations in underlying groundwater (see Monitoring section below), and ultimately discharging to the Clinch River.[205] TVA dewatered the area in January 2011. During investigation and repair work, TVA discovered additional sinkholes.[206] The clay liner was ultimately removed and replaced, and covered with a high-density polyethylene liner.[207]

Monitoring

Figure 9-3 shows the approximate locations of the groundwater wells discussed in this report. Four wells have been lost since 2008, and four wells have been added. Two wells, 4B and 16A, were destroyed in the 2008 ash spill; TVA installed well AD-1, and resumed monitoring existing well 22, to replace the two destroyed wells. TVA also installed wells AD-2 and AD-3 in 2009 to monitor the ash processing area. Wells 6A and 13B were destroyed during routine operations in 2009. Well 6AR was installed in 2009 to replace well 6A.

Wells around the ash disposal area show unsafe levels of manganese. Well 6A had manganese concentrations hundreds of times higher than the Lifetime Health Advisory before it was destroyed in 2009. Boron, sulfate, and TDS concentrations in this well, although below their respective health-based thresholds, were all elevated relative to other ash disposal area wells, suggesting that the manganese is at least partly attributable to the coal ash. Well 6AR has also shown very high manganese concentrations, in addition to very high concentrations of cobalt and statistically elevated concentrations of beryllium, cadmium, and nickel.[208] TVA has conceded that this contamination may be due, at least in part, to coal ash:

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[202] TVA, *Gypsum Disposal Facility Groundwater Quality Assessment Plan*, 2 (May 6, 2011).
[203] *See* Geosyntec, *Dye Trace Investigation Report – Flue Gas Desulfurization (FGD) Disposal Facility – Kingston Fossil Plant*, 7 (July 19, 2011).
[204] *See* TVA, *Kingston Fossil Plant Gypsum Disposal Facility Groundwater Monitoring Report – June 2010* (July 29, 2010).
[205] *See, e.g.*, Geosyntec, *supra* note 203, at 7 ("The drop-out occurred beneath the pond water surface and a vortex indicated drainage into the feature. On December 15, 2010 diffuse discharge, allegedly associated with the drop-out, was observed on the northern bank of the Clinch River.").
[206] *See* TVA, *Kingston Fossil Plant Gypsum Disposal Facility Groundwater Assessment Monitoring Report – June 2011 Sampling* (Aug. 16, 2011).
[207] *See* TVA, *Kingston Fossil Plant Gypsum Disposal Facility Groundwater Assessment Monitoring Report – March 2012 Sampling* (May 8, 2012).
[208] *See* Groundwater disposal reports for the Ash Disposal Area from June 2010 – December 2012.

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Concentrations of metals in well 6AR have been slightly elevated since the first sampling event in September 2009, which could be due to naturally-occurring metals associated with the alluvial deposits surrounding the well screen, as indicated by metallic staining and nodules on the lithological boring log of this well. Bottom ash, which was not present in the lithological boring log of this well, is present at a number of neighboring borings and could be a source for these elevated constituents.[209]

Groundwater near the ash processing area is also contaminated with coal ash pollutants. Boron concentrations in downgradient wells AD-2 and AD-3 have consistently been higher than in upgradient well AD-1, and although TVA rarely measures boron, the limited available data show that it is increasing.[210] In well AD-2, boron, cobalt, manganese, and sulfate concentrations have all increased by at least two-fold since 2009. Cobalt and manganese concentrations in this well are now 2-6 times higher than health-based guidelines.

The gypsum disposal area, as described above, experienced a sinkhole shortly after it was put into service in 2010. This event affected wells G4B, G5A, G5B, and G6B, causing selenium concentrations as high as 412 ug/L. Selenium levels have declined following TVA's remediation and repair work, but still remain elevated above background concentrations, and, in well G5B, above the MCL (see Figure 9-1 below).

Data gaps

- The well network at Kingston is insufficient, with no wells along the northern perimeter of the ash disposal area.
- More generally, TVA and TDEC have failed to assess concentrations of coal ash indicators like boron, chloride, manganese, and sulfate with the same level of scrutiny applied to other pollutants. These coal ash indicators are measured infrequently, as reflected in the groundwater data summary tables below. In well AD-2, for example, these pollutants have been measured less than a third of the time. The limited data that TVA does collect is not reported in the main body of the groundwater monitoring reports, is not compared to any groundwater protection standards, and is not statistically analyzed for upgradient-downgradient patterns or temporal trends. Without proper reporting and analysis, TDEC and the public are deprived of the most informative evidence about the extent to which Kingston's ash disposal areas are contaminating groundwater.

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[209] TVA, *Kingston Fossil Plant Ash Disposal Area Groundwater Compliance Report – June 2011* (Aug. 22, 2011).
[210] Boron in wells AD-1 and AD-2 was between 350 and 450 ug/L in early 2010, and was measured at 1,360 ug/L (AD-2) and 1,865 ug/L (AD-3) in September 2012.

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Figure 9-1: Selenium concentrations in gypsum disposal area wells G4B, G5A, G5B, and G6B (ug/L). Selenium in wells G1B, G3A, and G3B (not shown) has consistently been below 2 ug/L.

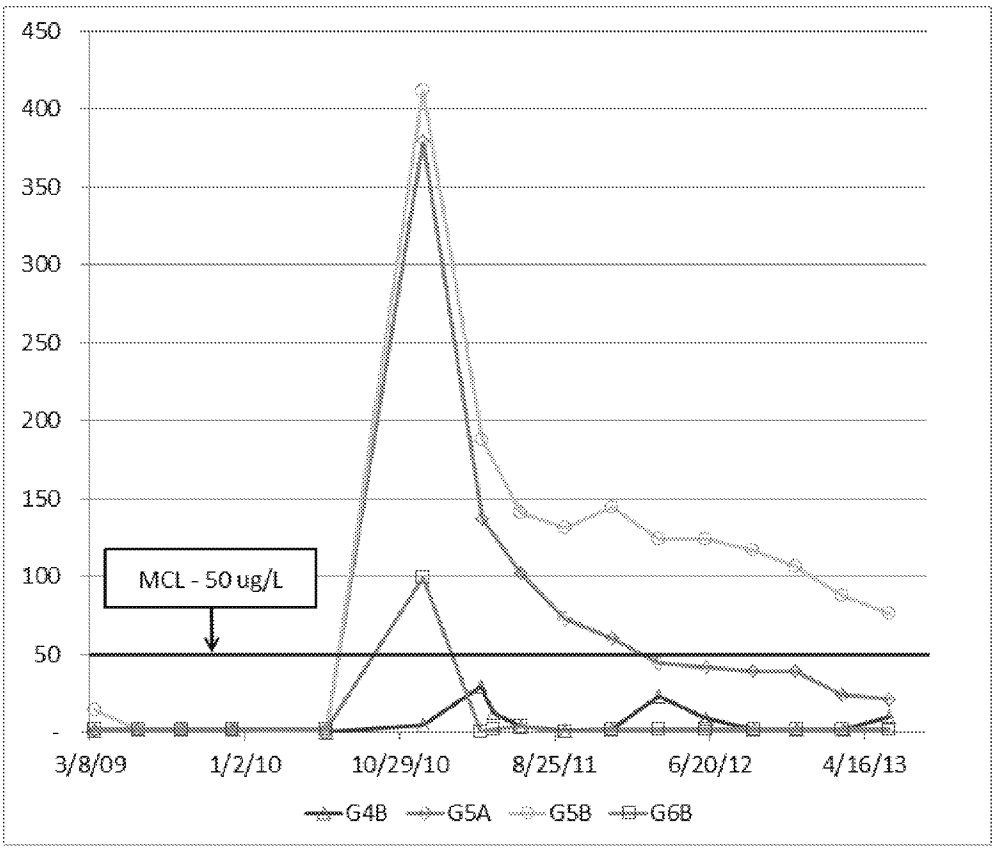

Figure 9-2: Kingston Fossil Plant in September 2007 (top), and in April 2013 (bottom). The ash spill occurred in December 2008. Note changes in the perimeter of ash disposal area, conversion of the ash pond to dry stacking, and construction of the gypsum disposal area on the southern peninsula.

Figure 9-3: Former (orange) and current (red) groundwater wells at Kingston Fossil Plant (approximate locations).

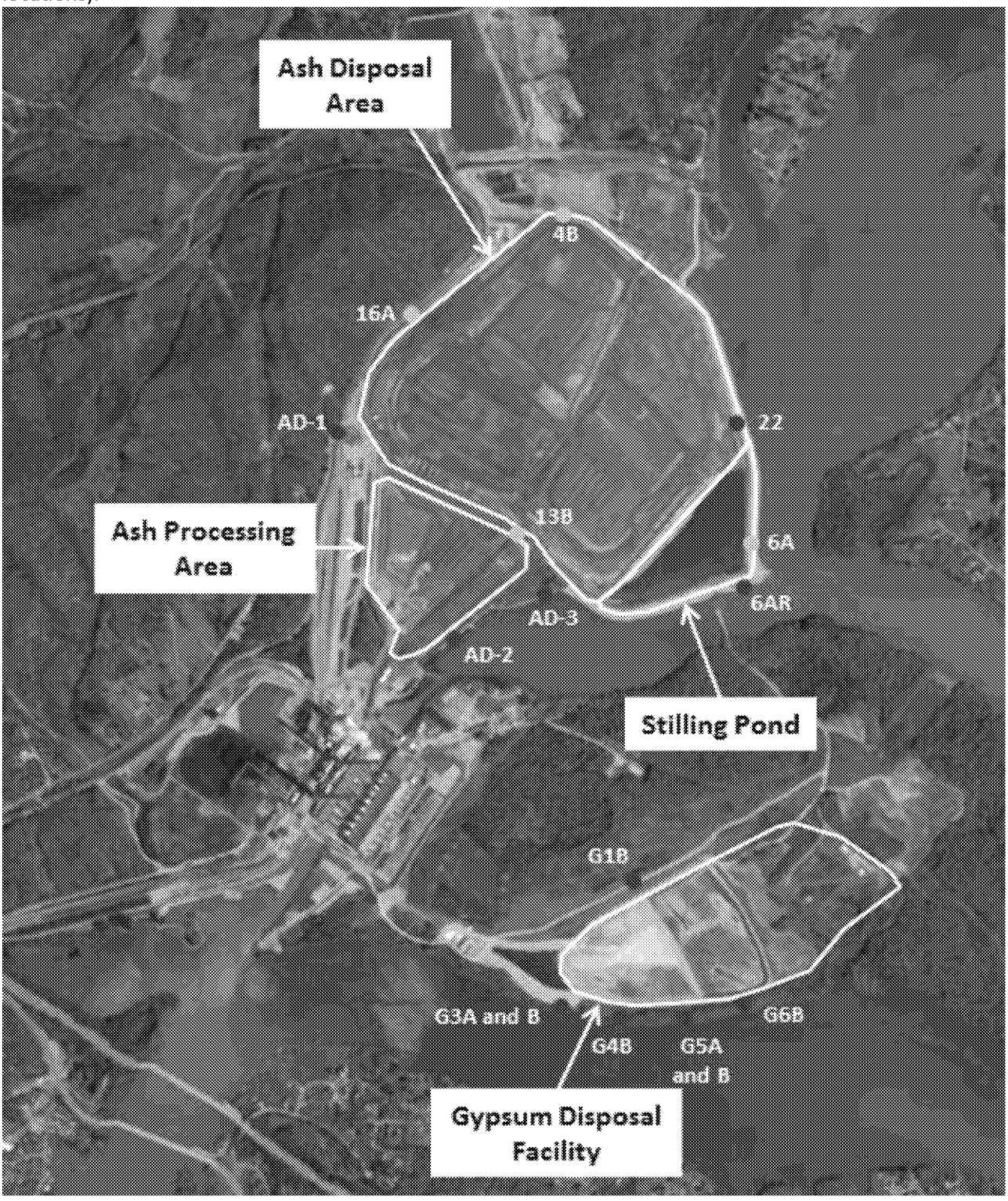

Table 9-1: Kingston Fossil Plant, Well AD-1. Based on 20 measurements between June 2009 and March 2013.[211]

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 2,430	(see note[212])
Antimony	6	<2	
Arsenic	10	<2	
Barium	2,000	44 – 102	
Beryllium	4	<2	
Boron	3,000	116 – 137	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	1.2 – 1.7 mg/L	(see note)
Chromium	100	0.4 – 4.4	
Cobalt	4.7	<2	
Copper	1,300	<0.3 – 15	
Fluoride	4,000	<100 – 429	
Lead	15	<2	
Lithium	31		No data
Manganese	300	28 – 176	(see note)
Mercury	2	<0.2	
Molybdenum	40	<5	(see note)
Nickel	100	<5	
Nitrate	10,000	<100	(see note)
Selenium	50	<2	
Silver	100	<2	
Strontium	9,300	90 – 201	(see note)
Sulfate	500 mg/L	19 – 29 mg/L	(see note)
TDS	500 mg/L	212 – 318 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<1 – 5	
Zinc	2,000	<50	

[211] EIP does not have all groundwater reports for this period on file; this table does not reflect data from March 2011.

[212] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 12 of the 20 sampling events represented here (no data from April-December 2010, September 2011-June 2012, or since September 2012).

Table 9-2: Kingston Fossil Plant, Well AD-2. Based on 14 measurements between January 2010 and March 2013.[213]

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 123	(see note[214])
Antimony	6	<2	
Arsenic	10	1.0 – 5.1	
Barium	2,000	25 – 49	
Beryllium	4	<2	
Boron	3,000	358 – 1,360	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	8.0 – 10.2 mg/L	(see note)
Chromium	100	<2	
Cobalt	4.7	4.7 – 11.2	
Copper	1,300	<5	
Fluoride	4,000	<100 – 140	
Lead	15	<2	
Lithium	31	No data	
Manganese	300	739 – 1,670	(see note)
Mercury	2	<0.2	
Molybdenum	40	0.6 – 5.2	(see note)
Nickel	100	2.0 – 4.4	
Nitrate	10,000	<100	(see note)
Selenium	50	<2	
Silver	100	<2	
Strontium	9,300	346 – 957	(see note)
Sulfate	500 mg/L	97 – 269 mg/L	(see note)
TDS	500 mg/L	28 – 498 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<4	
Zinc	2,000	<50	

[213] EIP does not have all groundwater reports for this period on file; this table does not reflect data from October 2010-August 2011, or from June 2012.

[214] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 10 of the 14 sampling events represented here (no data from April 2010-March 2012 or since September 2012).

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Table 9-3: Kingston Fossil Plant, Well AD-3. Based on 17 measurements between January 2010 and March 2013.[215]

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	54 – 102	(see note[216])
Antimony	6	<2	
Arsenic	10	<2	
Barium	2,000	24 – 58	
Beryllium	4	<2	
Boron	3,000	363 – 1,865	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	5.3 – 8.4 mg/L	(see note)
Chromium	100	<2	
Cobalt	4.7	2.6 – 8.3	
Copper	1,300	<5	
Fluoride	4,000	<100 – 426	
Lead	15	<2	
Lithium	31	No data	
Manganese	300	5,130 – 13,750	(see note)
Mercury	2	<0.2	
Molybdenum	40	0.4 – 0.6	(see note)
Nickel	100	<5	
Nitrate	10,000	<100	(see note)
Selenium	50	<2	
Silver	100	<2	
Strontium	9,300	636 – 746	(see note)
Sulfate	500 mg/L	204 – 552 mg/L	(see note)
TDS	500 mg/L	509 – 1,215 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<4	
Zinc	2,000	<50	

Table 9-4: Kingston Fossil Plant, Well 4B. Based on 2 measurements in June and December 2008. This well was destroyed in the December 2008 ash spill.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 160	
Antimony	6	<1	
Arsenic	10	<1 – 1.7	
Barium	2,000	30 – 35	
Beryllium	4	<1	
Boron	3,000	<200	
Cadmium	5	0.5 – 0.8	
Chloride	250 mg/L	2.8 – 5.7 mg/L	
Chromium	100	<1 – 4	
Cobalt	4.7	1.7 – 2.8	
Copper	1,300	4 – 19	
Fluoride	4,000	170 – 280	
Lead	15	<1 – 1.3	
Lithium	31	No data	
Manganese	300	1,100 – 1,800	
Mercury	2	<0.2	
Molybdenum	40	<5	
Nickel	100	14 – 18	
Nitrate	10,000	<100	
Selenium	50	1.0 – 1.2	
Silver	100	<0.5	
Strontium	9,300	250 – 460	
Sulfate	500 mg/L	240 – 500 mg/L	
TDS	500 mg/L	520 – 980 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	18 – 24	

[215] EIP does not have all groundwater reports for this period on file; this table does not reflect data from March 2011.

[216] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 12 of the 17 sampling events represented here (no data from April 2010-December 2010, September 2011-June 2012, or since September 2012).

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Table 9-5: Kingston Fossil Plant, Well 6A. Based on 3 measurements from June 2008 to June 2009. This well was destroyed in August 2009 during routine operations.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<1,000	
Antimony	6	<2	
Arsenic	10	6.3 – 6.5[217]	
Barium	2,000	<100 – 210	
Beryllium	4	<2	
Boron	3,000	711 – 1,900	
Cadmium	5	<1	
Chloride	250 mg/L	6.1 – 8.0	
Chromium	100	<20	
Cobalt	4.7	<20[218]	
Copper	1,300	<50	
Fluoride	4,000	<100 – 230	
Lead	15	<2	
Lithium	31	No data	
Manganese	300	130,000 – 220,000	
Mercury	2	<0.2	
Molybdenum	40	<25[219]	
Nickel	100	<50	
Nitrate	10,000	<100[220]	
Selenium	50	<20	
Silver	100	<20	
Strontium	9,300	681 – 700	
Sulfate	500 mg/L	2,500 – 3,500 mg/L	
TDS	500 mg/L	4,600 – 5,280 mg/L	
Thallium	2	<2	
Vanadium	63	<50	
Zinc	2,000	<500	

[217] One of the three measurements was reported as <20 ug/L.

[218] The three reported values for this period were 1.7 ug/L, <20 ug/L, and <2 ug/L.

[219] One of the three measurements was reported as <50 ug/L.

[220] One the three measurements was reported as <50 mg/L.

Table 9-6: Kingston Fossil Plant, Well 6AR. Based on 9 measurements from September 2009 to December 2012.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	198 – 204	(see note[221])
Antimony	6	<2	
Arsenic	10	<2	
Barium	2,000	22 – 43	
Beryllium	4	<2	
Boron	3,000	588 – 664	(see note)
Cadmium	5	1.0 – 2.5	
Chloride	250 mg/L	4.0 – 10.1 mg/L	(see note)
Chromium	100	<2	
Cobalt	4.7	84 – 111	
Copper	1,300	<5	
Fluoride	4,000	<500	
Lead	15	<2	
Lithium	31	No data	
Manganese	300	27,600 – 35,800	(see note)
Mercury	2	<0.2	
Molybdenum	40	<5	(see note)
Nickel	100	35 – 45	
Nitrate	10,000	<100	(see note)
Selenium	50	<10	
Silver	100	<2	
Strontium	9,300	119 – 128	(see note)
Sulfate	500 mg/L	19 – 229 mg/L	(see note)
TDS	500 mg/L	319 – 376 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<4	
Zinc	2,000	<50	

[221] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 5 of the 9 sampling events represented here (no data from June-December 2010 or since June 2011).

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Table 9-7: Kingston Fossil Plant, Well 13B. Based on 5 measurements from June 2008 to December 2009, when the well was destroyed during routine operations.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100	
Antimony	6	<2	
Arsenic	10	0.7 – 3.2	
Barium	2,000	356 – 485	
Beryllium	4	<2	
Boron	3,000	<200	
Cadmium	5	<2	
Chloride	250 mg/L	2.5 – 9.7 mg/L	
Chromium	100	<2	
Cobalt	4.7	<2	
Copper	1,300	<5	
Fluoride	4,000	100 – 230	
Lead	15	<2	
Lithium	31	No data	
Manganese	300	80 – 182	
Mercury	2	<0.2	
Molybdenum	40	<5	
Nickel	100	<5	
Nitrate	10,000	<100	
Selenium	50	<2	
Silver	100	<2	
Strontium	9,300	340 – 451	
Sulfate	500 mg/L	<5 – 46 mg/L	
TDS	500 mg/L	240 – 300 mg/L	
Thallium	2	<2	
Vanadium	63	<10	
Zinc	2,000	11 – 686	

Table 9-8: Kingston Fossil Plant, Well 16A. Based on 2 measurements in June and December 2008. This well was destroyed in the December 2008 ash spill.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	280 – 2,100	
Antimony	6	<1	
Arsenic	10	1.4	
Barium	2,000	51 – 64	
Beryllium	4	<1	
Boron	3,000	<200	
Cadmium	5	<0.5 – 0.6	
Chloride	250 mg/L	<1 – 2.3 mg/L	
Chromium	100	1.5 – 5.6	
Cobalt	4.7	<1 -1.6	
Copper	1,300	1.3 – 2.8	
Fluoride	4,000	300 – 420	
Lead	15	<1 – 2	
Lithium	31	No data	
Manganese	300	1,200 – 1,300	
Mercury	2	<0.2	
Molybdenum	40	<5	
Nickel	100	2.2 – 6.0	
Nitrate	10,000	<0.1	
Selenium	50	<1	
Silver	100	<0.5	
Strontium	9,300	275 – 280	
Sulfate	500 mg/L	27 – 28 mg/L	
TDS	500 mg/L	160 – 200 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	12 – 35	

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Table 9-9: Kingston Fossil Plant, Well 22. Based on 10 measurements in June 2009 and December 2012.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 362	(see note[222])
Antimony	6	<2	
Arsenic	10	<2	
Barium	2,000	21 – 36	
Beryllium	4	<2	
Boron	3,000	665 – 1,140	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	7.0 – 11.8 mg/L	(see note)
Chromium	100	<2	
Cobalt	4.7	<0.3 – 2.2	
Copper	1,300	<5	
Fluoride	4,000	<100	
Lead	15	<2	
Lithium	31	No data	
Manganese	300	1,830 – 2,320	(see note)
Mercury	2	<0.2	
Molybdenum	40	<5	(see note)
Nickel	100	<5	
Nitrate	10,000	<100	(see note)
Selenium	50	<2	
Silver	100	<2	
Strontium	9,300	408 – 502	(see note)
Sulfate	500 mg/L	78 – 102 mg/L	(see note)
TDS	500 mg/L	183 – 209 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<4	
Zinc	2,000	<50	

[222] Aluminum, boron, chloride, manganese, molybdenum, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 5 of the 10 sampling events represented here (no data from June-December 2010 or since June 2011).

Table 9-10: Kingston Fossil Plant, Well G1B. Based on 16 measurements between March 2009 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 1,420	(see note[223])
Antimony	6	<2	
Arsenic	10	<2	
Barium	2,000	54 – 475	
Beryllium	4	<2	
Boron	3,000	<200	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	1.2 – 1.9 mg/L	(see note)
Chromium	100	0.7 – 5.4	
Cobalt	4.7	<2	
Copper	1,300	<5	
Fluoride	4,000	<100	
Lead	15	<0.3 – 6.1	
Lithium	31		No data
Manganese	300	<5 – 178	(see note)
Mercury	2	<0.2	
Molybdenum	40	<5	(see note)
Nickel	100	<0.3 – 5.7	
Nitrate	10,000	111 – 582	(see note)
Selenium	50	<0.33 – 2.3	
Silver	100	<2	
Strontium	9,300	<50	(see note)
Sulfate	500 mg/L	1.1 – 7.6 mg/L	(see note)
TDS	500 mg/L	184 – 252 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<1 – 8.8	
Zinc	2,000	<50	

[223] Aluminum, boron, manganese, and molybdenum were omitted from monitoring in 5 of the 15 sampling events represented here (no data from June-December 2010, September-December 2011, or March 2013); chloride, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 8 of the 15 sampling events (no data from June-December 2010, June 2011-September 2012, or March 2013).

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Table 9-11: Kingston Fossil Plant, Well G3A. Based on 17 measurements between March 2009 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 1,720	(see note[224])
Antimony	6	<2	
Arsenic	10	<0.3 – 3.0	
Barium	2,000	18 – 36	
Beryllium	4	<2	
Boron	3,000	<200	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	2.8 – 4.3 mg/L	(see note)
Chromium	100	0.6 – 4.8	
Cobalt	4.7	<2	
Copper	1,300	<5	
Fluoride	4,000	<100 – 120	
Lead	15	<0.3 – 5.8	
Lithium	31		No data
Manganese	300	7 – 203	(see note)
Mercury	2	<0.2	
Molybdenum	40	<5	(see note)
Nickel	100	<5	
Nitrate	10,000	615 – 908	(see note)
Selenium	50	<2	
Silver	100	<2	
Strontium	9,300	<50	(see note)
Sulfate	500 mg/L	13.6 – 29 mg/L	(see note)
TDS	500 mg/L	170 – 229 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<1 – 5.9	
Zinc	2,000	<50	

[224] Aluminum, boron, manganese, and molybdenum were omitted from monitoring in 5 of the 16 sampling events represented here (no data from June-December 2010, September-December 2011, or March 2013); chloride, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 9 of the 16 sampling events (no data from June 2010-April 2011, September 2011-September 2012, or March 2013).

Table 9-12: Kingston Fossil Plant, Well G3B. Based on 17 measurements between March 2009 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 776	(see note[225])
Antimony	6	<2	
Arsenic	10	0.4 – 2.1	
Barium	2,000	13 – 22	
Beryllium	4	<2	
Boron	3,000	<200	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	2.5 – 3.4 mg/L	(see note)
Chromium	100	<0.3 – 9.8	
Cobalt	4.7	<2	
Copper	1,300	<5	
Fluoride	4,000	<100 – 244	
Lead	15	0.5 – 5.1	
Lithium	31		No data
Manganese	300	<5 – 252	(see note)
Mercury	2	<0.2	
Molybdenum	40	2.8 – 5.4	(see note)
Nickel	100	0.5 – 6.7	
Nitrate	10,000	<100 – 520	(see note)
Selenium	50	<2	
Silver	100	<2	
Strontium	9,300	52 – 94	(see note)
Sulfate	500 mg/L	48 – 65 mg/L	(see note)
TDS	500 mg/L	229 – 296 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<1 – 4.1	
Zinc	2,000	<50	

[225] Aluminum, boron, manganese, and molybdenum were omitted from monitoring in 5 of the 16 sampling events represented here (no data from June-December 2010, September-December 2011, or March 2013); chloride, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 9 of the 16 sampling events (no data from June 2010-April 2011, September 2011-September 2012, or March 2013).

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Table 9-13: Kingston Fossil Plant, Well G4B. Based on 17 measurements between March 2009 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	27 – 715	(see note[226])
Antimony	6	<2	
Arsenic	10	0.6 – 6.5	
Barium	2,000	24 – 42	
Beryllium	4	<2	
Boron	3,000	<200	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	2 – 42 mg/L	(see note)
Chromium	100	<0.3 – 5.0	
Cobalt	4.7	0.3 – 2.6	
Copper	1,300	0.5 – 6.7	
Fluoride	4,000	<100 – 338	
Lead	15	<0.3 – 2.6	
Lithium	31		No data
Manganese	300	4 – 31	(see note)
Mercury	2	<0.2	
Molybdenum	40	7 – 26	(see note)
Nickel	100	2.3 – 5.5	
Nitrate	10,000	<100 – 212	(see note)
Selenium	50	<0.3 – 29.3	
Silver	100	<2	
Strontium	9,300	55 – 105	(see note)
Sulfate	500 mg/L	33.4 – 75.8 mg/L	(see note)
TDS	500 mg/L	296 – 604 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	0.8 – 4.3	
Zinc	2,000	<50	

[226] Aluminum, boron, manganese, and molybdenum were omitted from monitoring in 5 of the 16 sampling events represented here (no data from June-December 2010, September-December 2011, or March 2013); chloride, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 9 of the 16 sampling events (no data from June 2010-April 2011, September 2011-September 2012, or March 2013).

Table 9-14: Kingston Fossil Plant, Well G5A. Based on 16 measurements between March 2009 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 193	(see note[227])
Antimony	6	<2	
Arsenic	10	<2	
Barium	2,000	12.5 – 148.5	
Beryllium	4	<2	
Boron	3,000	<12.5 – 1,410	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	2.7 – 172 mg/L	(see note)
Chromium	100	<0.3 – 4.0	
Cobalt	4.7	<2	
Copper	1,300	<0.3 – 11	
Fluoride	4,000	<100 – 614	
Lead	15	<2	
Lithium	31		No data
Manganese	300	1 – 11	(see note)
Mercury	2	<0.2	
Molybdenum	40	<5	(see note)
Nickel	100	<5	
Nitrate	10,000	1,020 – 1,930	(see note)
Selenium	50	<0.3 – 379	
Silver	100	<2	
Strontium	9,300	31 – 965	(see note)
Sulfate	500 mg/L	3.5 – 246 mg/L	(see note)
TDS	500 mg/L	151 – 841 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<4	
Zinc	2,000	<50	

[227] Aluminum, boron, manganese, and molybdenum were omitted from monitoring in 5 of the 16 sampling events represented here (no data from June-December 2010, September-December 2011, or March 2013); chloride, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 8 of the 16 sampling events (no data from June-December 2010, September 2011-September 2012, or March 2013).

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Table 9-15: Kingston Fossil Plant, Well G5B. Based on 16 measurements between March 2009 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	<100 – 4,500	(see note[228])
Antimony	6	<2	
Arsenic	10	0.8 – 3.8	
Barium	2,000	14 – 183	
Beryllium	4	<2	
Boron	3,000	<12.5 – 1,550	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	2.8 – 249 mg/L	(see note)
Chromium	100	<0.3 – 9.8	
Cobalt	4.7	<2	
Copper	1,300	<5	
Fluoride	4,000	<100 – 840	
Lead	15	<2 – 13.5	
Lithium	31	No data	No data
Manganese	300	11 – 263	(see note)
Mercury	2	<0.1 – 0.2	
Molybdenum	40	2 – 13	(see note)
Nickel	100	0.9 – 7.3	
Nitrate	10,000	171 – 1,700	(see note)
Selenium	50	<0.3 – 412	
Silver	100	<2	
Strontium	9,300	48 – 1,330	(see note)
Sulfate	500 mg/L	6.8 – 378 mg/L	(see note)
TDS	500 mg/L	195 – 1,090 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<4	
Zinc	2,000	<50	

[228] Aluminum, boron, manganese, and molybdenum were omitted from monitoring in 5 of the 16 sampling events represented here (no data from June-December 2010, September-December 2011, or March 2013); chloride, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 8 of the 16 sampling events (no data from June-December 2010, September 2011-September 2012, or March 2013).

Table 9-16: Kingston Fossil Plant, Well G6B. Based on 17 measurements between March 2009 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000	84 – 104	(see note[229])
Antimony	6	<2	
Arsenic	10	<2	
Barium	2,000	8.1 – 24.6	
Beryllium	4	<2	
Boron	3,000	<200	(see note)
Cadmium	5	<1	
Chloride	250 mg/L	3.1 – 6.6 mg/L	(see note)
Chromium	100	<0.3 – 3.8	
Cobalt	4.7	<2	
Copper	1,300	<5	
Fluoride	4,000	<100	
Lead	15	<2	
Lithium	31	No data	No data
Manganese	300	3 – 22	(see note)
Mercury	2	<0.2	
Molybdenum	40	<5	(see note)
Nickel	100	<5	
Nitrate	10,000	<100 – 345	(see note)
Selenium	50	<0.3 – 99.3	
Silver	100	<2	
Strontium	9,300	<50	(see note)
Sulfate	500 mg/L	3.5 – 12.7 mg/L	(see note)
TDS	500 mg/L	200 – 334 mg/L	(see note)
Thallium	2	<2	
Vanadium	63	<1 – 4.1	
Zinc	2,000	<50	

[229] Aluminum, boron, manganese, and molybdenum were omitted from monitoring in 5 of the 16 sampling events represented here (no data from June-December 2010, September-December 2011, or March 2013); chloride, nitrate, strontium, sulfate, and TDS were omitted from monitoring in 9 of the 16 sampling events (no data from June 2010-April 2011, September 2011-September 2012, or March 2013).

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10 Paradise Fossil Plant

Background

The Paradise Fossil Plant includes three coal units on the Green River outside of Drakesboro, KY. TVA built the plant between 1959 and 1970. The land around and beneath the site is heavily disturbed by coal mining and reclamation, and coal ash disposal areas have been built over mine spoil.[230]

The original ash disposal areas for Paradise were located close to the plant, under the current coal pile, coal yard drainage basin, and parking lot.[231] These areas were filled and graded by 1967.[232] TVA built the slag (bottom ash) ponds, including Slag Ponds 2A and 2B and the Slag Stilling Pond, in 1967-1970.[233] Stantec noted that this area may be underlain by both mine spoils and fly ash.[234] TVA built Jacob's Creek Ash and Stilling Ponds around 1971, and built the Peabody Ash and Stilling Ponds in 1997.[235]

At some point prior to 1980,[236] TVA began stacking bottom ash in the "Slag Mountain" area. The area is no longer used for disposal, but the ash is being actively reclaimed for commercial use and the area still includes two storm water retention ponds.[237] The dikes around the ponds have experienced erosion and partial structural failures.[238] The pond dikes also show significant

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[230] *See, e.g.*, Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Kentucky, Appendix B: Paradise Fossil Plant,* Scrubber Sludge Complex - Gypsum Stack page 11 ("It appears that most or all of the Scrubber Sludge Complex was constructed on top of thick mine spoil deposits which are difficult to characterize."). Stantec made the same observation about each of the eleven ash or gypsum disposal areas at Paradise. Stantec subsequently confirmed the presence of mine spoil beneath the gypsum area and the active ash pond in its Phase II assessment. Stantec Consulting Services, Inc., *Report of Geotechnical Exploration – Peabody Ash Pond, Paradise Fossil Plant* (Feb. 9, 2010); Letter from Stantec Consulting Services, Inc. to TVA reporting on geotechnical exploration of the south slope of the west pond of the scrubber sludge complex (Apr. 19, 2010).

[231] *See* Stantec Consulting Services, Inc., *Report of Geotechnical Exploration – Peabody Ash Pond, Paradise Fossil Plant – Appendix A, Historic Documents*, Reference No. 2: Draft Peabody Ash Pond Expansion 1998, page 1 (Feb. 9, 2010).

[232] *Id.*

[233] Letter from Anda Ray, TVA, to Richard Kinch, U.S. EPA, responding to a U.S. EPA request for information (Mar. 25, 2009).

[234] Stantec Phase 1 Assessment, *supra* note 230, at Slag Stilling Pond page 6.

[235] TVA letter, *supra* note 233; Stantec, Peabody Ash Pond Report, *supra* note 230, at iv.

[236] Stantec reports having access to inspection reports from 1980-2008, and states that slag was stacked in the Slag Mountain area "during early years of the plant operation." Stantec Phase 1 Assessment, *supra* note 230, at Slag Mountain pages 1-2.

[237] *Id.* at Slag Mountain page 1, Slag Mountain Pond 1, and Slag Mountain Pond 2.

[238] *Id.* at Slag Mountain Pond 1 page 1 ("a 75 foot long by 4 foot section of the south dike slide into the edge of Jacob's Creek in the early 1990'2") and Slag Mountain Pond 2 page 4 (describing a slide 40 feet long and 22 feet high).

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seepage around their perimeters, including one red water seep flowing at a rate of five gallons per minute,[239] and another seepage-affected area that nearly swallowed a Stantec engineer:

> A thick cover of leaves makes it difficult to identify the location and extent of wet areas, but while searching below the toe, a Stantec engineer stepped into a seepage ponded area and his leg sank approximately 16 inches into the ground (very saturated and disturbed).[240]

TVA installed sulfur dioxide scrubbers at Paradise in the early 1980s, and built the scrubber sludge complex around 1986.[241] TVA has sluiced both gypsum and fly ash into the areas.[242] In addition to erosion, sloughing, and one structural "blow out" in 2008, Stantec has observed "uncontrolled seepage saturating the slopes on all sides of this facility."[243]

TVA built the East and West Dredge Cells in 1991 as a place to stack fly ash dredged from the Jacob's Creek Pond, but apparently only dredged to the East Cell, and only during 1992-1994. The West Cell functions as a storm water control pond.[244]

Monitoring

The limited available data show that TVA is adding contamination to an already-contaminated area. The groundwater aquifers around the Paradise plant were originally disturbed by strip mining.[245] By 1989 local groundwater was no longer "considered usable as a water source."[246] TVA operates an asbestos landfill on the property just north of the Scrubber Sludge Complex, [247] and the two disposal areas share two groundwater monitoring wells.[248] The groundwater flow in the area is now affected by the TVA ash ponds.[249] There are therefore several complications in any attempt to isolate the effect of TVA's ash disposal areas on local groundwater quality:

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[239] *Id*. at Slag Mountain Pond 1 page 5.
[240] *Id*. at Slag Mountain Pond 2 page 4.
[241] TVA letter, *supra* note 233.
[242] Stantec Phase I Assessment, *supra* note 230, at Scrubber Sludge Complex Gypsum Stack page 9.
[243] *Id*. at Scrubber Sludge Complex Gypsum Stack pages 1-6.
[244] *Id*. at East and West Dredge Cells.
[245] TVA, *Draft Environmental Assessment – Development of Dredged Ash Disposal Area*, 10 (Mar. 1, 1989) ("The only significant water-bearing units within the Pennsylvanian Age regional aquifer are the Lisman Formation and the deeply buried Caseyville Formation. Coal-stripping operations have removed the Lisman formation in most of the upland areas. Where sandstone units of the Lisman Formation exits they receive direct infiltration and are susceptible to contamination from the surface.").
[246] *Id*. at 16.
[247] *See, e.g.*, Kentucky Department for Environmental Protection, Fact Sheet for Residual Landfill Permit # 089-00012 (Sep. 1996).
[248] Wells 94-42 and 97-45, both used as upgradient wells for the Scrubber Sludge Complex (or FGD Pond), are also upgradient wells for the asbestos landfill. *See, e.g.*, TVA, Groundwater and Surface Water Monitoring Sample Data Reporting Form – Residual Landfill – 2nd Quarter 2010 (2012).
[249] *See* TVA 1989, *supra* note 245, at 16. *See also id*. at 24, noting that ash placed in the area now occupied by the Peabody Ash Pond would be in direct contact with groundwater.

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First, there are very few data points (see Data Gaps, below). Second, the limited data are likely to reflect a mixture of impacts from historical strip mining, ongoing ash disposal, and other waste disposal. Finally, the ash ponds may be influencing local groundwater in ways that make site-wide flow patterns difficult to characterize. With these considerations in mind, there are a few observations that can be made about each disposal area.

Wells 10-1 and 10-2, at the eastern edge of the Scrubber Sludge Complex, show clear evidence of coal ash contamination, with very high concentrations of boron, manganese, and sulfate, in addition to high concentrations of cobalt.

Wells around the Jacob's Creek and Peabody Ash Ponds have only been sampled once, but all four showed unsafe concentrations of one or more pollutants, including manganese in all four wells and cobalt in three of the four wells. Well 10-6 stands out as having much higher concentrations of cobalt and manganese than the other three wells: Cobalt in well 10-6 was measured at 130 ug/l, while wells 10-3 through 10-5 had concentrations of 1.4 – 27 ug/L. Similarly, manganese in well 10-6 was measured at 28 mg/L, roughly 100 times higher than EPA's health advisory of 0.3 mg/L. Manganese in wells 10-3 through 10-5 was measured at 1.4 – 3.8 mg/L. Well 10-6 also stands out as having much higher boron concentrations than the other three wells, providing further evidence of ash contamination.

Wells along the Slag Ponds, measured once in 2011, also show evidence of contamination. Well 10-8 had unsafe concentrations of arsenic, cobalt, and manganese, although the cobalt and manganese concentrations were less than those seen in upgradient well 10-7. Well 10-9 had higher concentrations of cobalt and manganese than the upgradient well (both were orders of magnitude higher than health-based thresholds) and also had an extremely high concentration of boron, which was not detected in the upgradient well.

Data Gaps

Groundwater at Paradise is effectively unmonitored. Although TVA has sampled a series of wells one or more times, it rarely monitors wells on a routine basis, and when it does sample a well it typically omits pollutants associated with coal ash.

- As far as we know, TVA sampled the wells around the ash ponds just once, in June 2011. After finding evidence of coal ash contamination in several of these wells, especially wells 10-6 (at the Peabody Ash Pond) and 10-9 (at the Slag Ponds), TVA stopped sampling these wells, effectively ignoring the problem.
- TVA has been sampling wells around the Scrubber Sludge Complex semi-annually since 2011, but only for a very limited set of pollutants. Most pollutants, including key coal ash indicators like boron, manganese, and sulfate, were measured once (in wells 10-1

and 10-2) or not at all (in wells 94-35A, 94-42, and 97-45). Again, TVA appears to be avoiding evidence of coal ash contamination.

- Other areas of the site simply have no wells around them, most notably the area east of the site known as Slag Mountain, including the two storm water ponds in that area, but also including the East and West Dredge Cells.

Figure 10-1: Groundwater wells at Paradise Fossil Plant (approximate locations)

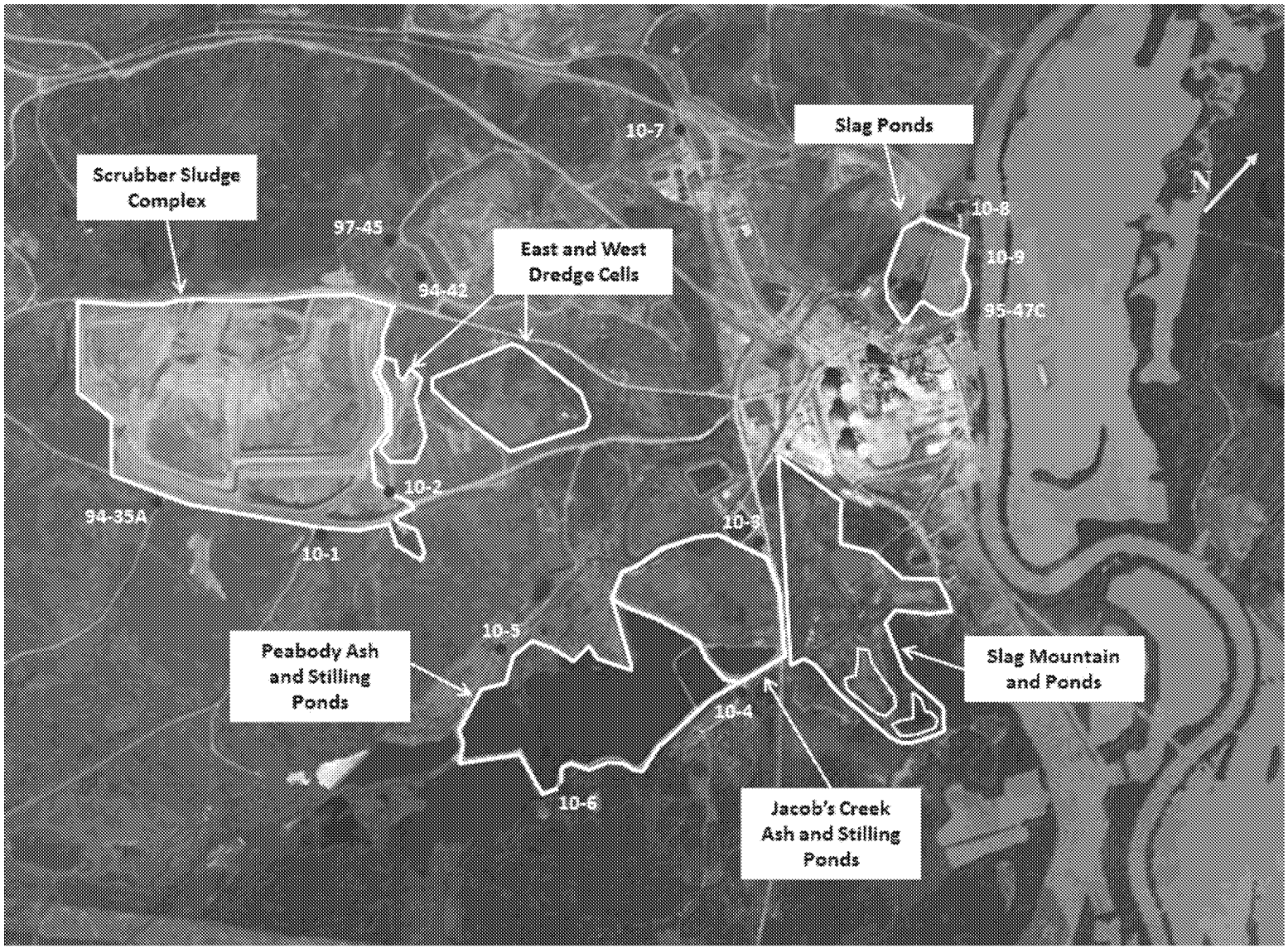

Table 10-1: Paradise Fossil Plant, Well 94-35A. Sampled 5 times between June 2011 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6		No data
Arsenic	10	4.1 – 8.4	
Barium	2,000		No data
Beryllium	4		No data
Boron	3,000		No data
Cadmium	5	<0.5	
Chloride	250 mg/L	410 mg/L	No data since 6/2011
Chromium	100		No data
Cobalt	4.7		No data
Copper	1,300	8.7	No data since 6/2011
Fluoride	4,000		No data
Lead	15	<1 – 1.7	
Lithium	31		No data
Manganese	300		No data
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	23	No data since 6/2011
Nitrate	10,000		No data
Selenium	50	5.8 – 17	
Silver	100		No data
Strontium	9,300		No data
Sulfate	500 mg/L	1,800 mg/L	No data since 6/2011
TDS	500 mg/L	3,700 mg/L	No data since 6/2011
Thallium	2		No data
Vanadium	63		No data
Zinc	2,000		No data

Table 10-2: Paradise Fossil Plant, Well 94-42. Sampled 5 times between June 2011 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6		No data
Arsenic	10	1.0 – 3.5	
Barium	2,000		No data
Beryllium	4		No data
Boron	3,000		No data
Cadmium	5	<0.5 – 0.5	
Chloride	250 mg/L	9.6 mg/L	No data since 6/2011
Chromium	100		No data
Cobalt	4.7		No data
Copper	1,300		No data
Fluoride	4,000		No data
Lead	15	<1	
Lithium	31		No data
Manganese	300		No data
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100		No data
Nitrate	10,000		No data
Selenium	50	<1	
Silver	100		No data
Strontium	9,300		No data
Sulfate	500 mg/L		No data
TDS	500 mg/L	4,900 mg/L	No data since 6/2011
Thallium	2		No data
Vanadium	63		No data
Zinc	2,000		No data

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Table 10-3: Paradise Fossil Plant, Well 94-47C. Sampled once, in June 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6		No data
Arsenic	10	<1	
Barium	2,000		No data
Beryllium	4		No data
Boron	3,000		No data
Cadmium	5	<0.5	
Chloride	250 mg/L	17 mg/L	
Chromium	100		No data
Cobalt	4.7		No data
Copper	1,300	2.6	
Fluoride	4,000		No data
Lead	15	<1	
Lithium	31		No data
Manganese	300		No data
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	63	
Nitrate	10,000		No data
Selenium	50	<1	
Silver	100		No data
Strontium	9,300		No data
Sulfate	500 mg/L	460 mg/L	
TDS	500 mg/L	910 mg/L	
Thallium	2		No data
Vanadium	63		No data
Zinc	2,000		No data

Table 10-4: Paradise Fossil Plant, Well 97-45. Sampled 5 times between June 2011 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6		No data
Arsenic	10	<1	
Barium	2,000		No data
Beryllium	4		No data
Boron	3,000		No data
Cadmium	5	<0.5 – 0.5	
Chloride	250 mg/L	3.3 mg/L	No data since 6/2011
Chromium	100		No data
Cobalt	4.7		No data
Copper	1,300		No data
Fluoride	4,000		No data
Lead	15	<1	
Lithium	31		No data
Manganese	300		No data
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	7.9	No data since 6/2011
Nitrate	10,000		No data
Selenium	50	<1 – 1.2	
Silver	100		No data
Strontium	9,300		No data
Sulfate	500 mg/L	1,600 mg/L	No data since 6/2011
TDS	500 mg/L	3,200 mg/L	No data since 6/2011
Thallium	2		No data
Vanadium	63		No data
Zinc	2,000		No data

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Table 10-6: Paradise Fossil Plant, Well 10-1. Sampled 5 times between June 2011 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	No data since 6/2011
Arsenic	10	1.9 – 4.4	
Barium	2,000	22	No data since 6/2011
Beryllium	4	<1	No data since 6/2011
Boron	3,000	10,500	No data since 6/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	340 mg/L	No data since 6/2011
Chromium	100	5.5	No data since 6/2011
Cobalt	4.7	8.1	No data since 6/2011
Copper	1,300	14.1	No data since 6/2011
Fluoride	4,000	480	No data since 6/2011
Lead	15	<5	
Lithium	31		No data
Manganese	300	2,700	No data since 6/2011
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	16.5	No data since 6/2011
Nitrate	10,000	<100	No data since 6/2011
Selenium	50	5 – 11	
Silver	100	<1	No data since 6/2011
Strontium	9,300		No data
Sulfate	500 mg/L	1,900 mg/L	No data since 6/2011
TDS	500 mg/L	3,750 mg/L	No data since 6/2011
Thallium	2	<1	No data since 6/2011
Vanadium	63	<2	No data since 6/2011
Zinc	2,000	12	No data since 6/2011

Table 10-7: Paradise Fossil Plant, Well 10-2. Sampled 5 times between June 2011 and June 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	No data since 6/2011
Arsenic	10	2.0 – 6.1	
Barium	2,000	16	No data since 6/2011
Beryllium	4	<1	No data since 6/2011
Boron	3,000	24,000	No data since 6/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	410 mg/L	No data since 6/2011
Chromium	100	<2	No data since 6/2011
Cobalt	4.7	5.9	No data since 6/2011
Copper	1,300	7.2	No data since 6/2011
Fluoride	4,000	1,200	No data since 6/2011
Lead	15	<1 -1.8	
Lithium	31		No data
Manganese	300	2,600	No data since 6/2011
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	17	No data since 6/2011
Nitrate	10,000	<100	No data since 6/2011
Selenium	50	7.4	
Silver	100	<1	No data since 6/2011
Strontium	9,300		No data
Sulfate	500 mg/L	1,800 mg/L	No data since 6/2011
TDS	500 mg/L	3,400 mg/L	No data since 6/2011
Thallium	2	1.2	No data since 6/2011
Vanadium	63	<2	No data since 6/2011
Zinc	2,000	19	No data since 6/2011

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Table 10-8: Paradise Fossil Plant, Well 10-3. Sampled once, in June 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	16	
Beryllium	4	M1	
Boron	3,000	420	
Cadmium	5	0.7	
Chloride	250 mg/L	15 mg/L	
Chromium	100	2.6	
Cobalt	4.7	27	
Copper	1,300	6.8	
Fluoride	4,000	350	
Lead	15	1.7	
Lithium	31		No data
Manganese	300	3,800	
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	43	
Nitrate	10,000	<100	
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300		No data
Sulfate	500 mg/L	1,400 mg/L	
TDS	500 mg/L	2,100 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	22	

Table 10-9: Paradise Fossil Plant, Well 10-4. Sampled once, in June 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	8.0	
Barium	2,000	64	
Beryllium	4	<1	
Boron	3,000	270	
Cadmium	5	<0.5	
Chloride	250 mg/L	9.8 mg/L	
Chromium	100	14	
Cobalt	4.7	1.4	
Copper	1,300	2	
Fluoride	4,000	615	
Lead	15	2.1	
Lithium	31		No data
Manganese	300	1,400	
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	9.4	
Nitrate	10,000	<0.1	
Selenium	50	1.3	
Silver	100	<1	
Strontium	9,300		No data
Sulfate	500 mg/L	98 mg/L	
TDS	500 mg/L	580 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	<10	

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Table 10-10: Paradise Fossil Plant, Well 10-5. Sampled once, in June 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	17	
Beryllium	4	<1	
Boron	3,000	530	
Cadmium	5	<0.5	
Chloride	250 mg/L	36 mg/L	
Chromium	100	23	
Cobalt	4.7	13	
Copper	1,300	8.2	
Fluoride	4,000	170	
Lead	15	1	
Lithium	31		No data
Manganese	300	3,000	
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	30	
Nitrate	10,000	<100	
Selenium	50	1.5	
Silver	100	1	
Strontium	9,300		No data
Sulfate	500 mg/L	1,900 mg/L	
TDS	500 mg/L	3,400 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	10	

Table 10-11: Paradise Fossil Plant, Well 10-6. Sampled once, in June 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	<5	
Barium	2,000	46	
Beryllium	4	<1	
Boron	3,000	3,200	
Cadmium	5	<0.5	
Chloride	250 mg/L	94 mg/L	
Chromium	100	12	
Cobalt	4.7	130	
Copper	1,300	<10	
Fluoride	4,000	290	
Lead	15	1.2	
Lithium	31		No data
Manganese	300	28,000	
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	29	
Nitrate	10,000	<100	
Selenium	50	7.8	
Silver	100	21	
Strontium	9,300		No data
Sulfate	500 mg/L	590 mg/L	
TDS	500 mg/L	1,100 mg/L	
Thallium	2	<1	
Vanadium	63	<10	
Zinc	2,000	<50	

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Table 10-12: Paradise Fossil Plant, Well 10-7. Sampled once, in June 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	2.7	
Barium	2,000	170	
Beryllium	4	<1	
Boron	3,000	<200	
Cadmium	5	<0.5	
Chloride	250 mg/L	45 mg/L	
Chromium	100	<2	
Cobalt	4.7	135	
Copper	1,300	<2	
Fluoride	4,000	160	
Lead	15	1.4	
Lithium	31		No data
Manganese	300	48,500	
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	21.5	
Nitrate	10,000	<100	
Selenium	50	<1	
Silver	100	<1	
Strontium	9,300		No data
Sulfate	500 mg/L	190 mg/L	
TDS	500 mg/L	580 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	<10	

Table 10-13: Paradise Fossil Plant, Well 10-8. Sampled once, in June 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	18	
Barium	2,000	300	
Beryllium	4	<1	
Boron	3,000	<200	
Cadmium	5	<0.5	
Chloride	250 mg/L	19 mg/L	
Chromium	100	3.6	
Cobalt	4.7	26	
Copper	1,300	<2	
Fluoride	4,000	160	
Lead	15	1.5	
Lithium	31		No data
Manganese	300	19,000	
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	18	
Nitrate	10,000	<100	
Selenium	50	2.7	
Silver	100	2.5	
Strontium	9,300		No data
Sulfate	500 mg/L	210 mg/L	
TDS	500 mg/L	920 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	13	

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Table 10-14: Paradise Fossil Plant, Well 10-9. Sampled once, in June 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	1.2	
Barium	2,000	12	
Beryllium	4	3.9	
Boron	3,000	15,000	
Cadmium	5	4.5	
Chloride	250 mg/L	14 mg/L	
Chromium	100	10	
Cobalt	4.7	370	
Copper	1,300	7.9	
Fluoride	4,000	190	
Lead	15	2.4	
Lithium	31		No data
Manganese	300	61,000	
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	200	
Nitrate	10,000	<100	
Selenium	50	5	
Silver	100	<1	
Strontium	9,300		No data
Sulfate	500 mg/L	280 mg/L	
TDS	500 mg/L	1,600 mg/L	
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	340	

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11 Shawnee Fossil Plant

Background

The Shawnee Fossil Plant is located on the Ohio River in West Paducah, KY. TVA has been operating 10 coal units at the site since the mid-1950s. The original ash pond was located under the current Dry Stack (see figure 11-1). TVA stopped using the pond for wet disposal in 1971, and started stacking dry fly ash in the area in 1984.[250] TVA started operating Ash Pond 2 in 1971; it is currently used to store wet bottom ash.[251] The Inactive Dredge cell was used briefly between 1983 and 1984/1985.[252] Little Bayou Creek runs along the southern edge of the ash disposal area before emptying into the Ohio River.

Monitoring

Figure 11-1 shows the approximate locations of the groundwater wells discussed in this report.

Four wells (D-8A, D-11, D-19, and D-27) have been in place since the late 1987-1988. The other ten wells were installed in 2007. Unlike other TVA plants, the monitoring wells at Shawnee are screened in three distinct aquifers under the plant: the alluvial aquifer, the Upper Continental Deposits (UCD), and the Regional Groundwater Aquifer (RGA). Tables 11-4 through 11-17, which summarize groundwater quality data at Shawnee, are grouped according to these three aquifers.

TVA did not begin performing site-wide upgradient-downgradient statistical analyses until 2010, after it had eight quarters of quarterly monitoring data from the new wells. After statistically analyzing the limited available data, TVA observed that the majority of wells in the UCD and RGA aquifers showed "statistical exceptions" for boron, pH, sulfate, and other parameters; it was clear that these were the result of coal ash contamination: "The prevalence of elevated levels of boron, sulfate, and TDS compared to background suggests that local groundwater might be affected by coal combustion byproduct leachate."[253]

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[250] *See* Stantec Consulting Services, Inc., *Report of Geotechnical Exploration and Slope Stability Evaluation – Ash Pond 1 & 2 and Consolidated Waste Dry Stack – Shawnee Fossil Plant*, 5 (July 14, 2010).
[251] *See* Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment , Kentucky, Appendix C, Shawnee Fossil Plant,* Active Ash Pond No. 2 page 1 and Consolidated Waste Dry Stack page 1 (June 24, 2009).
[252] *Id*. at Inactive Dredge Cell page 1.
[253] TVA, *Groundwater and Surface Water Sample Data Reporting Form, Shawnee Fossil Plant*, 2nd Quarter 2010, at 5 and 7 (Aug. 2010).

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From 2010 forward, TVA performed "assessment monitoring" according to Kentucky landfill regulations,[254] significantly increasing the number of monitored pollutants. The initial round of monitoring showed very high concentrations of several metals in well D-75A. This may have been, as TVA argued,[255] an artifact of sampling error, because subsequent results have been much lower (see Tables 11-1 and 11-9):

Table 11-1: Results for select metals showing anomalous 2010 results in well D-75A (ug/L).

	Sep. 2010	**June 2011**	**March 2012**	**June 2012**	**Nov. 2012**
Aluminum	*100,000*	<100	<100	<100	<100
Arsenic	*22*	3.6	<20	<10	<1
Barium	*1,300*	56	55	58	59
Beryllium	*5.8*	<1	<20	<1	<1
Chromium	*150*	<2	<40	<20	<2
Cobalt	*74*	1.3	<20	<10	<1
Lead	*120*	<1	<20	<1	<1
Nickel	*120*	1.2	<20	5.7	2.8
Vanadium	*200*	<2	<40	<4	<2

Setting the September 2010 results for well D-75A aside, the remaining available data show clear evidence of ash contamination in all three aquifers. Three alluvial wells along the Ohio River show high concentrations of boron and manganese; well D-30A also has high levels of cobalt, and well D-74A has high levels of molybdenum. The two downgradient UCD aquifer wells show consistently high boron, manganese, and sulfate; well D-76A has also had high levels of cobalt and molybdenum. All downgradient RGA aquifer wells show high levels of manganese, and three (D-74B, D-30B, and D-75B) have high levels of boron. Well D-75B also exceeded the health-based threshold for cobalt in recent monitoring.

The manganese results are particularly troubling, for four reasons: First, EPA has identified manganese as a coal ash pollutant.[256] Second, there is a clear difference in concentration between upgradient and downgradient wells, indicating that the coal ash disposal areas are responsible. Table 11-2 summarizes the manganese data for the site. Third, with concentrations orders of magnitude above the EPA Lifetime Health Advisory for manganese, the affected groundwater is hazardous to human health. It may also be hazardous to aquatic life as it leaches in Little Bayou Creek and the Ohio River: EPA has noted that "biota with

[254] The Kentucky Division of Waste Management formally informed TVA that Shawnee had been placed in assessment monitoring in February, 2011, but TVA began the process earlier than that, conducting the first round of assessment monitoring in September, 2010. See TVA, *Groundwater and Surface Water Sample Data Reporting Form, Shawnee Fossil Plant*, 2nd Quarter 2011, at 12 (June 2011); TVA, *Groundwater and Surface Water Sample Data Reporting Form, Shawnee Fossil Plant*, 3nd Quarter 2010, at Attachment B (Nov. 2010); 401 KAR 45:160.
[255] TVA, *Groundwater and Surface Water Sample Data Reporting Form, Shawnee Fossil Plant*, 3nd Quarter 2010 (Nov. 2010).
[256] U.S. EPA, *Steam Electric Power Generating Point Source Category: Final Detailed Study Report*, 6-3 (Oct. 2009).

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elevated levels [of manganese] have exhibited sublethal effects including metabolic changes and abnormalities of the liver and kidneys."[257] Finally, because Kentucky does not have an MCL for manganese, TVA has not identified or analyzed these exceedances.

Table 11-2: Manganese concentrations in Shawnee monitoring wells, 2010-2012; upgradient data are in blue, downgradient data are in black.[258]

Aquifer	Well	Mean (ug/L)	Range (ug/L)	N
Alluvium	*D-77 (upgradient)*	*358*	*60 – 640*	*5*
	D-11	340	110 – 640	4
	D-33A	893	800 – 950	4
	D-30A	7,920	5,300 – 10,000	5
	D-74A	894	740 – 1,200	5
UCD	*D-19 (upgradient)*	*26*	*<10 – 40*	*5*
	D-75A	66,400	64,000 – 69,000	5
	D-76A	5,480	4,700 – 5,900	5
Upper RGA	*D-27 (upgradient)*	*6*	*3 – 12*	*5*
	D-8A	2,000	1,900 – 2,100	5
	D-11B	5,325	4,800 – 5,400	4
	D-30B	4,600	3,100 – 5,300	5
	D-74B	1,480	1,000 – 1,800	5
	D-75B	5,450	4,550 – 6,700	5

A similar pattern can be observed for boron, as shown in Table 11-3. Boron is also one of the few parameters measured in surface water near TVA. In the results for the two sampling events that we have on file, boron was below detection (<200 ug/L) at all surface water sampling points other than the point on Little Bayou Creek immediately downstream of the ash disposal area, where it was measured at 710-860 ug/L. [259]

[257] *Id*. Although TVA monitors surface water along Little Bayou Creek, it does not measure manganese. TVA, *Groundwater and Surface Water Sample Data Reporting Form, Shawnee Fossil Plant*, 1st half 2012 (July 31, 2012).
[258] TVA only began measuring manganese in groundwater in late 2010.
[259] TVA, *Groundwater and Surface Water Sample Data Reporting Form, Shawnee Fossil Plant*, 1st half 2012 (July 31, 2012).

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Table 11-3: Boron concentrations in Shawnee monitoring wells, 2008-2012; upgradient data are in blue, downgradient data are in black.

Aquifer	Well	Mean (ug/L)	Range (ug/L)	N
Alluvium	*D-77 (upgradient)*	*240*	*<50 – 410*	*13*
	D-11	200	<200 – 220	9
	D-33A	2,510	2,300 – 2,600	9
	D-30A	5,020	990 – 12,000	10
	D-74A	7,560	4,700 – 10,000	10
UCD	*D-19 (upgradient)*	*<200*	*<200*	*13*
	D-75A	7,430	6,800 – 8,200	10
	D-76A	19,800	15,000 – 24,000	10
Upper RGA	*D-27 (upgradient)*	*<200*	*<200*	*13*
	D-8A	217	<200 – 280	10
	D-11B	2,522	2,100 – 2,800	9
	D-30B	4,290	500 – 6,600	10
	D-74B	9,020	6,300 – 11,000	10
	D-75B	5,875	5,000 – 6,700	10

Data gaps

1. Lack of historical data. Ten of the fourteen wells in the Shawnee monitoring network were installed in 2007, and through 2010 TVA was generally monitoring for a short list of parameters that included boron, chloride, copper, fluoride, molybdenum, sulfate, TDS, and vanadium. In addition, flooding in 2011-2012 made some wells inaccessible.[260] As a result, although we have 12 sampling events on file from 2008-2012, any given pollutant-well combination may have been sampled only 2 or 3 times.

[260] TVA, *Groundwater and Surface Water Sample Data Reporting Form, Shawnee Fossil Plant*, 2nd half of 2011 (May 8, 2012).

Figure 11-1: Groundwater wells at Shawnee Fossil Plant (approximate locations)

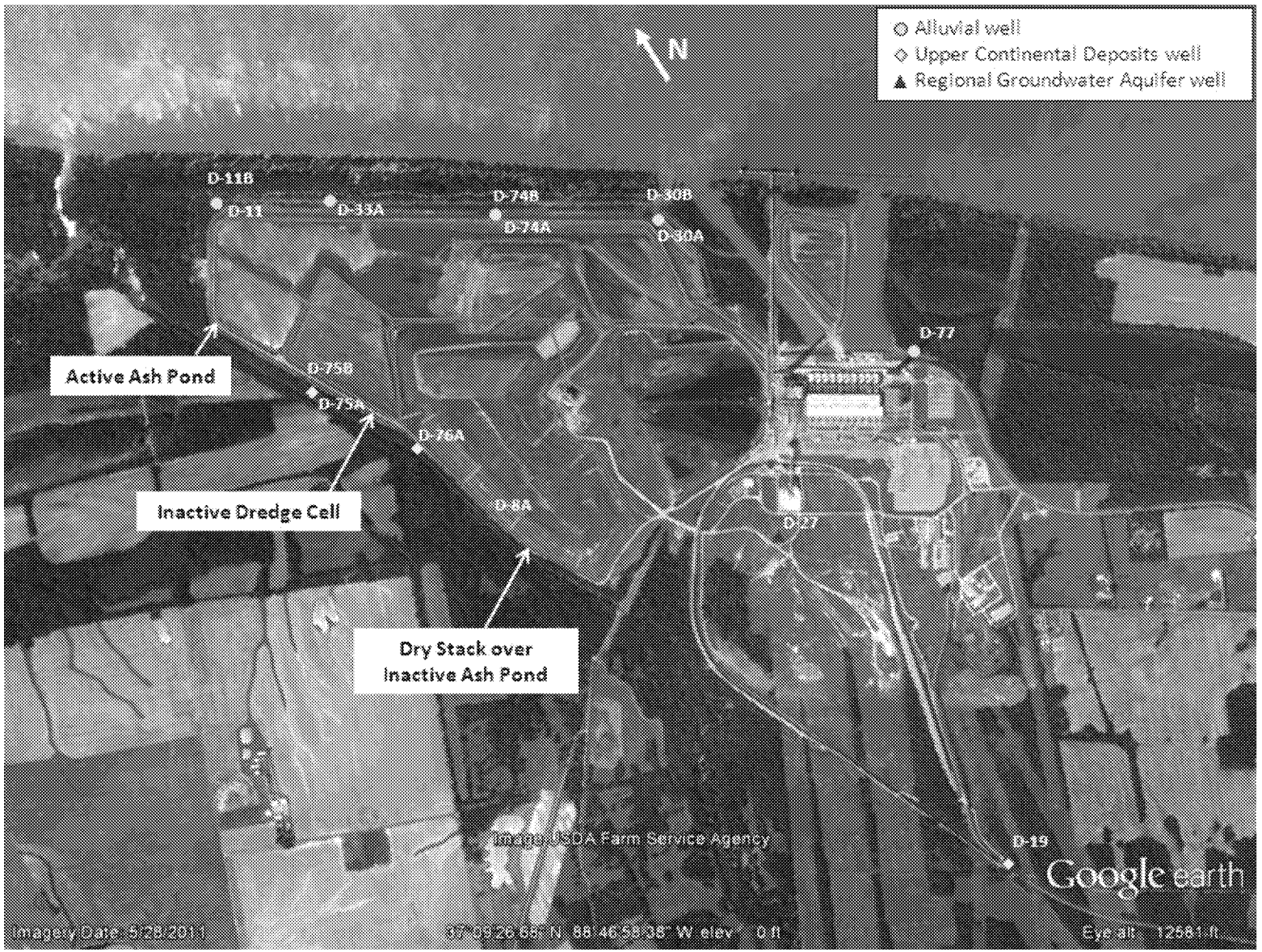

Table 11-4: Shawnee Fossil Plant, alluvial well D-11. Sampled 9 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[261]
Aluminum	16,000	200 – 4,000	4 results
Antimony	6	<1	2 results
Arsenic	10	<1 – 3	4 results
Barium	2,000	78 – 140	4 results
Beryllium	4	<1	4 results
Boron	3,000	<200 – 220	
Cadmium	5	<0.5 – 0.8	4 results
Chloride	250 mg/L	14 – 24 mg/L	
Chromium	100	<2 – 16	4 results
Cobalt	4.7	<1 – 6.3	4 results
Copper	1,300	<2 – 8.2	
Fluoride	4,000	<100 – 150	
Lead	15	<1 – 4.6	4 results
Lithium	31		No data
Manganese	300	110 – 640	4 results
Mercury	2	<0.2	4 results
Molybdenum	40	<5	
Nickel	100	9.6 – 29	4 results
Nitrate	10,000		No data
Selenium	50	<1	4 results
Silver	100	<1	2 results
Strontium	9,300	53 – 71	4 results
Sulfate	500 mg/L	34 – 40 mg/L	
TDS	500 mg/L	100 – 150 mg/L	
Thallium	2	<1	4 results
Vanadium	63	<2 – 15	
Zinc	2,000	<10 – 64	4 results

[261] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

Table 11-5: Shawnee Fossil Plant, alluvial well D-33A. Sampled 9 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[262]
Aluminum	16,000	<100	4 results
Antimony	6	<1	2 results
Arsenic	10	4.5 – 5.8	4 results
Barium	2,000	45 – 63	4 results
Beryllium	4	<1	4 results
Boron	3,000	2,300 – 2,600	
Cadmium	5	<0.5	4 results
Chloride	250 mg/L	15 – 21 mg/L	
Chromium	100	<2	4 results
Cobalt	4.7	<1 – 1.7	4 results
Copper	1,300	<2	
Fluoride	4,000	110 – 250	
Lead	15	<1	4 results
Lithium	31		No data
Manganese	300	800 – 950	4 results
Mercury	2	<0.2	4 results
Molybdenum	40	<5	
Nickel	100	<1 – 2.2	4 results
Nitrate	10,000		No data
Selenium	50	<1	4 results
Silver	100	<1	2 results
Strontium	9,300	51 – 59	4 results
Sulfate	500 mg/L	54 – 69 mg/L	
TDS	500 mg/L	140 – 180 mg/L	
Thallium	2	<1	4 results
Vanadium	63	<10	
Zinc	2,000	<10	4 results

[262] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

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Table 11-6: Shawnee Fossil Plant, alluvial well D-74A. Sampled 10 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[263]
Aluminum	16,000	<100 – 280	5 results
Antimony	6	<1	2 results
Arsenic	10	<10	5 results
Barium	2,000	<20 – 33	5 results
Beryllium	4	<10[264]	5 results
Boron	3,000	4,700 – 10,000	
Cadmium	5	<5	5 results
Chloride	250 mg/L	9.8 – 21 mg/L	
Chromium	100	<20	5 results
Cobalt	4.7	<10[265]	5 results
Copper	1,300	<20	
Fluoride	4,000	<100 – 390	
Lead	15	<10	5 results
Lithium	31		No data
Manganese	300	740 – 1,200	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	270 – 720	
Nickel	100	<10	5 results
Nitrate	10,000		No data
Selenium	50	<10	5 results
Silver	100	<1	2 results
Strontium	9,300	180 – 310	5 results
Sulfate	500 mg/L	67 – 320 mg/L	
TDS	500 mg/L	140 – 600 mg/L	
Thallium	2	<10[266]	5 results
Vanadium	63	<20	
Zinc	2,000	<100	5 results

[263] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

[264] Although one of the four beryllium results was reported as <10 ug/L (March 2012), results before and after this date were reported as <1 ug/L, and a beryllium exceedance is unlikely.

[265] One result was reported as <10 ug/L (March 2012); other results have been in the range of 2.6 – 3.2 ug/L.

[266] Although one of the four thallium results was reported as <10 ug/L (March 2012), results before and after this date were reported as <1 ug/L, and an exceedance is unlikely.

Table 11-7: Shawnee Fossil Plant, alluvial well D-30A. Sampled 10 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[267]
Aluminum	16,000	<100 – 120	5 results
Antimony	6	<1	2 results
Arsenic	10	<5	5 results
Barium	2,000	23 – 110	5 results
Beryllium	4	<5[268]	5 results
Boron	3,000	990 – 12,000	
Cadmium	5	<2.5	5 results
Chloride	250 mg/L	25 – 46 mg/L	
Chromium	100	<10	5 results
Cobalt	4.7	8.6 – 16	5 results
Copper	1,300	<10	
Fluoride	4,000	<100 – 400	
Lead	15	<5	5 results
Lithium	31		No data
Manganese	300	5,300 – 10,000	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<10	
Nickel	100	5.8 – 14	5 results
Nitrate	10,000		No data
Selenium	50	<5	5 results
Silver	100	<1	2 results
Strontium	9,300	180 – 450	5 results
Sulfate	500 mg/L	92 – 500 mg/L	
TDS	500 mg/L	180 – 600 mg/L	
Thallium	2	<5[269]	5 results
Vanadium	63	<10	
Zinc	2,000	<50	5 results

[267] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

[268] The March 2012 result was reported as <5 ug/L, but all results from before and after that date have been <1 ug/L, so an exceedance is unlikely.

[269] Although one of the four thallium results was reported as <5 ug/L (March 2012), results before and after this date were reported as <1 ug/L, and an exceedance is unlikely.

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Table 11-8: Shawnee Fossil Plant, alluvial well D-77. Sampled 13 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[270]
Aluminum	16,000	<100 – 2,300	5 results
Antimony	6	<1	2 results
Arsenic	10	<1 – 13	7 results
Barium	2,000	<2 – 420	5 results
Beryllium	4	<1	5 results
Boron	3,000	<200 – 410	
Cadmium	5	<0.5	7 results
Chloride	250 mg/L	36 – 130 mg/L	
Chromium	100	<2 – 77	5 results
Cobalt	4.7	<1 – 12	5 results
Copper	1,300	<1 – 6.5	
Fluoride	4,000	<100 – 220	
Lead	15	<1 – 3.8	7 results
Lithium	31		No data
Manganese	300	60 – 640	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<2 – 9.9	
Nickel	100	4.2 – 53	7 results
Nitrate[271]	10,000	1.3 – 2.9	3 results
Selenium	50	1.8 – 4.4	7 results
Silver	100	<1	2 results
Strontium	9,300	95 – 130	6 results
Sulfate	500 mg/L	40 – 120 mg/L	
TDS	500 mg/L	220 – 560 mg/L	
Thallium	2	<1	5 results
Vanadium	63	<2 – 10	
Zinc	2,000	<10 – 72	7 results

[270] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

[271] These results are not for nitrate alone, but for nitrate+nitrite (as N).

Table 11-9: Shawnee Fossil Plant, UCD well D-75A. Sampled 10 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[272]
Aluminum	16,000	<100 – 100,000	5 results
Antimony	6	<1	2 results
Arsenic	10	<1 – 22	5 results
Barium	2,000	55 – 1,300	5 results
Beryllium	4	<20[273]	5 results
Boron	3,000	6,800 – 8,200	
Cadmium	5	<10[274]	5 results
Chloride	250 mg/L	6.5 – 12 mg/L	
Chromium	100	<2 – 150	5 results
Cobalt	4.7	<1 – 74	5 results
Copper	1,300	<2 – 100	
Fluoride	4,000	110 – 320	
Lead	15	<1 – 120	5 results
Lithium	31		No data
Manganese	300	64,000 – 69,000	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<40	
Nickel	100	<20 – 120	5 results
Nitrate	10,000		No data
Selenium	50	<20	5 results
Silver	100	<1 – 1.2	2 results
Strontium	9,300	670 – 760	5 results
Sulfate	500 mg/L	920 – 1,200 mg/L	
TDS	500 mg/L	1,500 – 1,800 mg/L	
Thallium	2	<20[275]	5 results
Vanadium	63	<2 – 200	
Zinc	2,000	<10 – 380	5 results

[272] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

[273] Data were reported as 5.8, <1, <20, and <1 ug/L for sampling dates in September 2010, June 2011, March 2012, and June 2012, respectively.

[274] Although the March 2012 result was reported as <10 ug/L, results before and after that date have been between <0.5 and 0.9 ug/L, so an exceedance is unlikely.

[275] Although the March 2012 result was reported as <20 ug/L, results before and after that date have been between <1 and 1.4 ug/L, so an exceedance is unlikely.

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Table 11-10: Shawnee Fossil Plant, UCD well D-76A. Sampled 10 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[276]
Aluminum	16,000	790 – 2,900	5 results
Antimony	6	<1	2 results
Arsenic	10	<1 – 1.5	5 results
Barium	2,000	<2 – 21	5 results
Beryllium	4	<1 – 1.8	5 results
Boron	3,000	15,000 – 24,000	
Cadmium	5	<0.5 – 0.8	5 results
Chloride	250 mg/L	2.1 – 4.2 mg/L	
Chromium	100	<2	5 results
Cobalt	4.7	<1 – 57	5 results
Copper	1,300	<2 – 2.7	
Fluoride	4,000	170 – 390	
Lead	15	<1 – 2.7	5 results
Lithium	31		No data
Manganese	300	4,700 – 5,900	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<2 – 170	
Nickel	100	<1 – 38	5 results
Nitrate	10,000		No data
Selenium	50	<1 – 2.6	5 results
Silver	100	<1	2 results
Strontium	9,300	770 – 840	5 results
Sulfate	500 mg/L	1,100 – 1,500 mg/L	
TDS	500 mg/L	440 – 2,000 mg/L	
Thallium	2	<1	5 results
Vanadium	63	<2 – 11	
Zinc	2,000	<10 – 87	5 results

[276] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

Table 11-11: Shawnee Fossil Plant, UCD well D-19. Sampled 13 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[277]
Aluminum	16,000	420 – 3,100	5 results
Antimony	6	<1	2 results
Arsenic	10	<1 – 1.0	7 results
Barium	2,000	33 – 55	5 results
Beryllium	4	<1	5 results
Boron	3,000	<200	
Cadmium	5	<0.5	7 results
Chloride	250 mg/L	19 – 25 mg/L	
Chromium	100	<2 – 58	5 results
Cobalt	4.7	<1 – 20	5 results
Copper	1,300	<5	
Fluoride	4,000	<100 – 160	12 results
Lead	15	<1 – 1.7	7 results
Lithium	31		No data
Manganese	300	<10 – 40	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<2 – 7.3	
Nickel	100	1 – 44	7 results
Nitrate	10,000	2.0 – 2.1	3 results
Selenium	50	3.2 – 5.25	7 results
Silver	100	<1	2 results
Strontium	9,300	44 – 55	6 results
Sulfate	500 mg/L	110 – 150 mg/L	
TDS	500 mg/L	300 – 410 mg/L	
Thallium	2	<1	5 results
Vanadium	63	<10	
Zinc	2,000	<10 – 26	7 results

[277] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

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Table 11-12: Shawnee Fossil Plant, RGA well D-11B. Sampled 9 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[278]
Aluminum	16,000	<100 – 710	4 results
Antimony	6	<1	2 results
Arsenic	10	<1	4 results
Barium	2,000	42 – 68	4 results
Beryllium	4	<1	4 results
Boron	3,000	2,100 – 2,800	
Cadmium	5	<0.5 – 0.6	4 results
Chloride	250 mg/L	14 – 18 mg/L	
Chromium	100	<2 – 2.7	4 results
Cobalt	4.7	1.1 – 1.9	4 results
Copper	1,300	<2	
Fluoride	4,000	<100 – 150	
Lead	15	<1	4 results
Lithium	31		No data
Manganese	300	4,800 – 5,900	4 results
Mercury	2	<0.2	4 results
Molybdenum	40	<5	
Nickel	100	56 – 59	4 results
Nitrate	10,000		No data
Selenium	50	<1	4 results
Silver	100	<1	2 results
Strontium	9,300	130 – 140	4 results
Sulfate	500 mg/L	230 – 280 mg/L	
TDS	500 mg/L	420 – 550 mg/L	
Thallium	2	<1	4 results
Vanadium	63	<10	
Zinc	2,000	13 – 18	4 results

[278] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

Table 11-13: Shawnee Fossil Plant, RGA well D-75B. Sampled 10 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[279]
Aluminum	16,000	<100 – 170	5 results
Antimony	6	<1	2 results
Arsenic	10	<1 – 1.1	5 results
Barium	2,000	21 – 51	5 results
Beryllium	4	<1	5 results
Boron	3,000	5,000 – 6,700	
Cadmium	5	<0.5 – 0.51	5 results
Chloride	250 mg/L	8.9 – 12 mg/L	
Chromium	100	<2 – 6.5	5 results
Cobalt	4.7	2.3 – 5.8	5 results
Copper	1,300	<1 – 3.9	
Fluoride	4,000	<100 – 120	9 results
Lead	15	<1	5 results
Lithium	31		No data
Manganese	300	4,550 – 6,700	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<2 – 5.7	
Nickel	100	8.8 – 18	5 results
Nitrate	10,000		No data
Selenium	50	<1 – 3.4	5 results
Silver	100	<1	2 results
Strontium	9,300	510 – 670	5 results
Sulfate	500 mg/L	380 – 500 mg/L	
TDS	500 mg/L	740 – 920 mg/L	
Thallium	2	<1	5 results
Vanadium	63	<10	
Zinc	2,000	<10	5 results

[279] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

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Table 11-14: Shawnee Fossil Plant, RGA well D-74B. Sampled 10 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[280]
Aluminum	16,000	<100 – 180	5 results
Antimony	6	<1	2 results
Arsenic	10	<1 – 1	5 results
Barium	2,000	21 – 32	5 results
Beryllium	4	<1	5 results
Boron	3,000	6,300 – 11,000	
Cadmium	5	<0.5 – 0.59	5 results
Chloride	250 mg/L	9.4 – 25 mg/L	
Chromium	100	<2	5 results
Cobalt	4.7	<1	5 results
Copper	1,300	<1 – 5.5	
Fluoride	4,000	<100 – 250	
Lead	15	<1	5 results
Lithium	31		No data
Manganese	300	1,000 – 1,800	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<2 – 5.7	
Nickel	100	12 – 19	5 results
Nitrate	10,000		No data
Selenium	50	1.6 – 24	5 results
Silver	100	<1	2 results
Strontium	9,300	160 – 240	5 results
Sulfate	500 mg/L	160 – 340 mg/L	
TDS	500 mg/L	230 – 600 mg/L	
Thallium	2	<1	5 results
Vanadium	63	<10	
Zinc	2,000	<10	5 results

[280] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

Table 11-15: Shawnee Fossil Plant, RGA well D-30B. Sampled 10 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[281]
Aluminum	16,000	<100 – 1,200	5 results
Antimony	6	<1	2 results
Arsenic	10	<1	5 results
Barium	2,000	52 – 65	5 results
Beryllium	4	<1	5 results
Boron	3,000	500 – 6,600	
Cadmium	5	<0.5	5 results
Chloride	250 mg/L	15 – 25 mg/L	
Chromium	100	<2	5 results
Cobalt	4.7	2.8 – 3.5	5 results
Copper	1,300	<1 – 4.2	
Fluoride	4,000	<100 – 190	
Lead	15	<1	5 results
Lithium	31		No data
Manganese	300	3,100 – 5,300	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<5	
Nickel	100	4.0 – 6.5	5 results
Nitrate	10,000		No data
Selenium	50	<1	5 results
Silver	100	<1	2 results
Strontium	9,300	170 – 240	5 results
Sulfate	500 mg/L	57 – 410 mg/L	
TDS	500 mg/L	220 – 550 mg/L	
Thallium	2	<1	5 results
Vanadium	63	<10	
Zinc	2,000	<10	5 results

[281] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

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Table 11-16: Shawnee Fossil Plant, RGA well D-8A. Sampled 10 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[282]
Aluminum	16,000	<100	5 results
Antimony	6	<1	2 results
Arsenic	10	<1 – 1.2	5 results
Barium	2,000	84 – 110	5 results
Beryllium	4	<1	5 results
Boron	3,000	<200 – 270	
Cadmium	5	<0.5 – 0.5	5 results
Chloride	250 mg/L	27 – 34 mg/L	
Chromium	100	<2	5 results
Cobalt	4.7	1.6 – 4.1	5 results
Copper	1,300	<2 – 3.5	
Fluoride	4,000	<100 – 120	
Lead	15	<1	5 results
Lithium	31		No data
Manganese	300	1,900 – 2,100	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<5	
Nickel	100	1.4 – 4.6	5 results
Nitrate	10,000		No data
Selenium	50	<1	5 results
Silver	100	<1	2 results
Strontium	9,300	69 – 80	5 results
Sulfate	500 mg/L	11 – 15 mg/L	
TDS	500 mg/L	130 – 170 mg/L	
Thallium	2	<1	5 results
Vanadium	63	<10	
Zinc	2,000	<10 – 11	5 results

[282] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

Table 11-17: Shawnee Fossil Plant, RGA well D-27. Sampled 13 times between August 2008 and November 2012.

Chemical	Threshold	Data	Data gaps[283]
Aluminum	16,000	55 – 225	5 results
Antimony	6	<0.25	2 results
Arsenic	10	<2.5	6 results
Barium	2,000	170 – 195	5 results
Beryllium	4	<1	5 results
Boron	3,000	<50	
Cadmium	5	<0.5	6 results
Chloride	250 mg/L	29 – 35 mg/L	
Chromium	100	<2.5	5 results
Cobalt	4.7	<2	5 results
Copper	1,300	<5	
Fluoride	4,000	<100 – 233	12 results
Lead	15	<2.5	6 results
Lithium	31		No data
Manganese	300	3 – 12	5 results
Mercury	2	<0.2	5 results
Molybdenum	40	<5	
Nickel	100	<2.5	6 results
Nitrate	10,000	1.4	2 results
Selenium	50	<2.5	6 results
Silver	100	<5	2 results
Strontium	9,300	103 – 129	6 results
Sulfate	500 mg/L	35 – 46.7 mg/L	
TDS	500 mg/L	220 – 304 mg/L	
Thallium	2	<0.25	5 results
Vanadium	63	<10	
Zinc	2,000	<2.5 – 57	6 results

[283] Most parameters were not measured in every sampling event at every well; this column provides the number of results for each parameter measured less often than every sampling event.

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12 Widows Creek Fossil Plant

Background

The Widows Creek Fossil Plant is located on the Tennessee River in Stevenson, AL. Widows Creek itself is a partially rechanneled stream that flows through the site. TVA built Units 1 through 6 in the 1950s. Two more units, Units 7 and 8, came online in 1964. As part of a recent compliance agreement with EPA, TVA has agreed to retire units 1-6 between 2013 and 2015, and all six units are currently idle.[284]

The original ash pond was located immediately north of the plant; it was abandoned in 1969. Fly ash and bottom ash have been wet sluiced and stacked in the Main Ash Pond A area since then. Gypsum from the plant's sulfur dioxide scrubbers was disposed of in the Old Scrubber Sludge Pond until 1986. In 1986 the Old Scrubber Sludge Pond was converted to a dredge cell, and has since been dewatered. TVA started using the current Gypsum Stack in 1986. The Gypsum Stack was expanded to its current footprint in the 1990s. Smaller ponds on the site include copper and iron ponds, now closed, stilling ponds associated with both the Main Ash Pond and the Gypsum Stack, and a red water pond north of the Main Ash Pond.

Widows Creek has had a series of large and small structural issues over its lifetime, including erosion and sloughing along the southern perimeter of the bottom ash stack within Ash Pond A, seepage around Main Ash Pond A and the Old Scrubber Sludge Pond, and a large spill of gypsum from the active Gypsum Stack into the stilling pond and Widows Creek in January of 2009.[285]

Monitoring

Although this report is generally focused on recent groundwater quality data, Widows Creek has been monitored less than any other TVA plant, and so we will also discuss an earlier report for this plant.

TVA assessed the potential groundwater impacts of its gypsum stack expansion in 1990.[286] The report is useful in several ways. First, it describes the site's geologic vulnerability, noting that "Widows Creek Fossil Plant is situated on karst terrain," and that "[a]s in all karst terrains,

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[284] U.S. EPA, Federal Facilities Compliance Agreement, Docket No. CAA-04-2010-1760, ¶¶ 73, 89 (Apr. 2011).
[285] *See* Stantec Consulting Services, Inc., *Report of Phase 1 Facility Assessment, Alabama , Appendix C: Widows Creek Fossil Plant* (June 24, 2009); Stantec Consulting Services, Inc., *Report of Phase 2 Geotechnical Exploration – Ash Pond Complex – Widows Creek Fossil Plant* (Feb. 4, 2010).
[286] TVA, *Widows Creek Fossil Plant – Assessment of Potential Effects on Groundwater of the Phase II FGD Pond* (Dec. 1990).

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solution activity along faults, bedding planes, joints and fractures produces enlarged openings and effective routes for groundwater movement."[287] The report later makes this observation:

> It is important to realize that a potential exists for piping of liner material into the karst subsurface drainage system. This type of undermining activity can result in a sudden collapse of the remaining liner material and pirating of the contents of overlying ponds or basins. TVA has experienced several such problems at their facilities located in karst terrains.[288]

TVA also noted that leachate from the gypsum stack expansion would migrate to the Widows Creek stream and increase the concentration of some pollutants including iron, manganese, and sulfate.[289]

Second, the report depicts the then-existing groundwater monitoring well network, and it appears to have included over 30 wells.[290] We do not know if any of these wells have been maintained or monitored since 1990, but as described below, recent groundwater monitoring reports only include 7 wells. It therefore appears that the monitoring network has been substantially abandoned.

Finally, the 1990 report includes a discussion of groundwater quality. TVA presented data from five upgradient wells, from 1984-1989, that generally showed low concentrations of coal ash constituents: Boron never exceeded 200 ug/L, for example, and sulfate never exceeded 500 mg/L. One well immediately north of the as-yet unbuilt gypsum stack expansion, well W15, showed high concentrations of manganese, sulfate, and iron that may have been naturally occurring.[291] TVA also discussed well W14, located immediately northwest of the plant (near where well 10-48 is located in Figure 12-1): "A high TDS level and a predominance of sulfate indicates increasing likelihood that a well has been affected by ash waste. Therefore, well W14 would appear to be affected by the ash waste disposal area."[292]

We do not know the extent to which TVA monitored groundwater between 1990 and 2008. Our information requests for 2008-2011 suggest that no monitoring occurred during that period.

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[287] *Id*. at ii and 6.
[288] *Id*. at 9.
[289] *Id*. at ii.
[290] *Id*. at 6 – 7.
[291] *Id*. at 13, 26 – 28.
[292] *Id*. at 13.

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TVA began monitoring wells W10, 31, and 10-48 through 10-52 in March 2011.[293] Figure 12-1 shows the approximate locations of these seven wells. Although data since then are spotty (see data gaps section below), there have been exceedances of health-based guidelines for at least boron (well 10-52), cobalt (well 31), manganese (wells 10-48 through 10-52), and sulfate (well 10-50).

Data gaps

Based on TVA's responses to our information requests, it appears that the groundwater quality database for Widows Creek is very poor, with an insufficient number of wells, inadequate monitoring frequency, an inadequate set of monitored pollutants, and an inconsistent pattern of monitoring. It is very difficult to say anything meaningful about groundwater quality or the impact of coal ash at the site based on the data that TVA have been collecting.

1. Discontinued monitoring at some wells. Wells 10-48, 10-49, and 10-50 were sampled in March and October of 2011, but not since then.

2. Discontinued monitoring of coal ash indicators. Boron, chloride, manganese, and TDS, all of which are associated with coal ash, were measured in each of the new wells (10-48 through 10-52) in March 2011, but not since then. TVA did not measure these pollutants in wells W10 or 31 at all. Similarly, TVA measured sulfate, another coal ash indicator, only once in wells 10-48 through 10-50.

3. Some pollutants are not being monitored at all. TVA is not measuring aluminum, molybdenum, or strontium in any wells, and is not measuring boron, chloride, manganese, or TDS in wells W10 and 31.

4. Incomplete well network. The existing network of wells is clearly less informative than the 30+ wells that TVA maintained in the 1980s (see above), and many possible groundwater migration pathways are not covered (e.g., north, west, or south of the Abandoned Ash Disposal Area, east of Main Ash Pond A and the Dredge Cell, or north and east of the Gypsum Stack).

[293] TVA, *Widows Creek Fossil plant Ash Impoundment Groundwater Monitoring Report*, March 2011. Wells 10-48 through 10-52 were installed in 2010. We presume that wells W10 and 31 are older wells.

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Figure 12-1: Groundwater wells at Widows Creek Fossil Plant (approximate locations)

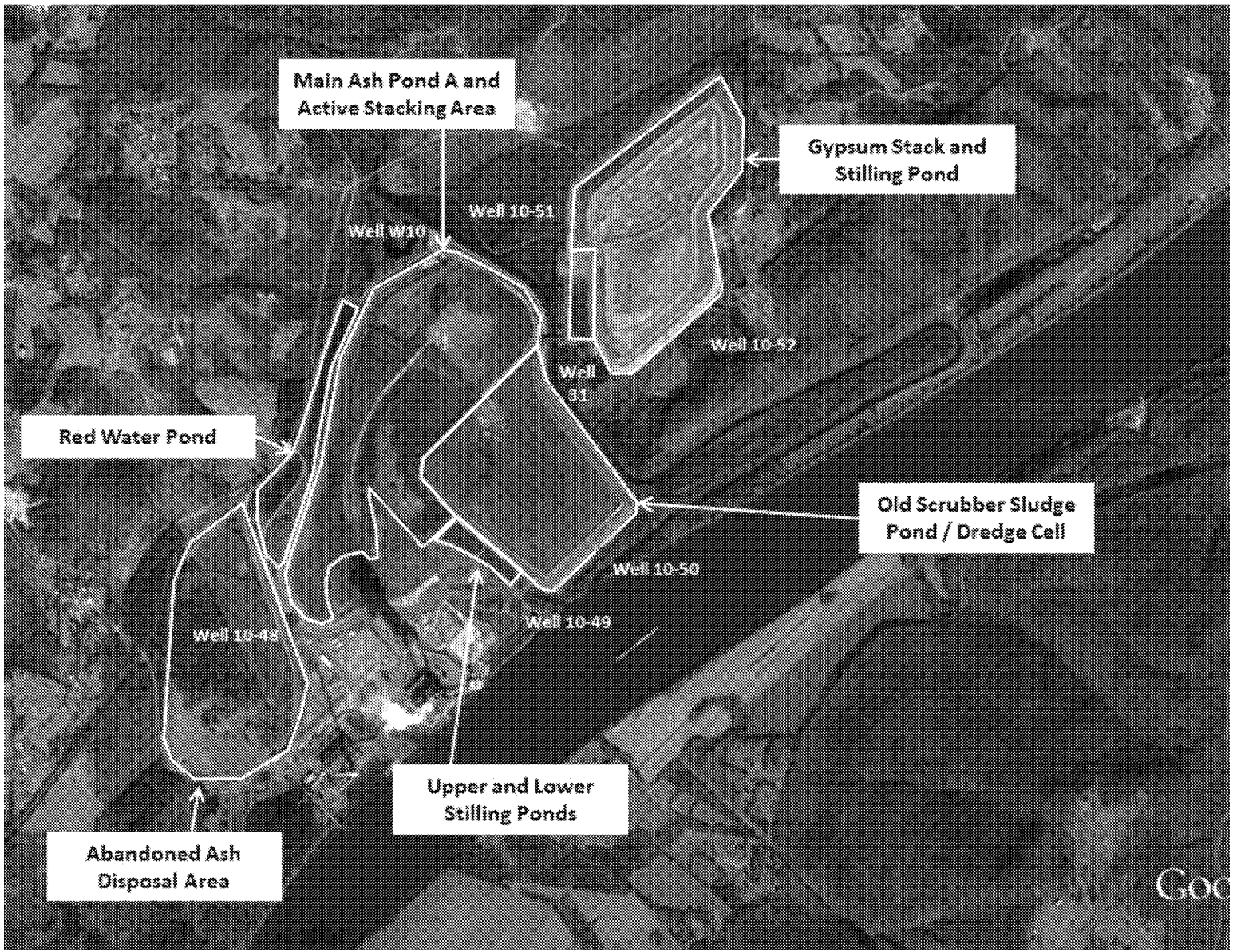

Table 21-1: Widows Creek Fossil Plant, Well W-10. Sampled 5 times between March 2011 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	9.2 – 12.0	
Beryllium	4	<1	
Boron	3,000		No data
Cadmium	5	<0.5	
Chloride	250 mg/L		No data
Chromium	100	<2	
Cobalt	4.7	<1	No data since 10/2011
Copper	1,300	6.4 – 7.8	No data since 10/2011
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300		No data
Mercury	2	<0.2	
Molybdenum	40		No data
Nickel	100	<1 – 1.2	
Nitrate	10,000	0.16 – 0.17	
Selenium	50	<1	
Silver	100	<1	No data since 10/2011
Strontium	9,300		No data
Sulfate	500 mg/L	<5 mg/L	
TDS	500 mg/L		No data
Thallium	2	<1	
Vanadium	63	<2	No data since 10/2011
Zinc	2,000	<10 – 10	No data since 10/2011

Table 12-2: Widows Creek Fossil Plant, Well 31. Sampled 5 times between March 2011 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	<1 – 3.1	
Barium	2,000	39 – 57	
Beryllium	4	<1	
Boron	3,000		No data
Cadmium	5	<0.5	
Chloride	250 mg/L		No data
Chromium	100	<2	
Cobalt	4.7	2.7 – 38	No data since 10/2011
Copper	1,300	6.4 – 7.8	No data since 10/2011
Fluoride	4,000	<100 – 360	
Lead	15	<1	
Lithium	31		No data
Manganese	300		No data
Mercury	2	<2	
Molybdenum	40		No data
Nickel	100	<1 – 6.2	
Nitrate	10,000	<0.1 – 0.13	
Selenium	50	<1 – 14	
Silver	100	<1	No data since 10/2011
Strontium	9,300		No data
Sulfate	500 mg/L	45 – 270 mg/L	
TDS	500 mg/L		No data
Thallium	2	<1	
Vanadium	63	<2	No data since 10/2011
Zinc	2,000	<10	No data since 10/2011

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Table 12-3: Widows Creek Fossil Plant, Well 10-48. Sampled in March and October 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	<1	
Barium	2,000	30 – 35	
Beryllium	4	<1	
Boron	3,000	2,950	3/2011 only
Cadmium	5	<0.5	
Chloride	250 mg/L	19 mg/L	3/2011 only
Chromium	100	<2	
Cobalt	4.7	<1	
Copper	1,300	<2	
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	1,400	3/2011 only
Mercury	2	<2	
Molybdenum	40		No data
Nickel	100	3.8 – 6.2	
Nitrate	10,000	<0.1	3/2011 only
Selenium	50	<1 – 3.6	
Silver	100	<1	
Strontium	9,300		No data
Sulfate	500 mg/L	550 mg/L	3/2011 only
TDS	500 mg/L	990 mg/L	3/2011 only
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	<10	

Table 12-4: Widows Creek Fossil Plant, Well 10-49. Sampled in March and October 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	2.7 – 5.1	
Barium	2,000	<2 – 340	
Beryllium	4	<1	
Boron	3,000	200	3/2011 only
Cadmium	5	<0.5	
Chloride	250 mg/L	23 mg/L	3/2011 only
Chromium	100	<2	
Cobalt	4.7	3.3 – 4.3	
Copper	1,300	<2	
Fluoride	4,000	160 – 240	
Lead	15	<1	
Lithium	31		No data
Manganese	300	32,000	3/2011 only
Mercury	2	1.1	
Molybdenum	40		No data
Nickel	100	4.2 – 10.0	
Nitrate	10,000	0.45	3/2011 only
Selenium	50	<1	
Silver	100	<1 – 4.3	
Strontium	9,300		No data
Sulfate	500 mg/L	310 mg/L	3/2011 only
TDS	500 mg/L	1,100 mg/L	3/2011 only
Thallium	2	<1	
Vanadium	63	<2	
Zinc	2,000	<10 – 14	

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Table 12-5: Widows Creek Fossil Plant, Well 10-50. Sampled in March and October 2011.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	2.7 – 4.4	
Barium	2,000	150 – 170	
Beryllium	4	<1	
Boron	3,000	2,400	3/2011 only
Cadmium	5	<0.5	
Chloride	250 mg/L	290 mg/L	3/2011 only
Chromium	100	<2	
Cobalt	4.7	1.6 – 3.5	
Copper	1,300	<2	
Fluoride	4,000	<100 – 115	
Lead	15	<1	
Lithium	31		No data
Manganese	300	1,500	3/2011 only
Mercury	2	<2	
Molybdenum	40		No data
Nickel	100	5.8 – 7.6	
Nitrate	10,000	0.49	3/2011 only
Selenium	50	2.9 – 6.4	
Silver	100	<1	
Strontium	9,300		No data
Sulfate	500 mg/L	740 mg/L	3/2011 only
TDS	500 mg/L	1,100 mg/L	3/2011 only
Thallium	2	<1	
Vanadium	63	2.3 – 3.4	
Zinc	2,000	<10	

Table 12-6: Widows Creek Fossil Plant, Well 10-51. Sampled 5 times between March 2011 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	2.2 – 4.3	
Barium	2,000	41 – 55	
Beryllium	4	<1	
Boron	3,000	240	No data since 3/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	43 mg/L	No data since 3/2011
Chromium	100	<2	
Cobalt	4.7	<1	No data since 10/2011
Copper	1,300	<2	No data since 10/2011
Fluoride	4,000	<100	
Lead	15	<1	
Lithium	31		No data
Manganese	300	1,200	No data since 3/2011
Mercury	2	<2	
Molybdenum	40		No data
Nickel	100	1.6 – 5.4	
Nitrate	10,000	<0.1	
Selenium	50	<1 – 2.5	
Silver	100	<1	No data since 10/2011
Strontium	9,300		No data
Sulfate	500 mg/L	170 – 260 mg/L	
TDS	500 mg/L	685 mg/L	No data since 10/2011
Thallium	2	<1	
Vanadium	63	<2	No data since 10/2011
Zinc	2,000	<10	No data since 10/2011

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Table 12-7: Widows Creek Fossil Plant, Well 10-52. Sampled 5 times between March 2011 and April 2013.

Chemical	Threshold	Data	Data gaps
Aluminum	16,000		No data
Antimony	6	<1	
Arsenic	10	1.5 – 4.6	
Barium	2,000	34 – 47	
Beryllium	4	<1	
Boron	3,000	13,000	No data since 3/2011
Cadmium	5	<0.5	
Chloride	250 mg/L	370 mg/L	No data since 3/2011
Chromium	100	<2	
Cobalt	4.7	1.3 – 1.4	No data since 10/2011
Copper	1,300	<2	No data since 10/2011
Fluoride	4,000	230 – 300	
Lead	15	<1 – 1.1	
Lithium	31		No data
Manganese	300	1,600	No data since 3/2011
Mercury	2	<2	
Molybdenum	40		No data
Nickel	100	9.4 – 17.5	
Nitrate	10,000	<0.1	
Selenium	50	5.4 – 20	
Silver	100	<1	No data since 10/2011
Strontium	9,300		No data
Sulfate	500 mg/L	1,100 mg/L	
TDS	500 mg/L	2,700 mg/L	No data since 10/2011
Thallium	2	<1	
Vanadium	63	<2	No data since 10/2011
Zinc	2,000	<10	No data since 10/2011

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13 Discussion

It is clear that TVA's coal ash disposal areas have contaminated groundwater to the point that it is unsafe to drink and may also threaten aquatic ecosystems. And yet the TVA states have not required TVA to clean up the pollution. There are several reasons for this. First, the groundwater quality database for the TVA sites is spotty, with poor characterization of certain time periods, certain locations, and certain pollutants. Second, the most compelling evidence of contamination involves pollutants that the states are not actively regulating (see "unmeasured coal ash pollutants" below). Since the states are not regulating these pollutants, TVA rarely measures them, and almost never analyzes them statistically or compares them to any kind of groundwater protection standard. Finally, in cases where states have opportunities to hold TVA accountable, they almost always give TVA a pass.

13.1 Evidence of contamination

In general, groundwater beneath and around the TVA coal ash disposal areas shows clear signs of coal ash contamination, including elevated and unsafe concentrations of boron, sulfate, and other coal ash indicators. Table 13-2 summarizes the extent of pollution in the TVA fleet as a whole, comparing all downgradient wells to all upgradient wells. The table shows that concentrations of coal ash indicators are higher downgradient than upgradient, and frequently much higher than health-based guidelines. Boron, cobalt, manganese, and sulfate are each present at unsafe levels in 30 or more downgradient TVA wells. Twenty-seven wells (24% of all downgradient wells) have sulfate concentrations greater than 500 mg/L, manganese concentrations greater than 0.3 mg/L <u>and</u> boron concentrations greater than 1 mg/L (typical background concentrations of boron are <0.2 mg/L). This contamination exists, to varying degrees, at every TVA coal plant.

MCL exceedances. TVA has violated MCLs for many pollutants across its fleet:

- Antimony, with an MCL of 6 ug/L, has been routinely found at 5-15 ug/L downgradient of Colbert Ash Pond 4, and has increased to a concentration of 59 ug/L downgradient of the Colbert ash landfill stilling pond.
- Arsenic exceeds the MCL of 10 ug/L at various sites, including Allen, Bull Run, Colbert, Cumberland, Paradise, and Shawnee. Concentrations downgradient of Colbert Ash Pond 4 have been as high as 76 ug/L.
- Well 19R at Gallatin's abandoned ash disposal area has had beryllium concentrations of 11-25 ug/L in recent years, 3-5 times higher than the MCL of 4 ug/L.
- Cadmium has exceeded its MCL at Gallatin and John Sevier.

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- Colbert, Cumberland, and Shawnee have had problems with lead occasionally exceeding its MCL.
- Mercury was above its MCL in Gallatin well 21, and increasing, when that well was abandoned in 2011. Mercury has also exceeded its MCL at the Johnsonville South Rail Loop area.
- Selenium concentrations of over 400 ug/L were caused by a sinkhole at the Kingston gypsum disposal area; this is eight times higher than the selenium MCL of 50 ug/L.

Coal ash indicator pollutants. The serious contamination at the TVA plants often involves pollutants without MCLs. These pollutants are nonetheless toxic, and frequently present at concentrations much higher than health-based guidelines. TVA has argued that certain pollutants are naturally occurring (see Bull Run and Gallatin sections of this report). However, the pollutants in downgradient groundwater regularly exceed naturally occurring concentrations. Downgradient groundwater also tends to mirror pure coal ash leachate. As an illustration, Table 13-1 below compares the groundwater from three points at the John Sevier site – a well upgradient of the fly ash landfill, a downgradient well, and a sample from the fly ash landfill leachate collection system. It is clear that the groundwater in the downgradient well is very similar to the pure leachate, with elevated levels of arsenic, boron, cobalt and manganese, strontium, and sulfate.

Four of these pollutants – boron, cobalt, manganese, and sulfate – are elevated well above safe concentrations in groundwater throughout the TVA fleet:

Boron. Boron has proven to be toxic to the developing fetus and the male reproductive system in animal studies.[294] The EPA developed drinking water guidelines to protect against low birth weight and testicular toxicity; these include the Child Health Advisory of 3 mg/L.[295] While boron in upgradient wells is almost always below detection, and never exceeds 1 mg/L,[296] boron exceeded the Child Health Advisory in 36 downgradient wells at 10 TVA coal plants. Concentrations range as high as 38 mg/L (at the Cumberland plant); this is more than ten times the Child Health Advisory, and 200 times higher than the typical background concentration (<0.2 mg/L). TVA has clearly caused dangerously unsafe boron contamination throughout its fleet.

[294] *See, e.g.*, U.S. EPA, Toxicological Review of Boron and Compounds (June 2004); Agency for Toxic Substances and Disease Registry , Toxicological Profile for Boron (November 2010).
[295] *See* U.S. EPA, Drinking Water Health Advisory for Boron (May 2008).
[296] Out of 177 upgradient boron measurements on file, 148 were below detection (less than 0.2 mg/L), and the maximum detected value was 0.97 mg/L.

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Table 13-1. John Sevier Fossil Plant Leachate Collection System, sampled 10 times between April 2008 and April 2013, compared to up- and downgradient groundwater wells.

Chemical	Upgradient well W1	Downgradient well W-30	Leachate Collection System
Aluminum	<100 – 140	<100 – 110	<100 – 200
Antimony	<1	<1	<1
Arsenic	<1	**<1 – 7**	**<1 – 44**
Barium	190 – 230	16 – 27	20 – 74
Beryllium	<2	<2	<1
Boron	<0.2	**4,100 – 5,650**	**3,400 – 5,300**
Cadmium	<0.5	<0.5	<0.5
Chloride	9 – 11 mg/L	15 – 18 mg/L	8 – 15 mg/L
Chromium	<1 – 4	<1 – 3	<1 – 2
Cobalt	<1	**1 – 5**	**<1 – 10**
Copper	<2	<1 – 3	<1 – 3
Fluoride	<100 – 100	310 – 420	<100 – 300
Lead	<1	<1	<1
Manganese	<10 – 39	**1,200 – 3,800**	**230 – 4,800**
Mercury	<0.2	<0.2	<0.2
Molybdenum	<5	<5	No data
Nickel	<1 – 3	7 – 33	5 – 16
Nitrate	<100 – 530	<100 – 100	300 – 1,100
Selenium	<1 – 1	<1 – 2	<1 – 2
Silver	<1	<1	<1
Strontium	590 – 800	**3,200 – 5,050**	**3,100 – 8,300**
Sulfate	25 – 27 mg/L	**960 – 1,100 mg/L**	**550 – 950 mg/L**
TDS	260 – 320 mg/L	1,750 – 2,000 mg/L	No data
Thallium	<1	<1	<1
Vanadium	<10	<10	<10
Zinc	<10 – 96	<10	<10 – 220

Cobalt. Cobalt is associated with heart disease, blood disease (polycythemia), neurological symptoms, and other endpoints.[297] The U.S. EPA, when assessing the risks of coal ash disposal to groundwater, identified cobalt as one of the two "constituents with the highest estimated risks for surface impoundments," the other being arsenic.[298] Even before looking at the data, then, there is a clear reason to be concerned about cobalt. And, in fact, cobalt concentrations at every TVA plant but Allen have exceeded the Regional Screening Level, often by ten times or

[297] *See, e.g.*, ATSDR, Toxicological Profile for Cobalt (Apr. 2004). The most sensitive endpoint for intermediate oral exposure was polycythemia, which has been observed in humans.

[298] U.S. EPA co-proposed Subtitle D coal ash regulations, 75 Fed. Reg. 35128, 35145 (stating that cobalt's estimated Hazard Quotient was as high as 500 for unlined surface impoundments).

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more. Concentrations at Bull Run, Cumberland, Gallatin, Kingston, and Paradise have exceeded 100 ug/L. TVA often observes that cobalt is naturally occurring (see Bull Run and Gallatin sections of this report), but cobalt in upgradient TVA wells rarely exceeds the Regional Screening Level, and is usually below detection.[299] Taken together, the evidence strongly suggests that TVA's coal ash disposal operations are contaminating groundwater with unsafe levels of cobalt.

Manganese. The EPA identified manganese as a pollutant associated with coal ash in its coal ash disposal rule.[300] The Lifetime Health Advisory for manganese is 0.3 mg/L.[301] Manganese concentrations exceed this concentration at every TVA coal plant, typically by very large margins. Concentrations greater than 30 mg/L – more than 100 times higher than the health advisory – have been recorded at Cumberland, Gallatin, Kingston, Paradise, Shawnee, and Widows Creek. Although manganese is an essential element at low doses, it has been associated with neurological toxicity at higher doses. For example, increased neurological symptoms were observed in communities exposed to concentrations of 1.6 – 2.3 mg/L.[302] Manganese exceeds this range in 40 downgradient wells at 9 of the TVA coal plants. Infants may be uniquely susceptible due to higher uptake and retention of manganese, and due to higher manganese concentrations in infant formula.[303]

Sulfate. Sulfate concentrations above 500 mg/L in drinking water can cause diarrhea, and the EPA established a drinking water advisory at this level.[304] Natural concentrations of sulfate are usually below 500 mg/L. Of the 176 upgradient TVA well measurements that we have on file, 158 were below 100 mg/L, and only 3 exceeded the Drinking Water Advisory. In downgradient wells, on the other hand, sulfate concentrations range as high as 6,300 mg/L (at the Gallatin plant), more than ten times the Drinking Water Advisory. In total, 32 downgradient wells at 10 of the TVA coal plants have exceeded the Drinking Water Advisory for sulfate.

Restricted analysis. We also made a more conservative assessment of the data by filtering out groundwater results that potentially reflected natural contamination, or man-made sources other than coal ash. We began by eliminating all downgradient wells that had boron concentrations less than 1 mg/L and sulfate concentrations less than 150 mg/L. One mg/L is

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[299] Our database includes 189 cobalt measurements in upgradient wells. Of these, 153 were below detection, 24 were detected at concentrations less than 4.7 ug/L, and only 11 exceeded 4.7 ug/L.

[300] *See, e.g.*, U.S. EPA co-proposed Subtitle D coal ash regulations, which would list manganese as an "assessment monitoring" parameter, 75 Fed. Reg. 35128, 35253 (June 21, 2010).

[301] Concentrations greater than 0.05 mg/L are unusable as sources of domestic water because they exceed the EPA Secondary MCL.

[302] *See, e.g.*, U.S. EPA, Integrated Risk Information System, Manganese (1996), available at http://www.epa.gov/iris/subst/0373.htm.

[303] *Id.*

[304] *See* U.S. EPA, Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Sulfate (Feb. 2003).

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the maximum boron value seen in upgradient TVA wells. The maximum sulfate concentration in upgradient TVA wells (aside from three potentially contaminated upgradient wells at the Paradise plant)[305] was 150 mg/L. This eliminated 23 downgradient wells. In the remaining 87 wells, we identified all pollutants that exceeded their respective health-based guidelines one or more times during the past five years (2008-2013). We did not count exceedances that appeared to be outliers (e.g., one high value for a pollutant that is usually below detection in a particular well), and we did not count exceedances for pollutants where the mean concentration in the downgradient well was lower than the mean concentration in the relevant upgradient well. We did not apply the same upgradient-downgradient filter to wells around the Paradise scrubber sludge disposal area or fly ash ponds, because the upgradient wells at these locations were immediately adjacent to disposal areas and had sulfate concentrations greater than 1,000 mg/L, suggesting that they were contaminated.[305] The results of the restricted analysis are shown in Table 13-3 and summarized in Table ES-1. The main conclusions of the broader analysis conclusions remain unchanged in the restricted analysis – there is evidence of coal ash contamination in groundwater at all 11 TVA coal plants; boron, cobalt, manganese, and sulfate each exceed health-based guidelines in more than 30 downgradient wells; and downgradient contamination frequently exceeds health-based guidelines by orders of magnitude.

Persistent pollutants. Finally, we isolated a subset of the wells identified in our restricted analysis that had persistent problems – these wells showed *average* concentrations of selected pollutants above health-based guidelines in the data that we had on file for the 2008-2013 period. We excluded pollutants that did not exceed health-based guidelines in at least half of available samples, and as described above, excluded pollutants that were higher in upgradient wells. We also limited our scope to six pollutants – arsenic, boron, cobalt, manganese, and molybdenum. The results of this analysis are shown in Table 13-4.

13.2 Data gaps

Unmonitored ash disposal legacy sites. Many of TVA's closed coal ash disposal areas are unmonitored. These include the abandoned ash pond at Allen, the east and west dredge cells at Bull Run, the Area J ash pond at John Sevier, Area 1 at Johnsonville, and the "Slag Mountain" area and the east and west dredge cells at Paradise.

[305] Three nominally upgradient wells at the Paradise plant show sulfate concentrations greater than 1,000 mg/L. Well 94-35A is immediately adjacent to the scrubber sludge disposal area, well 97-45 is immediately adjacent to an asbestos landfill, and well 10-5 is immediately adjacent to an ash pond. Since these three wells are potentially contaminated by ash or other sources, we did not treat them as upgradient for purposes of establishing a background sulfate screening threshold.

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Abandonment of contaminated wells. In several instances TVA has stopped monitoring individual wells despite (or perhaps in response to) evidence of contamination. These abandoned wells include:

- Wells P2 and P3 at Allen, which showed arsenic and manganese contamination before TVA stopped monitoring them in 2008;
- well 93-2 at Cumberland, which showed high concentrations of arsenic, boron, cobalt, manganese, molybdenum, selenium, and sulfate when it was 'replaced' with a well screened in a different geological layer;
- wells around the coal yard drainage basin at Colbert, which showed high concentrations of aluminum, cadmium, manganese, and sulfate when they were abandoned in 1999;
- wells MC2 and MC3 near Ash Pond 4 at Colbert, abandoned in 2003 despite high concentrations of antimony, arsenic, boron, and molybdenum;
- well 21 at Gallatin, which showed high concentrations of cobalt, manganese, mercury and other pollutants when it was abandoned in 2011;
- wells B6 and B8 at Johnsonville's South Rail Loop disposal area, with high concentrations of boron (up to 12 mg/L), cobalt (up to 65 ug/L), and manganese (up to 2.9 mg/L), now approved for 'replacement;'
- voluntary USWAG monitoring wells around the Fly Ash and Bottom Ash Ponds at Paradise, not monitored since 2011.

Unmeasured coal ash pollutants. It is impossible to require corrective action for pollutants that are never measured. The pollutants most likely to be elevated as a result of coal ash contamination include aluminum, boron, chloride, manganese, molybdenum, strontium, sulfate, and TDS.[306] These are the pollutants that should be measured most often, and yet they are the pollutants that TVA measures the least: TVA has generally failed to measure any of these pollutants in the USWAG ash impoundment wells in recent years, and measures them infrequently in other wells.

Clearly the monitoring program is focused on an inadequate set of monitoring parameters, and both TVA and the states appear to be at fault. TVA is responsible for what it chooses to monitor in its voluntary monitoring program, and it has chosen to avoid coal ash indicator pollutants. When it comes to monitoring required by the states, the states are equally to blame. Solid waste regulations in the TVA states do not require monitoring for these

[306] *See, e.g.*, U.S. EPA co-proposed Subtitle D coal ash regulations, which would have made boron, chloride, sulfate, and TDS, among others, as "detection monitoring" parameters, and would have included aluminum, boron, chloride, manganese, molybdenum, sulfate, and TDS among the "assessment monitoring" parameters. 75 Fed. Reg. 35128, 35253 (June 21, 2010).

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pollutants.[307] They do, however, give state agencies the ability to establish alternative monitoring and reporting requirements.[308] TDEC has established these alternative requirements at some plants for some pollutants. But TDEC and the other state agencies have largely failed to require monitoring for coal ash pollutants at coal ash sites. In other words, when given the choice between properly regulating these sources of pollution and choosing to bury their heads in the sand, the state agencies have chosen to bury their heads in the sand.

13.3 Analytical gaps

Poor use of groundwater protection standards. Selection of comparison values in reports is important; if done incorrectly, trends in groundwater quality will be missed. The most glaring omission in this regard is the fact that many pollutants, including boron, manganese, sulfate, and other coal ash pollutants, are almost never analyzed for upgradient/downgradient trends or changes over time. This is despite TVA's observation that boron and sulfate, in particular, are "ash leachate indicators."[309] The failure to assess spatial and temporal trends for coal ash pollutants at coal ash sites is willful ignorance.

When TVA does conduct statistical analyses, they often do so in a way that hides ongoing contamination. The use of intrawell Upper Prediction Limits (UPLs) is a case in point. An intrawell UPL is the high end of the historical range of a pollutant's concentration in the well being evaluated. Since each round of sampling is compared to historical data for the same well, an exceedance will only appear if the concentration in that well increases over time. If the historical baseline period already showed contamination, then this approach will not identify ongoing problems.

Consider, for example, boron in well W31 at the John Sevier plant, one of the only plants where boron is analyzed. The data that we have on file for this well show boron concentrations ranging from 9,000 to 18,000 ug/L, three to six times higher than the Child Health Advisory (3,000 ug/L) and orders of magnitude higher than boron concentrations in upgradient well W1 (consistently less than 200 ug/L). Yet groundwater monitoring reports for 2008-2009 did not show any boron exceedances for this well. This is because it was already contaminated in 2003-2004, the time period from which TVA and TDEC derived the UPL (19,000 ug/L).

We should note that this practice appears to be changing at many plants. To return to boron at John Sevier, TVA and TDEC started comparing downgradient wells to background

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[307] Ala. Admin. Code R. 335-13-4 Appendix I; 401 Ky. Admin. Regs. 45:160; Tenn. Comp. R. & Regs. 0400-11-01-.04(7).

[308] Ala. Admin. Code R. 335-13-4-.27(3)(a)(4); 401 Ky. Admin. Regs. 45:160 Section 8(2)(c); Tenn. Comp. R. & Regs. 0400-11-01-.04(7)(a)1.(ii).

[309] *See, e.g.*, TVA, Groundwater Monitoring Report – Allen Fossil Plant, at 2 (Aug. 22, 2008).

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concentrations from an upgradient well in 2010. Not surprisingly, they found boron exceedances in Well W31 and three other wells, in addition to exceendances of interwell UPLs for manganese, strontium, and sulfate (see John Sevier Chapter).

Another standard practice in TVA groundwater reporting has been to use a combination of health-based and statistical criteria (MCLs and UPLs), using the higher of the two for each pollutant.[310] This is not legally improper – Tennessee regulations, for example, prescribe this approach.[311] However, it is an approach that favors the polluter to the detriment of public health. If the UPL is higher than the MCL, groundwater can reach unsafe levels without being an 'exceedance.' In the case of the April 2009 groundwater report for Gallatin, for example, the groundwater protection standard for mercury was set at the UPL of 2.87 ug/L, which was higher than the MCL of 2 ug/L. The UPL was calculated using contaminated well 21 as a 'background' well. In cases like these, groundwater can exceed the MCL without exceeding the groundwater protection standard or triggering a regulatory response.

In the opposite case, which is more common, the MCL exceeds the UPL. This also hides a problem, however. If coal ash contaminates groundwater to the extent that downgradient wells show higher concentrations of some pollutants than upgradient wells, but none of these pollutants exceed their respective MCLs, then TVA will not report any exceedances, and the state will not be alerted to evidence of contamination.

In short, there are two scenarios – unsafe groundwater that is not significantly different from background conditions, and contaminated groundwater that is not yet 'unsafe' – that escape regulatory action. A better, more protective approach would be to use the lower of the MCL and the UPL for each pollutant as the groundwater protection standard. This would flag groundwater that either exceeds health-based criteria or shows evidence of changes that might be the result of contamination. Unfortunately, switching to this approach would require changes to the laws governing waste disposal in the TVA states.

Environmental impacts to surface water. The groundwater contamination at TVA's coal plants is not just a problem for groundwater quality – much of the contaminated groundwater flows into adjacent rivers and streams creating potential risks to aquatic life. This risk is often ignored by state agencies, who assume that the receiving waters dilute any contamination below dangerous levels. However, we are not aware of any monitoring or modeling that can show either a significant risk or the absence of a significant risk, a situation that TVA commented on over 30 years ago in an internal memorandum about the John Sevier plant:

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[310] Among many other examples, see TVA, *Gallatin Fossil Plant Abandoned Ash Disposal Area, Groundwater Assessment Monitoring Report – April 2009* (May 19, 2009), or TVA, *John Sevier Fossil Plant Dry Fly Ash Landfill, Groundwater Assessment Monitoring Report – April 2010* (June 27, 2010).
[311] Tenn. Comp. R. & Regs. 1200-01-07-.04(7)(a)(1)(i).

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> Although the potential for significant ground-water contamination is low, the question of whether there is any threat to the quality of the Holston River via groundwater contaminant transport has not been resolved. Furthermore, the broader question of the cumulative effect of the numerous ash disposal areas sited immediately adjacent to the Tennessee River and its tributaries should also be addressed.[312]

This may be the single biggest gap in the body of knowledge about environmental impacts of ash disposal at TVA plants.

Although there is no available modeling that would demonstrate the risk (or absence of risk) to aquatic ecosystems, simple back-of-the-envelope calculations sufficiently demonstrate the problem. To begin with, the Department of Energy has published surface water screening values for most of the coal ash pollutants in the form of "preliminary remediation goals."[313] These are frequently many orders of magnitude lower than the concentrations present in groundwater at TVA sites. The goal for boron, for example, is 0.0016 mg/L. Although we cannot directly evaluate groundwater by this standard, because we know it will be diluted by river water, we can calculate how much dilution would be required to achieve a safe concentration. Groundwater along the banks of the Holston River at the John Sevier plant, for example, generally exceeds 3 mg/L, and has reached 18 mg/L in some wells. This means that the groundwater entering the river will present a risk to aquatic life even if it is diluted 1,000-fold. The same can be said about boron at other sites. The same can be also be said about other pollutants: The preliminary remediation goal for aluminum is 0.087 mg/L; concentrations in Gallatin well 19R, adjacent to the Cumberland River, hover around 100 mg/L, more than 1,000 times higher than the surface water goal. And as with human health risks, the cumulative ecological impact of multiple pollutants must be considered. One study of the toxicity of aluminum to fish, for example, found that the presence of low concentrations of zinc and copper enhanced aluminum's toxicity.[314]

TVA's ash disposal clearly poses a potential threat to aquatic ecosystems. Future groundwater quality oversight should include attempts to model the loads of coal ash pollution entering surface water through hydrologically connected groundwater, and prevent chronic loadings of ecologically toxic pollutants.

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[312] TVA, Memorandum from Roger P. Betson, Water Systems Development Branch, to C. Paul Jones, Civil Engineering Branch, re: John Sevier Steam Plant – Proposed Fly Ash Disposal Area – Potential for Ground Water Degradation (Apr. 21, 1981).

[313] U.S. Department of Energy, Preliminary Remediation Goals for Ecological Endpoints (Aug. 1997).

[314] R. W. Gensemer & R.C. Playle, The Bioavailability and Toxicity of Aluminum in Aquatic Environments, 29 CRITICAL REVIEWS IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY 315, 409 (1999).

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Table 13-2 (page 1 of 3). Statistical summary of selected pollutants in wells throughout the TVA coal fleet, 2008-2013. Highlighted pollutants exceeded their respective health-based criteria in 20 or more downgradient samples.

		Downgradient wells (N = 110)			**Upgradient wells** (N = 26)		
Pollutant	Health-based criterion	Wells exceeding criterion (% of wells)[315]	Mean[316] concentration	Maximum concentration	Wells exceeding criterion (% of wells)[317]	Mean concentration	Maximum concentration
Aluminum	16 mg/L	4 (4%)	1.9 mg/L	125 mg/L	1 (5%)	1.0 mg/L	38 mg/L
Antimony	6 ug/L	5 (5%)	1.5 ug/L	59 ug/L	0	1.0 ug/L	1 ug/L
Arsenic	10 ug/L	18 (17%)	4.7 ug/L	135 ug/L	1 (4%)	1.8 ug/L	13 ug/L
Barium	2 mg/L	1 (1%)	0.08 mg/L	2.4 mg/L	0	0.20 mg/L	1.9 mg/L
Beryllium	4 ug/L	2 (2%)	1.7 ug/L	24.5 ug/L	0	1.5 ug/L	0.4 ug/L
Boron	3 mg/L	36 (34%)	3.2 mg/L	38 mg/L	0	0.2 mg/L	1 mg/L
Cadmium	5 ug/L	4 (4%)	0.8 ug/L	8.2 ug/L	0	0.6 ug/L	2 ug/L
Chloride	250 mg/L	10 (9%)	71.3 mg/L	1,500 mg/L	2 (8%)	69.4 mg/L	1,200 mg/L
Chromium	100 ug/L	2 (2%)	4.3 ug/L	280 ug/L	0	5.2 ug/L	77 ug/L
Cobalt	4.7 ug/L	40 (36%)	17.2 ug/L	370 ug/L	8 (36%)	9.2 ug/L	135 ug/L
Copper	1.3 mg/L	0	0.004 mg/L	0.1 mg/L	0	0.004 mg/L	0.2 mg/L
Fluoride	4 mg/L	0	0.3 mg/L	3.0 mg/L	0	0.2 mg/L	2.6 mg/L

[315] The denominator in each percentage in this column is the number of downgradient wells in which a pollutant was measured. This is often less than the total number of downgradient wells.
[316] The value shown in this column is the mean of well-specific means.
[317] The denominator in each percentage in this column is the number of upgradient wells in which a pollutant was measured. This is often less than the total number of upgradient wells.

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Table 13-2 (page 2 of 3). Statistical summary of selected pollutants in wells throughout the TVA coal fleet, 2008-2013. Highlighted pollutants exceeded their respective health-based criteria in 20 or more downgradient samples.

		Downgradient wells (N = 110)			**Upgradient wells** (N = 26)		
Pollutant	Health-based criterion	Wells exceeding criterion (% of wells)[318]	Mean[319] concentration	Maximum concentration	Wells exceeding criterion (% of wells)[320]	Mean concentration	Maximum concentration
Lead	15 ug/L	2 (2%)	1.9 ug/L	160 ug/L	3 (12%)	2.2 ug/L	100 ug/L
Lithium[321]	31 ug/L	6 (29%)	23.4 ug/L	200 ug/L	1 (25%)	27.6 ug/L	71 ug/L
Manganese	0.3 mg/L	78 (73%)	6.5 mg/L	220 mg/L	10 (48%)	3.6 mg/L	49 mg/L
Mercury	2 ug/L	1 (1%)	0.3 ug/L	3 ug/L	0	0.2 ug/L	0.3 ug/L
Molybdenum	40 ug/L	22 (23%)	56.4 ug/L	2,200 ug/L	0	4.7 ug/L	13 ug/L
Nickel	100 ug/L	6 (5%)	17 ug/L	250 ug/L	0	9.3 ug/L	99 ug/L
Nitrate	10 mg/L	0	0.5 mg/L	4.2 mg/L	0	0.7 mg/L	8.9 mg/L
Selenium	50 ug/L	3 (3%)	4.0 ug/L	412 ug/L	0	1.9 ug/L	17 ug/L
Silver	100 ug/L	0	1.4 ug/L	21 ug/L	0	1.2 ug/L	10 ug/L
Strontium	9.3 mg/L	1 (1%)	0.7 mg/L	10 mg/L	0	0.4 mg/L	3.8 mg/L

[318] The denominator in each percentage in this column is the number of downgradient wells in which a pollutant was measured. This is often less than the total number of downgradient wells.
[319] The value shown in this column is the mean of well-specific means.
[320] The denominator in each percentage in this column is the number of upgradient wells in which a pollutant was measured. This is often less than the total number of upgradient wells.
[321] Since lithium is only measured at the Colbert plant, this row only reflects the 21 downgradient and 4 upgradient wells at Colbert.

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Table 13-2 (page 3 of 3). Statistical summary of selected pollutants in wells throughout the TVA coal fleet, 2008-2013. Highlighted pollutants exceeded their respective health-based criteria in 20 or more downgradient samples.

		Downgradient wells (N = 110)			**Upgradient wells** (N = 26)		
Pollutant	Health-based criterion	Wells exceeding criterion (% of wells)[322]	Mean[323] concentration	Maximum concentration	Wells exceeding criterion (% of wells)[324]	Mean concentration	Maximum concentration
Sulfate	500 mg/L	33 (30%)	440 mg/L	6,300 mg/L	3 (13%)	248 mg/L	1,900 ug/L
Thallium	2 ug/L	0	1.0 ug/L	1.4 ug/L	0	1.1 ug/L	0.4 ug/L
TDS	500 mg/L	67 (61%)	973 mg/L	6,700 mg/L	10 (42%)	960 mg/L	5,000 mg/L
Vanadium	63 ug/L	4 (4%)	6.3 ug/L	200 ug/L	0	4.5 ug/L	26 ug/L
Zinc	2 mg/L	0	0.04 mg/L	1.0 mg/L	1 (4%)	0.06 mg/L	2.7 mg/L

[322] The denominator in each percentage in this column is the number of downgradient wells in which a pollutant was measured. This is often less than the total number of downgradient wells.
[323] The value shown in this column is the mean of well-specific means.
[324] The denominator in each percentage in this column is the number of upgradient wells in which a pollutant was measured. This is often less than the total number of upgradient wells.

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Table 13-3 (page 1 of 4). Pollutants exceeding health-based guidelines between 2008 and 2013 in wells likely to be affected by coal ash (see 'restricted analysis' description above).

Plant / well	Pollutants exceeding health-based guidelines (maximum concentration)
Allen Fossil Plant	
Well P6	Arsenic (43 ug/L), Manganese (0.87 mg/L)
Bull Run Fossil Plant	
Well 45	Boron (4.2 mg/L), Manganese (10 mg/L), Sulfate (910 mg/L)
Well 45R	Boron (18 mg/L), Manganese (7.8 mg/L), Molybdenum (180 ug/L), Sulfate (2,200 mg/L)
Well G	Boron (3.3 mg/L), Molybdenum (100 ug/L), Sulfate (520 mg/L)
Well 47	Cobalt (31 ug/L), Molybdenum (50 ug/L), Sulfate (1,000 mg/L)
Well 48	Cobalt (100 ug/L), Sulfate (1,800 mg/L)
Well 49	Molybdenum (700 ug/L)
Well 10-52	Arsenic (31 ug/L), Manganese (0.355 mg/L)
Colbert Fossil Plant	
Well 19B	Cobalt (7.2 ug/L)
Well CA12A	Lead (160 ug/L)
Well CA17B	Cobalt (19 ug/L), Manganese (1.7 mg/L), Molybdenum (72 ug/L), Sulfate (1,000 mg/L)
Well CA20A	Aluminum (40 mg/L), Arsenic (13 ug/L), Manganese (0.42 mg/L)
Well CA21B	Arsenic (19 ug/L), Boron (9.3 mg/L), Cobalt (13 ug/L), Lithium (200 ug/L), Molybdenum (180 ug/L)
Well CA22B	Aluminum (29 mg/L), Boron (7.3 mg/L), Cobalt (10 ug/L), Lithium (160 ug/L) Molybdenum (88 ug/L)
Well CA27BR	Antimony (24 ug/L)
Well CA28B	Manganese (0.68 mg/L)
Well CA29AR	Manganese (0.7 mg/L), Molybdenum (67 ug/L)
Well CA29BR	Arsenic (12 ug/L), Molybdenum (65 ug/L)
Well CA30B	Chromium (280 ug/L), Cobalt (11 ug/L), Manganese (1.7 mg/L), Molybdenum (47 ug/L), Nickel (220 ug/L), Sulfate (540 mg/L)
Well CA31A	Manganese (0.65 mg/L), Molybdenum (51 ug/L)
Well CA9R	Antimony (59 ug/L), Lithium (53 ug/L), Molybdenum (57 ug/L)
Well MC1	Antimony (15 ug/L), Arsenic (76 ug/L), Boron (3.7 mg/L), Molybdenum (180 ug/L)
Well MC4	Antimony (11 ug/L), Arsenic (65 ug/L), Boron (3.6 mg/L), Molybdenum (180 ug/L)
Well MC5A	Antimony (11 ug/L), Arsenic (72 ug/L), Boron (3.5 mg/L), Manganese (0.310 mg/L), Molybdenum (170 ug/L), Vanadium (120 ug/L)
Well MC5C	Lithium (84 ug/L), Molybdenum (54 ug/L)

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Table 13-3 (page 2 of 4). Pollutants exceeding health-based guidelines between 2008 and 2013 in wells likely to be affected by coal ash (see 'restricted analysis' description above).

Plant / well	Pollutants exceeding health-based guidelines (maximum concentration)
Cumberland Fossil Plant	
Well 10-1	Cobalt (7.4 ug/L), Manganese (4.3 mg/L)
Well 10-2	Cobalt (150 ug/L), Manganese (17 mg/L)
Well 93-1	Arsenic (18.4 ug/L), Cobalt (10 ug/L), Manganese (32 mg/L)
Well 93-2	Arsenic (17 ug/L), Boron (38 mg/L), Cobalt (9.4 ug/L), Manganese (4.9 mg/L), Molybdenum (540 ug/L), Sulfate (2,100 mg/L)
Well 93-2R	Arsenic (35.1 ug/L), Boron (16 mg/L), Cobalt (9 ug/L), Manganese (18 mg/L), Sulfate (1,400 mg/L)
Well 93-3	Boron (6.5 mg/L), Manganese (1.6 mg/L)
Well 93-4	Arsenic (17.9 ug/L), Boron (8.1 mg/L), Manganese (0.51 mg/L), Sulfate (1,100 mg/L)
Gallatin Fossil Plant	
Well 17	Cobalt (7.8 ug/L), Manganese (1.5 mg/L)
Well 19R	Aluminum (125 mg/L), Arsenic (135 ug/L), Beryllium (24.5 ug/L), Boron (4.5 mg/L), Cadmium (6.8 ug/L), Cobalt (320 ug/L), Manganese (33 mg/L), Nickel (250 ug/L), Sulfate (6,300 mg/L)
Well 20	Boron (5.8 mg/L), Cobalt (250 ug/L), Manganese (22 mg/L), Sulfate (2,050 mg/L)
Well 21	Cadmium (5.8 ug/L), Cobalt (330 ug/L), Manganese (18 mg/L), Mercury (3 ug/L), Nickel (110 ug/L), Strontium (10 mg/L), Sulfate (1,800 mg/L)
Well 26	Arsenic (22 ug/L), Boron (5.9 mg/L), Cobalt (15 ug/L), Manganese (9.4 mg/L), Sulfate (1,000 mg/L)
Well 27	Arsenic (15 ug/L), Boron (5.4 mg/L), Manganese (0.6 mg/L), Sulfate (920 mg/L)
John Sevier	
Well W28	Boron (3.1 mg/L), Cobalt (6.4 ug/L), Manganese (4 mg/L), Sulfate (890 mg/L)
Well W29	Manganese (8.3 mg/L)
Well W30	Boron (5.65 mg/L), Cobalt (5 ug/L), Manganese (3.8 mg/L), Sulfate (1,100 mg/L)
Well W31	Boron (18 mg/L), Cadmium (8.2 ug/L), Molybdenum (2,200 ug/L), Sulfate (1,800 mg/L)

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Table 13-3 (page 3 of 4). Pollutants exceeding health-based guidelines between 2008 and 2013 in wells likely to be affected by coal ash (see 'restricted analysis' description above).

Plant / well	Pollutants exceeding health-based guidelines (maximum concentration)
Johnsonville Fossil Plant	
Well B6	Boron (6.5 mg/L)
Well B8	Boron (10.5 mg/L), Cobalt (65 ug/L), Manganese (2.9 mg/L), Sulfate (1,400 mg/L)
Well B6R	Boron (7.2 mg/L), Manganese (1.5 mg/L)
Well AP1	Boron (6.3 mg/L), Cobalt (21 ug/L), Manganese (3.5 mg/L)
Well AP2	Cobalt (58 ug/L), Manganese (13 mg/L), Sulfate (820 mg/L)
Well AP3	Boron (5.3 mg/L), Cadmium (5.8 ug/L), Cobalt (55 ug/L), Manganese (20 mg/L), Nickel (120 ug/L), Sulfate (780 mg/L)
Kingston Fossil Plant	
Well 4B	Manganese (1.8 mg/L)
Well 22	Manganese (2.3 mg/L)
Well 6A	Manganese (220 mg/L), Sulfate (3,500 mg/L)
Well 6AR	Cobalt (111 ug/L), Manganese (35.8 mg/L)
Well AD-2	Cobalt (11.2 ug/L), Manganese (1.7 mg/L)
Well AD-3	Cobalt (8.3 ug/L), Manganese (13.8 mg/L), Sulfate (552 mg/L)
Well G5A	Selenium (379 ug/L)
Well G5B	Selenium (412 ug/L)
Paradise Fossil Plant	
Well 10-1	Boron (10.5 mg/L), Cobalt (8.1 ug/L), Manganese (2.7 mg/L), Sulfate (1,900 mg/L)
Well 10-2	Boron (24 mg/L), Cobalt (5.9 ug/L), Manganese (2.6 mg/L), Sulfate (1,800 mg/L)
Well 10-3	Cobalt (27 ug/L), Manganese (3.8 mg/L), Sulfate (1,900 mg/L)
Well 10-6	Boron (3.2 mg/L), Cobalt (130 ug/L), Manganese (28 mg/L), Sulfate (590 mg/L)
Well 10-8	Arsenic (18 ug/L)
Well 10-9	Boron (15 mg/L), Cobalt (370 ug/L), Manganese (61 mg/L), Nickel (200 ug/L)

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Table 13-3 (page 4 of 4). Pollutants exceeding health-based guidelines between 2008 and 2013 in wells likely to be affected by coal ash (see 'restricted analysis' description above).

Plant / well	Pollutants exceeding health-based guidelines (maximum concentration)
Shawnee Fossil Plant	
Well D33A	Manganese (0.95 mg/L)
Well D74A	Boron (10 mg/L), Manganese (1.2 mg/L), Molybdenum (720 ug/L)
Well D30A	Boron (12 mg/L), Cobalt (16 ug/L), Manganese (10 mg/L)
Well D75B	Boron (6.7 mg/L), Cobalt (5.8 ug/L), Manganese (6.7 mg/L)
Well D11B	Manganese (5.9 mg/L)
Well D74B	Boron (11 mg/L), Manganese (1.8 mg/L)
Well D30B	Boron (6.6 mg/L), Manganese (5.3 mg/L)
Well D75A	Aluminum (100 mg/L), Arsenic (22 ug/L), Beryllium (5.8 ug/L), Boron (8.2 mg/L), Chromium (150 ug/L), Cobalt (74 ug/L), Lead (120 ug/L), Manganese (69 mg/L), Nickel (120 ug/L), Sulfate (1,200 mg/L), Vanadium (200 ug/L)
Widows Creek Fossil Plant	
Well 31	Cobalt (38 ug/L)
Well 10-48	Manganese (1.4 mg/L), Sulfate (550 mg/L)
Well 10-49	Manganese (32 mg/L)
Well 10-50	Manganese (1.5 mg/L), Sulfate (740 mg/L)
Well 10-51	Manganese (1.2 mg/L)
Well 10-52	Boron (13 mg/L), Manganese (1.6 mg/L), Sulfate (1,100 mg/L)

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Table 13-4 (page 1 of 3). Groundwater wells in which average concentrations of selected pollutants exceeded health-based guidelines.[325] Each cell identifies a well, and, in parentheses, the mean of data on file for that well during the 2008-2013 period.

	Arsenic (ug/L)	Boron (mg/L)	Cobalt (ug/L)	Manganese (mg/L)	Molybdenum (ug/L)	Sulfate (mg/L)
Guideline	10	3	4.7	0.3	40	500
Allen	P6 (28.4)					
Bull Run	10-52 (27.5)	F45 (3.6) F45R (15.3)	47 (10.3) 48 (49.1)	F45 (9.7) F45R (6.7)	49 (605) F45R (76)	47 (778) 48 (1641) F45 (745) F45R (1786)
Colbert	MC1 (68.8) MC4 (48.7) MC5A (47.8)	CA21B (4.4) MC1 (3.3) MC4 (3.3)	CA17B (10.0)	CA17B (1.1) CA28B (0.6) CA29AR (0.4) CA30B (1.2)	CA21B (71) CA29AR (51) CA29BR (58) MC1 (159) MC4 (160) MC5A (142) MC5C (45)	
Cumberland	93-2 (11.6)	93-2 (34.9) 93-2R (14.0) 93-3 (6.0) 93-4 (5.6)	10-1 (6.9) 10-2 (140) 93-1 (5.1) 93-2 (6.9)	10-1 (4.2) 10-2 (16.5) 93-1 (9.3) 93-2 (3.8) 93-2R (13.5) 93-3 (1.2)	93-2 (469)	93-2R (1313) 93-4 (776)

[325] This analysis was limited to the pollutants shown (other pollutants, not shown, also exceeded health-based guidelines), was limited to wells in which half or more of available sample results exceeded health-based guidelines, and was limited to wells likely to be affected by coal ash (see 'restricted analysis' description in the text of the report).

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Table 13-4 (page 2 of 3). Groundwater wells in which 2008-2013 average concentrations of selected pollutants exceeded health-based guidelines.[326]

Plant	Arsenic (ug/L)	Boron (mg/L)	Cobalt (ug/L)	Manganese (mg/L)	Molybdenum (ug/L)	Sulfate (mg/L)
Guideline	10	3	4.7	0.3	40	500
Gallatin		19R (3.5) 20 (5.5) 26 (5.7) 27 (5.0)	19R (186) 20 (197) 21 (161) 26 (14.7)	19R (17.4) 20 (20.2) 21 (11.0) 26 (9.1) 27 (0.4)		19R (4088) 20 (1597) 21 (936) 26 (943) 27 (893)
John Sevier		W30 (5.0) W31 (13.3)		W28 (2.9) W29 (4.1) W30 (2.6)	W31 (2200)	W28 (835) W30 (1025) W31 (1337)
Johnsonville		10-AP1 (6.3) 10-AP3 (5.3) B6 (3.5) B6R (7.2) B8 (9.9)	10-AP1 (16.0) 10-AP2 (46.0) 10-AP3 (51.0) B8 (52.3)	10-AP1 (3.5) 10-AP2 (13.0) 10-AP3 (20.0) B6R (1.5) B8 (2.7) B8R (1.1)		10-AP2 (820) 10-AP3 (780) B8 (1028)
Kingston			6AR (95.9) AD2 (7.2)	22 (2.1) 6A (176) 6AR (30.9) AD2 (1.0) AD3 (7.3)		6A (2967)

[326] This analysis was limited to the pollutants shown (other pollutants, not shown, also exceeded health-based guidelines), was limited to wells in which half or more of available sample results exceeded health-based guidelines, and was limited to wells likely to be affected by coal ash (see 'restricted analysis' description in the text of the report).

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Table 13-4 (page 3 of 3). Groundwater wells in which 2008-2013 average concentrations of selected pollutants exceeded health-based guidelines.[327]

Plant	Arsenic (ug/L)	Boron (mg/L)	Cobalt (ug/L)	Manganese (mg/L)	Molybdenum (ug/L)	Sulfate (mg/L)
Guideline	10	3	4.7	0.3	40	500
Paradise	10-8 (18.0)	10-1 (10.5) 10-2 (24.0) 10-6 (3.2) 10-9 (15.0)	10-1 (8.1) 10-2 (5.9) 10-3 (27.0) 10-6 (130) 10-9 (370)	10-1 (2.7) 10-2 (2.6) 10-3 (3.8) 10-4 (1.4) 10-6 (28.0) 10-9 (61.0)		10-1 (1900) 10-2 (1800) 10-3 (1400) 10-6 (590)
Shawnee		D30A (5.0) D30B (4.3) D74A (7.6) D74B (9.0) D75A (7.4) D75B (5.9) D76A (19.8)	D30A (11.1) D76A (35.2)	D11B (5.3) D30A (7.9) D30B (4.6) D33A (0.9) D74B (1.5) D75A (66.4) D75B (5.5) D76A (5.5)	D74A (559)	D75A (1061) D76A (1230)
Widows Creek		10-52 (13.0)	31 (20.4)	10-48 (1.4) 10-49 (32.0) 10-50 (1.5) 10-51 (1.2) 10-52 (1.6)		10-48 (550) 10-50 (740) 10-52 (1100)

[327] This analysis was limited to the pollutants shown (other pollutants, not shown, also exceeded health-based guidelines), was limited to wells in which half or more of available sample results exceeded health-based guidelines, and was limited to wells likely to be affected by coal ash (see 'restricted analysis' description in the text of the report).

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ATTACHMENT B:

U.S. EPA, Relationship Between the Resource Conservation and Recovery Act's Coal Combustion Residuals Rule and the Clean Water Act's National Pollutant Discharge Elimination System Permit Requirements: Use of Groundwater Data Obtained Prior to the CCR Rule, ,

https://www.epa.gov/coalash/relationship-between-resource-conservation-and-recovery-acts-coal-combustion-residuals-rule.

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Relationship Between the Resource Conservation and Recovery Act's Coal Combustion Residuals Rule and the Clean Water Act's National Pollutant Discharge Elimination System Permit Requirements

The Coal Combustion Residuals (CCR) rule, promulgated under the Resource Conservation and Recovery Act (RCRA), and the Clean Water Act (CWA) each address environmental impacts of the various units at coal fired power plants. As a general matter, the Clean Water Act addresses instances in which there are discharges to the jurisdictional waters of the United States ("jurisdictional waters"), while the CCR rule deals with the disposal units themselves (where they are located, specific design and operating criteria, structural stability requirements, groundwater monitoring and corrective action, closure of the units, etc.) and with their impacts or potential impacts to groundwater. The CCR rule establishes minimum national criteria which must be met by all disposal units; the rule additionally recognizes that different factors on a site specific basis are important for determining the best method of environmental protection at individual disposal unit sites and thus provides technical criteria to enable flexibility where appropriate to achieve the requirements of the rule. For example, in some cases, dewatering and leaving CCRs in place with safeguards and monitoring may achieve the necessary environmental protections and in fact offer a significantly lower environmental footprint and cost than removal and disposal off site.

On this page:

- Questions Regarding the Relationship Between the CCR Rule and CWA NPDES Permit Requirements
- Releases and the Requirement to Respond
- Use of Groundwater Data Obtained Before the CCR Rule
- Closure Requirements

Questions Regarding the Relationship Between the CCR Rule and CWA NPDES Permit Requirements

How do the CCR rule and the CWA permit requirements generally work together with respect to landfills and surface impoundments that contain CCRs?

The CCR rule is designed specifically to address releases to groundwater as well as non-groundwater releases from CCR waste disposal units. Implementation of actions to comply with the CCR rule, such as dewatering of a CCR unit, must be done in compliance with other applicable laws, including the Clean Water Act. Independent of the CCR rule, the CWA prohibits any point source discharge of a pollutant to a water of the United States unless it is authorized by a National Pollutant Discharge Elimination System (NPDES) permit under CWA section 402.

What role does dewatering of CCR units play in compliance with the CCR rule? Is a facility that seeks to

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dewater a CCR surface impoundment required to obtain a CWA NPDES permit? How does this work and can EPA help to ensure that NDPES permits are granted in a timely manner to allow dewatering and closure to proceed?

Dewatering of CCR units is an important step in the process of closure of CCR units in order to comply with the CCR rule, and may require discharge to a jurisdictional waters. If the facility will need to discharge any of the water from the surface impoundment into a jurisdictional water, then, as required by the Clean Water Act, that facility will need an NPDES permit (or potentially a modification to an existing permit) for that discharge.

The dewatering of a surface impoundment is a necessary first step in ensuring that the eventual closure of the unit will meet the statutory standard under RCRA of "no reasonable probability of adverse effects on human health or the environment." Over the long-term the closure of the CCR unit will substantially reduce the significant health and environmental risks associated with these units--e.g., from the potential catastrophic release, and/or contamination from leaching into groundwater, as well as into any hydrologically connected jurisdictional waters. In the short term the point source discharge will be subject to NPDES permit requirements under CWA section 402 which "restores and maintains the chemical, physical, and biological integrity of the Nation's waters."

EPA encourages the water and waste programs in the states to work together in this area to ensure that closure of the CCR unit can proceed in a timely fashion while at the same time ensuring that NPDES permit conditions are in place to protect the receiving jurisdictional waters.

Can the ground water, corrective action, closure and post closure requirements under RCRA's CCR rule be implemented in a manner consistent with protection of surface water under the CWA? Can the closure in place option in the CCR rule be conducted in a manner consistent with protection of surface water under the CWA?

Yes, the comprehensive requirements of the CCR rule were designed specifically to address all releases to groundwater as well as non-groundwater releases, from CCR disposal units and the impacts of those releases on public health and the environment.

The CCR rule specifically provides a closure in place option, and anticipates that owner/operators would be able to utilize this option in appropriate circumstances. Provided the requirements of the CCR rule as well as the CWA are met, the CCR rule's closure in place option can be implemented consistent with protection of groundwater and surface water resources. See the closure requirements question below for more detail.

Does the issuance of an NPDES permit covering discharges from a CCR unit exempt the owner/operator from any requirements under the CCR rule?

No, discharges covered by an NPDES permit are not a "solid waste" pursuant to RCRA section 1004(27). The RCRA exclusion only applies to "industrial discharges that are point sources subject to permits," i.e., to the discharges to jurisdictional waters, and not to any activity, including groundwater releases or contaminant migration, that occurs prior to that point. See title 40 of the Code of Federal Regulations (CFR) § 261.4(a)(2)("This exclusion applies only to the actual point source discharge. It does not exclude industrial wastewaters while they are being collected, stored or treated before discharge"). For purposes of the RCRA exclusion, EPA considers the "actual point source discharge" to be the point at which a discharge reaches the jurisdictional waters, and not in the groundwater or otherwise prior to the jurisdictional water. Thus, the issuance of an NPDES permit for discharges from a facility's CCR surface impoundment would not exempt the owner/operator from any requirements under the CCR rule applicable to the disposal unit, such as the requirements to ensure the structural stability of the unit, to clean up all releases to the aquifer, and to meet all closure standards.

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Releases and the Requirement to Respond

What is the scope of the requirement to respond to "releases"?

(a) Does the phrase "or immediately upon detection of a release from a CCR unit" in 40 CFR § 257.96(a) apply to both groundwater and non-groundwater releases?

No. Section § 257.96(a) establishes two different standards for triggering corrective action, one for groundwater releases and one for non-groundwater releases. The requirement that a facility commence corrective action "immediately upon detection of a release from a CCR unit" applies only to non-groundwater releases. By contrast EPA interprets the regulation to require corrective action for

groundwater releases only upon a determination that contaminants are present in amounts exceeding the groundwater protection standards in § 257.95(h).

Note, however that the regulations include other provisions that address releases from a CCR unit. For example, the inspection requirements for surface impoundments and landfills at §§ 257.83 and 257.84 state that if a deficiency or release is identified during an inspection, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken. In addition, in the requirements for control of fugitive dust at § 257.80 it states that in the annual report the owner/operator must describe any corrective measures taken in response to citizen complaints.

(b) Is a facility required to initiate corrective action to clean up groundwater contamination, even though the concentration does not exceed the groundwater protection standard?

No, under the CCR rule, a facility is not required to initiate corrective action to clean up groundwater contamination if the contamination is at levels below the groundwater protection standard established in the CCR rule. As noted, EPA interprets the regulation to require corrective action for groundwater releases only upon a determination that contaminants are present in amounts exceeding the groundwater protection standards in § 257.95(h) (that is, a statistically significant increase over background or the maximum contaminant level or MCL).

(c) In settlement of a portion of the lawsuit challenging the CCR rule, EPA agreed to a remand on the issue of defining which non-groundwater releases are subject to the full corrective action process. Please provide guidance on what facilities should do in the interim.

EPA has committed as part of a settlement agreement to revisit the question of whether the *procedures* to be used in cleaning up groundwater releases should apply to all non-groundwater releases. EPA agreed that, in principle, for some non-groundwater releases, it may not make sense to require facilities to follow the full corrective action procedures in §§ 257.96-257.98 in cleaning up or remedying the releases, and agreed to conduct a rulemaking on that narrow issue. However, the requirement to clean up those releases remains unaffected.

It is true, however, that as currently written, the regulations do require compliance with the full corrective action process, whether pursuant to the obligation in section § 257.90(d) or § 257.96. Nevertheless, given the settlement, EPA would recommend that compliance determinations focus primarily on the rapid remediation of detected non-groundwater releases, consistent with §§ 257.90(d), 257.73(d)(2) and 257.83(b)(5) rather than adherence to the specific corrective action procedures in §§ 257.96-257.98.

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Use of Groundwater Data Obtained Prior to the CCR Rule

Can groundwater data that were not developed/obtained under the CCR rule (e.g., data that existed prior to publication of the rule) trigger the groundwater release assessment and corrective action requirements under the CCR rule (i.e., 40 CFR 257.90(d), 257.96-.98)?

If the pre-existing data and accompanying data analysis are as scientifically valid and consistent with the data and analysis required and developed under the CCR rule and they provide equivalent confidence that the standard in § 257.96 (a) has been met, such data would trigger the corrective action requirements in §§ 257.96-.98. Whether any pre-existing data are sufficiently credible to trigger the § 257.96 corrective action process will necessarily be determined on a case-by-case basis.

However, as a general matter, if a facility has any data that indicates groundwater contamination may be occurring, the facility should be taking appropriate steps without hesitation to address the issue or potential issues shown by the data or sampling results. Such steps could include additional well installation, sampling or analysis--for example if the data shows contamination but the facility has not established an appropriate background level--or it could include actions to locate and address the potential source of the contamination.

Because the CCR rule was designed to be self-implementing, it contains detailed, prescriptive requirements for establishing a groundwater monitoring system and for sampling and analyzing groundwater. For example, the data collection protocol includes numerous criteria that specify monitoring locations, frequency, and chemical parameters. See §§ 257.91, 257.93-257.95. The data collected are analyzed using specific statistical protocols that provide for comparison with background and Maximum Contaminant Levels. These statistical analyses are conducted for each constituent in each monitoring well, using methodologies that meet specific performance standards. See § 257.93(f), (g). Data that have been developed following such protocols would be considered to be credible, scientifically valid, and suitable for determining whether or not a release has occurred requiring further action under the CCR rule. It is EPA's expectation that facilities will follow this exacting process and use it to determine whether and when corrective action

is warranted.

As the regulation is currently structured, the requirement to comply with the corrective action procedures in § 257.96 is predicated on the detection of "any constituent…at a statistically significant level exceeding the groundwater protection standard" (The groundwater protection standard is defined in § 257.95(h) and is either the drinking water maximum contaminant level or the background level of the contaminant). To the extent a facility has scientifically valid/credible data demonstrating that the standard in § 257.96(a) has been met (detection of "any constituent…at a statistically significant level" above a groundwater protection standard) the rule requires them to take action to begin assessing the situation and developing a remedy.

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Closure Requirements

What are the options and the performance standards for closure of units under the CCR rule?

Under the CCR rule, closure must be initiated upon the final receipt of waste (for example, where the unit has reached the end of its useful life or the owner/operator has determined that the unit is no longer needed) or in response to a determination that the unit must close "for cause" (i.e., that is the unit does not meet location standards, the unit does not meet structural stability requirements, or the unit is an unlined surface impoundment that is contaminating groundwater). Moreover, all units must prepare closure and post closure care plans by October 17, 2016, and post them to the facility's CCR web site by November 16, 2016.

The CCR rule establishes two options for closure: clean closure or closure with waste in place. The regulations also establish performance standards for each option that must be met.The two standards are described below:

(a) Section 257.102(c) sets out the "clean closure" requirements and states that: an owner or operator may elect to close a CCR unit by removing and decontaminating all areas affected by releases from the CCR unit. CCR removal and decontamination of the CCR unit are complete when constituent concentrations throughout the CCR unit and any areas affected by releases from the CCR unit have been removed and groundwater monitoring concentrations do not exceed the groundwater protection standard established pursuant to § 257.95 (h) for constituents listed in appendix IV to this part.

If a facility "clean closes" a unit, that unit is not subject to post-closure care (that is continued GW monitoring or corrective action) as the site essentially has been "cleaned up."

(b) Section 257.102(d) sets out the requirements/performance standards for closure with waste in place.

i. Paragraph (d)(1) - Must ensure that the CCR unit is closed in a manner that at a minimum will "*control, minimize, or eliminate to the maximum extent feasible,* post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere; preclude the probability of future impoundment of water, sediment, or slurry; include measures that provide for slope stability; minimize the need for future maintenance; and be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices" (emphasis added).

ii. Paragraph (d)(2) - Drainage and stabilization of CCR surface impoundments – before installing a final cover system, free liquids must be eliminated by removing liquid wastes or solidifying the remaining waste and waste residues and remaining wastes must be stabilized sufficient to support the final cover system.

iii. Paragraph (d)(3) - Sets out requirements for the final cover system.

In order to close a unit with waste in place, the facility must meet all of the performance standards in § 257.102(d). If the facility is unable to meet the performance standards for closure with waste in place for a particular unit, it must clean close the unit. Whether any particular unit or facility can meet the performance standards for closure with waste in place is a site-specific determination that will depend on a number of factual and engineering considerations, such as the hydrogeology of the site, the engineering of the unit, and the kinds of engineering measures available. For example, if a small corner of a unit is submerged in the underlying aquifer, a facility might be able to meet the performance standard for closure with waste in place for the majority of the unit, by "clean closing" the submerged portion of the unit, and installing the necessary engineering measures to ensure that the rest of the unit meets the performance standards in § 257.102(d).

Overall, dewatering and leaving CCRs in place may offer important environmental safeguards and monitoring. Closure with waste in place may help avoid sizable transportation related impacts by eliminating the significant truck traffic that would accompany off site movement of CCRs. In addition, this option may also allow owners and operators to clean close some units while consolidating all the CCRs in a single on-site unit. On-site CCR consolidation can provide for greater land use options and flexibility. Closure with waste in

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place may allow owners and operators to focus their long term monitoring, care and cleanup obligations on a single unit rather than many units.

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