Letter to the
National Drinking Water Advisory Council
LCR Long-Term Revisions Meeting
EPA East Building – Room 1117 A
December 11 and 12, 2013

Dear Chair Morales,

We are presenting this paper to the National Drinking Water Advisory Committee (NDWAC) for your consideration, as you deliberate potential long-term revisions to the EPA federal Lead and Copper Rule (LCR) of 1991. All our statements of fact are based on cited primary materials and peer-reviewed scientific studies that were published since the LCR's promulgation. Attention to these primary materials and studies is important, for they sometimes diverge from, or even contradict, widespread assumptions about the LCR and authoritative statements of public officials with presumed regulatory expertise.

In light of the fact that NDWAC is charged with providing EPA with recommendations likely to have broad and serious public health implications, we would like to ensure that your advice is premised on documented and verifiable facts, accurate understandings, and sound science. In the name of public health, which is EPA's goal for the long-term revisions,[1] we believe that the first step toward constructive deliberation must be acknowledgment of the following critical fact to which the science points clearly and indisputably:

Lead service lines (LSLs), whether intact or partially replaced, can pose a serious public health risk, especially to the populations most vulnerable to lead (i.e., developing fetuses, infants, and young children), even when public water systems meet the LCR Lead Action Level (LAL) of 15 ppb.

Once this fact is accepted, NDWAC, EPA officials, public water systems, the public health community, and the public at large can have a productive dialogue about best ways to revise the LCR in order to mitigate or eliminate LSLs as a health risk. The advantage we have today as compared to two decades ago is that sound science is readily available and real solutions are within reach. Our central challenge is to steer clear of legally, historically, and scientifically unsubstantiated understandings of the issue that serve narrow interests and hardened positions other than the public's health.

The information we are providing herein highlights that:

- Twenty-two years after the LCR's promulgation, lead-contaminated drinking water is a) far more prevalent than often assumed, and b) a significantly greater contributor to children's total blood lead levels than usually acknowledged (and possibly the primary source of lead for many fetuses, infants, and young children across the US).

[1] US EPA. 2012. Lead and Copper Rule Long-term Revisions SBREFA Background Document (8/29), http://www.ruralwater.org/lcr4.pdf.

- Acute exposure to lead particles with concentrations like those detected in Washington, DC (multiple samples >700 ppb, with the highest measurement at 20,000 ppb in 2007;[2] 200 ppb in 2011[3]) and "City B" (580 ppb in 2011[4]) during periods of compliance with the LAL, can expose pregnant women to a daily lead dose exceeding that in 1900's abortion pills.

- Sampling under the LCR does not reflect "worst case" conditions as stipulated by the Rule. In public water systems where samples of water sitting in LSLs have been collected (a practice that goes above and beyond current LCR monitoring requirements), lead levels tend to be significantly higher than those reported by public water systems to the EPA's federal compliance database, the Safe Drinking Water Information System (SDWIS). As a result, LCR-mandated monitoring can mislead water utilities, their customers, and state and federal officials into believing that lead corrosion is successfully minimized, when in fact taps in consumer homes dispense significant concentrations of lead and place communities, especially vulnerable people, at high risk of exposure.

- Although developing fetuses, infants, and young children may be exposed to lead in drinking water on a daily basis, the monitoring practices in place for the detection of a) lead in water and b) lead in blood are not well-designed to capture links between the two. In fact, it can be argued that these practices are designed to miss such links.

- The LCR currently does not address a major potential cause of elevated lead levels in drinking water. Evidence increasingly suggests that physical disturbances to LSLs, which occur on a daily basis in public water systems throughout the US, can cause significant increases in drinking water lead levels for undetermined periods of time.

- NDWAC's LCR recommendations of 2011 include advice that, if adopted, would prolong the public's exposure to lead in drinking water.

In the attached paper, we expand on the above statements and provide the literature that substantiates them. We ask that NDWAC give proper consideration to this information. We also ask that information provided to NDWAC by others be subject to the same evidentiary criteria, so that the recommendations made by NDWAC are informed by actual historical evidence, accurate interpretations of regulatory language, and sound science, rather than wishful thinking, unsubstantiated statements or conjecture.

Should you have any questions, please don't hesitate to contact us.

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[2] Lambrinidou, Y. Documents obtained from DC Public Schools (available upon request).
[3] DC Water, LCR compliance monitoring results, 2011 (semester 2), http://www.dcwater.com/lead/lcr_pdf/LCR%202011_Semester%202.pdf
[4] Del Toral, M. A., et al. 2013. Detection and Evaluation of Elevated Lead Release from Service Lines: A Field Study. *Environmental Science & Technology* 47(16):9300-9307.
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Respectfully,

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BACKGROUND

1. The LCR is a *public health* law.

The LCR was promulgated to protect the public from lead and copper in drinking water. ***The LCR is, by definition, a public health law***. It was enacted as a regulatory program under the Safe Drinking Water Act (SDWA) of 1974, which required regulation of drinking water contaminants *deemed harmful to human health*. As the US Environmental Protection Agency (EPA) explains in the final Rule:

> The Safe Drinking Water Act (42 U.S.C. 300f et seq.) (SDWA or the Act) requires EPA to establish maximum contaminant level goals (MCLGs) and national primary drinking water regulations (NPDWRs) *for contaminants that, in the judgment of the Administrator, may have any adverse effect on the health of persons and that are known or anticipated to occur in public water systems.*[1] (emphasis added)

2. Lead in drinking water poses a well-documented and serious public health risk, especially to fetuses, infants, and young children.

- Recent investigations in the US have shown that lead in water used for drinking or cooking can be the primary source of lead for children with elevated blood lead levels.[2]

- Research on the Washington, DC 2001-2004 lead-in-water crisis found that hundreds (and probably thousands) of children 2.5 years of age and younger developed elevated blood lead levels from concentrations of lead in water that may very well be present (but untested and/or undetected) in tap water across the country, and the most severe consequences occurred when the city's lead-in-water levels still met LCR requirements.[3]

- Recent research in Washington, DC found that children in homes with a partially replaced lead service line were twice as likely to have elevated blood lead levels as compared to children in homes with an intact lead service line, and four times as likely to have elevated blood lead levels as compared to children in homes with no lead service line.[4] This association stood even when the city's drinking water met LCR requirements. Today, thousands of US homes receive their water through a partially replaced LSL. Although tens of thousands of these replacements were mandated by the LCR, a far greater number was carried out during water main and other repair and maintenance work.[5]

- Prenatal exposure to lead and lead in drinking water has been linked to spontaneous abortion, stillbirth, and infant mortality at concentrations commonly detected at US taps (i.e., in lead particles, which are pieces of

lead solder or rust that tend to leach into water on a periodic but unpredictable basis).[6,7,8] Acute exposure to lead particles with concentrations like those detected in Washington, DC (multiple samples >700 ppb, with the highest measurement at 20,000 ppb in 2007;[*] 200 ppb in 2011[†]) and "City B" (580 ppb in 2011[‡]) during periods of compliance with the LAL, can expose pregnant women to a daily lead dose exceeding that in 1900's abortion pills. In infants and young children lead exposure can result in physical and mental delays.

3. **The LCR's Maximum Contaminant Level Goal (MCLG) for lead *is* health-based and is set at zero.**

   The SDWA required EPA to set an MCLG for every drinking water contaminant it regulated. An MCLG is "the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety."[9] MCLGs are based *solely* on public health considerations. The LCR's "health-based"[10] MCLG for lead was set at zero "based on the best available science which shows there is no safe level of exposure to lead."[11]

4. **The LCR's Lead Action Level (LAL) is *not* health-based, is set at 15 ppb, and should *never* be presented (or implicated) as a "threshold" below which lead-in-water levels are "safe" to drink.**

   The LCR's LAL was set at 15 ppb as a result of technological and financial considerations. According to EPA: "The action level for lead has been set at 15 parts per billion (ppb) because EPA believes, given present technology and resources, this is the lowest level to which water systems can reasonably be required to control this contaminant should it occur in drinking water at their customers [*sic*] home taps."[12] Yet public water systems issue claims of safety merely on the basis of a LAL non-exceedance,[§] EPA has publicly stated that

[*] Lambrinidou, Y. Documents obtained from DC Public Schools (available upon request).
[†] DC Water, LCR compliance monitoring results, 2011 (semester 2), http://www.dcwater.com/lead/lcr_pdf/LCR%202011_Semester%202.pdf
[‡] Del Toral, M. A., et al. 2013.Detection and Evaluation of Elevated Lead Release from Service Lines: A Field Study. *Environmental Science & Technology*47(16):9300-9307.

[§] **Chicago 2013:** In the 6/1/12-9/30/12 lead-in-water monitoring period, the 90th percentile measurement for lead was 6.6 ppb and 1 of 50 samples tested >15 ppb.*Letter from Chicago Department of Water Management (CDWM) Commissioner to City Council members* ***"Chicago drinking water is safe and meets or exceeds all standards*** set by the USEPA and IEPA" (emphasis added). Sources: http://www.cityofchicago.org/content/dam/city/depts/water/ConsumerConfidenceReports/2012_WaterQualityReport.pdf; http://aldermanmoreno.tumblr.com/post/63001379365/just-received-this-letter-from-water-dept-commissioner.

Chicago 2012: In the 6/1/09-9/30/09 lead-in-water monitoring period, the 90th percentile measurement for lead was 6.07 ppb and 1 of 50 samples tested >15 ppb.*Chicago Tribune*: "A representative from the Chicago Department of Water Management, which tests tap water under current procedures, said it was aware of and analyzing the results of the research, and is serving as an active partner with the EPA in its review. ***'Chicago water is safe and meets or exceeds all standards'*** set by the agency, the statement said" (emphasis added). Sources: http://www.cityofchicago.org/content/dam/city/depts/water/ConsumerConfidenceReports/2010WaterQualityReport.pdf

systems complying with the LCR are providing water that is "safe to drink,"** and the Centers for Disease Control and Prevention (CDC) in its guidelines for environmental risk assessments at the homes of children with elevated blood lead levels advises against investigating water as a potential source of lead, if the child resides in a jurisdiction that meets the LAL (see discussion below, page 8).[13] Perversely, even as hundreds of Washington, DC children were being lead poisoned from elevated lead in water, EPA Region 3 claimed that much higher levels of lead in water were necessary to be a health concern, and EPA stood silent and assisted public health officials in asserting the 15 ppb standard had a high safety factor.

5. **All evidence suggests that 22 years after the LCR's promulgation, lead-contaminated drinking water is a) far more prevalent than often assumed, and b) a significantly greater contributor to children's total blood lead levels than usually acknowledged (and possibly the primary source of lead for many fetuses, infants, and young children across the US).**

   There is no doubt that lead-in-water levels in the US have dropped markedly since the early 1990s as a result of the LCR requirement for corrosion control treatment. However, to date there is *no evidence* to support the widespread claim that in general drinking water poses a far lesser health risk than paint, dust, and soil as a source of lead for US children. Here is why:

   - **Lead-bearing plumbing materials, the main source of lead in water, exist in the vast majority of US homes.**

     Lead leaches into water from lead service lines (intact or partially replaced), lead solder, leaded brass fixtures, and galvanized iron pipes that have come into contact with lead-contaminated water (e.g., in homes with

; http://articles.chicagotribune.com/2012-01-31/health/ct-met-epa-lead-tests-20120131_1_lead-levels-high-levels-round-of-water-testing.

It is worth noting that some water utilities have made claims of "safety" even while *in exceedance* of the LAL [e.g., Washington, DC 2003 (seeHolder, E. H., Jr. 2004. "Summary of Investigation Reported to the Board of Directors of the District of Columbia Water and Sewer Authority," Covington & Burling, 7/16); Providence, RI 2010 (http://www.provwater.com/news/faq/lsr_faq.htm)].

** **Burneson, E. (EPA Headquarters)**, "Lead and Copper Rule" meeting, Oct. 14-15, 2008, Washington, DC (Stated that: EPA's position is that water systems in compliance with the LCR are providing water that is safe to drink); **Jon M. Capacasa (EPA Region 3)**, April 15, 2008, Congressional hearing (Stated under oath that: "EPA can report that the drinking water serving the District of Columbia meets all federal health based standards and the system is in compliance with all National Primary Drinking Water Regulations," http://www.epa.gov/ocir/hearings/testimony/110_2007_2008/2008_0415_jmc.pdf; **Voltaggio, T. C. (EPA Region 3)**, Washington DC City Council Hearing, April 1, 2004, Washington DC (Stated that: The 15 ppb LAL is not necessarily based upon a risk assessment indicating that consumers drinking above this level would have "a particular health level"; 15 ppb is a "low" level of lead in drinking water; If EPA were to find that people were drinking water with 15 ppb lead, it would not take action, and that's appropriate because 15 ppb lead is not necessarily a number you should not exceed to prevent health harm; A 90th percentile lead-in-water level that exceeds 15 ppb is merely a "bell" ringing that tells you to reduce corrosion, and not necessarily an indication that someone is being hurt from lead in water); **Rogers, R. (EPA Region 3)**, Washington DC City Council Hearing, April 1, 2004, Washington DC (Stated that: 15 ppb is a level that is both attainable and health-protective).

an intact, fully replaced, or partially replaced lead service line). Most homes across the country have at least one of these plumbing materials, while many have a combination of two or more.

- **Today, the main method for detecting lead-in-water contamination in jurisdictions across the country is the LCR-mandated monitoring program that water utilities are required to implement as often as twice a year to once every nine years in order to capture worse-case lead levels at the tap.[14] Studies by EPA and others have shown that this program is not reliable for identifying the true extent of lead-in-water contamination, even when implemented appropriately.[††] As a result, LCR-mandated monitoring can mislead both water utilities and their customers into believing that lead corrosion is successfully minimized, when in fact taps in customer homes dispense significant concentrations of lead and place consumers at high risk of exposure.**

  Many questions have been raised about the integrity of the LCR-mandated lead-in-water monitoring program in terms of reliability, validity, and accuracy of results. In Washington, DC, for example, concerned safe drinking water and environmental health organizations have raised repeated concerns about a) the time of the year LCR-monitoring samples are taken, in light of the fact that temperature can affect lead-in-water levels, b) the chemistry of the water when LCR-monitoring samples are taken, in light of the fact that temporary annual water treatment switches (e.g., from chloramine to free chlorine) can result in dramatic but temporary drops in lead, c) the sample pool of targeted homes, in light of the fact that many of these homes may not satisfy the LCR requirement of posing "the greatest risk of lead leaching,"[15] and d) water sample invalidation practices, in light of the fact that sometimes samples are discarded prior to analysis when deemed to have stagnated too long prior to collection (despite the fact that EPA has made it clear that there is no cap on stagnation prior to sampling collection) or for other unspecified reasons.[16,17]

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†† The LCR-mandated monitoring program is sometimes implemented in ways known to temporarily reduce worst-case lead-in-water levels [see, the Chicago Department of Water Management LCR sampling protocol that was in use until 2009, which included a) flushing of taps prior to stagnation, b) aerator removal, and c) manual removal of particles prior to sampling. To date, Chicago has never exceeded the LCR LAL. However, a 1993 sampling round in the city of Chicago by Consumer Reports indicated a LAL exceedance, even though the taps sampled were random, and did not necessarily come from the city's highest-risk homes (Consumer Reports. 1993. Is there Lead in Your Water? 58:73-78.)]. Similarly, in Washington, DC in late 2005, non-LCR-monitoring samples collected by concerned residents in homes with a LSL indicated a LAL exceedance, even though at the time the city was officially under the LAL (Edwards, M. 2013. Personal communication). Other times, water utilities do not report lead-in-water levels accurately, even when they discover significant contamination (see, Leonnig, C. et al. 2004. Lead Levels in Water Misrepresented Across US. *Washington Post* (10/5); Holder, E. H., Jr. 2004. "Summary of Investigation Reported to the Board of Directors of the District of Columbia Water and Sewer Authority," Covington & Burling, 7/16).

Several recent studies, moreover, have shown that the LCR sampling protocol, by design, does not have the capacity to capture an accurate picture of lead corrosion in US distribution systems because:

a. It requires collection of only 1st liter samples, despite the fact that peak lead-in-water levels can appear in subsequent draws (especially when lead in particulate – versus soluble – form is involved, as particles tend to leach into water erratically and unpredictably).[18],[19] This limitation can become stark when one compares lead-in-water concentrations measured for LCR compliance (1st draw only) to lead-in-water concentrations measured for non-compliance purposes (subsequent draws) in the same jurisdiction. For example, a new EPA study reported that in "City B" lead levels were tested in water that had been sitting in lead service lines (or sometimes possibly in internal plumbing) and revealed a LAL exceedance, even though "City B" was officially under the LAL at the time based on 1st liter compliance samples. Levels above 15 ppb ranged from 16 ppb to 580 ppb, with many exceeding 50 ppb.[20] The same situation is true of the lead service line sampling done in Chicago, compared to using the 1st liter samples. In addition, if 2nd draw samples counted for LCR compliance, in 2007 the Washington, DC water utility would have exceeded the LAL.[‡‡] An internationally renowned lead corrosion expert at the EPA Office of Research and Development (ORD) who conducted a review of studies in which multiple samples were taken at each targeted tap estimates that if the highest lead-in-water measurements were counted toward LCR compliance, 90th percentile lead-in-water levels would be 4-7 times higher than they are today, especially in public water systems that do not use an effective lead corrosion inhibitor such as orthophosphate.[21]

b. It allows for steps of sample preparation prior to analysis that can fail to dissolve lead particles enough to render them measurable. This can result in gross under-detection of actual lead levels at the tap and miss lead-in-water concentrations high enough to exceed the Consumer Product Safety Commission's (CPSC) "acute health threat" for lead.[7,22,23]

- **Although the populations most vulnerable to harm from lead – fetuses, infants, and young children – ingest drinking water on a daily basis,**

[‡‡] In 2007, Washington, DC's official 90th percentile lead value for LCR compliance was 10 ppb during the January-June monitoring cycle and 11 ppb during the July-December monitoring cycle. In contrast, Washington, DC's 90th percentile lead value of 2nd draw samples was >15 ppb (DC WASA, Drinking Water Quality Report 2007, http://www.dcwater.com/news/publications/2007%20Water%20Quality%20Report.pdf).

the monitoring practices in place for the detection of a) lead in water and b) lead in blood are not well-designed to capture links between the two. In fact, it can be argued that these practices are designed to miss such links.

In the final Rule, EPA estimated that:

> The total drinking water contribution to overall lead levels may range from as little as 5 percent to more than 50 percent of children's total lead exposure. Infants dependent on formula may receive more than 85% of their lead from drinking water. As exposures decline to sources of lead other than drinking water, such as gasoline and soldered food cans, drinking water will account for a larger proportion of total intake.[24]

More recently, CDC estimated that "≥30% of current EBLs [elevated blood lead levels] do not have an immediate lead paint source" and studies suggest that "lead exposures result from multiple sources."[25] Moreover, studies in Washington, DC and Chicago, IL – two cities with a high concentration of lead service lines and partially replaced lead service lines – raise serious questions about children's current exposures to lead in water across the US. Specifically:

a. An award-winning 2009 paper about the public health impact of Washington, DC's historic lead-in-water contamination of 2001-2004 found that a) hundreds and probably thousands of children 2.5 years of age and younger developed elevated blood lead levels from concentrations of lead in water that may very well be dispensed (but untested and/or undetected) at taps across the country, and b) the most severe adverse effects occurred in the second half of 2001, when the city's lead-in-water levels rose suddenly and dramatically but the water utility had not yet officially exceeded the LCR's Lead Action Level (LAL) of 15 ppb and consumers were not aware of the contamination.[3] This suggests that, even when the LCR is implemented properly and honestly (in Washington, DC it was not), there can be a critical lag between the time of consumer exposure to high levels of lead at the tap and water utility dissemination of LCR-mandated health alerts (if a LAL exceedance is even captured and reported).

b. A 2011 paper by the CDC found that in Washington, DC, children in homes with a partially replaced lead service line were twice as likely to have elevated blood lead levels as compared to children in homes with an intact lead service line, and four times as likely to have elevated blood lead levels as

compared to children in homes with no lead service line.[26] This association stood even when the city's drinking water tested under the LCR LAL and corrected for confounders, such as lead paint risk. The potential public health implications of this finding can be grave given the fact that in the US there are tens (and possibly even hundreds) of thousands of residences with partially replaced lead service lines. The majority of these replacements have been forced on consumers by their water utilities, as part of routine or emergency water main and other work rather than the LCR.[27]

c. A 2013 EPA study in Chicago found that the most severe lead leaching often occurred in lead service lines that had been physically disturbed due to street excavation, service line repairs, water meter and shut-off valve work, days, months, or even years before the sampling.[18] Prior disturbance of a lead service line is not among the LCR criteria that deem a home at increased risk of lead in water and would render such a home especially appropriate for inclusion in a water utility's LCR compliance sampling pool. The study also indicates that lower than average water use may also potentially be a factor in high lead levels. It is, therefore, possible that the compliance monitoring currently occurring across the country in jurisdictions with lead service lines misses (partly or wholly) a universe of homes with severe lead-in-water problems.

Evidence that US children today may be routinely exposed to elevated levels of lead in drinking water that LCR-compliance monitoring can miss becomes more troubling when one considers the following:

a. **Federal blood lead screening recommendations neglect two highly vulnerable to lead populations**: Based on the assumption that lead paint, dust, and soil constitute the primary sources of lead in a child's environment, the CDC considers children between the ages of 1 and 6 at highest risk of lead exposure. This is because children at this stage of development are usually old enough to crawl or walk independently; touch floors, objects, and other surfaces such as paint chips that may be contaminated with lead; and place their hands into their mouths. The CDC recommends blood lead testing for children at 12 *and* 24 months of age. For children who have not been screened by the age of 2, CDC recommends a blood lead test between 36-72 months.[28] Two extremely high-risk populations that are highly vulnerable to lead and that can be exposed to the contaminant routinely via drinking water are, for all intents and purposes, left out of CDC's recommendations: fetuses and

infants dependent on formula. CDC does not recommend routine blood lead screening for pregnant women, unless such women are deemed at high risk for lead exposure, a subjective assessment which rarely emphasizes drinking water as a potential source (see, for example, 2010 CDC podcast).[29] Infants dependent on formula also fall through the blood lead screening "cracks," despite the 1991 EPA estimate that they "may receive more than 85% of their lead from drinking water" (*Federal Register*, Vol. 56, No. 110, June 7, 1991, p. 26470).[See also 3.] To date, there has been no systematic screening of this population group for lead in blood.

b. **Environmental risk assessment guidelines for detection of lead at the homes of children with elevated blood lead levels are not designed to find lead in drinking water, even if this constitutes a child's primary source of exposure**: CDC's case management guidelines for environmental risk assessment at the homes of children with elevated blood lead levels recommend a focus on "immediate lead hazards" and point to deteriorating paint, dust, and soil.[13] The same guidelines insinuate that federal regulations to minimize lead in drinking water and keep the public informed about lead levels at the tap (i.e., the Lead Ban of 1986, the LCR, and the SDWA amendments of 1996) offer adequate public health protection to consumers served by public water utilities:

> Exposure to lead in tap water has been reduced by measures taken during the last two decades under the requirements of the 1986 and 1996 amendments to the Safe Drinking Water Act and a subsequent EPA regulation (the Lead and Copper Rule). The latter regulation, which only applies to public water systems, requires those systems to monitor tap water for lead and to implement public education and other measures to reduce lead levels in drinking water if they exceed 15 ug/L in more than 10% of household samples. *Lead levels are reduced by treating the supplied water to make it less corrosive and, in some cases, by replacing lead water-service lines.* These regulations do not apply to the more than 40 million households supplied by private well water that can have elevated levels of lead if the water is corrosive and lead is present in the well pump or household plumbing system. In most jurisdictions, there is no monitoring for lead in the drinking water supplied by private wells (emphasis added).[13]

CDC suggests that environmental risk assessments at the homes of children with elevated blood lead levels forgo lead-in-water sampling unless:

- The 90th percentile LCR-compliance level in the child's jurisdiction exceeds the LAL, or
- No non-water source of lead can be found, or
- The child's drinking water comes from a well.

Given this guidance, and the limitations and flaws of LCR-compliance monitoring, it becomes clear that lead in water can be missed both as a primary and secondary contributor to a child's elevated blood lead levels. This weakness may be exacerbated by recent trends in lead poisoning prevention laws that presume any non-intact paint in or on pre-1978 residences to be lead-based.

In summary, although it does seem to have reduced lead -in-water levels in the US, the LCR in its current form cannot be considered adequately protective of public health. Evidence suggests that a) 90th percentile lead-in-water levels are often higher than reported and possibly in exceedance of the LAL, b) lead service line replacement – the LCR's main remedy for LAL exceedances – may place consumers at greater risk of health harm from lead, and c) generations of fetuses, infants, and young children may still be ingesting high concentrations of lead through their drinking water, but with little chance of ever finding out.

6. **The National Drinking Water Advisory Council (NDWAC) LCR recommendations of 2011 include advice that, if adopted, would prolong the public's exposure to lead in drinking water.**

NDWAC's 2011 recommendations to EPA (http://water.epa.gov/drink/ndwac/upload/ndwaclettertoepadec2011.pdf) include two actions that would be protective of public health vis-à-vis exposure to lead at the tap. These are: a) "EPA should issue immediate guidance on the possible negative health impacts related to compliance with the current lead service line replacement provision of the LCR"; b) "EPA should revise the LCR to include provisions to notify the homeowner if a lead service line is repaired or replaced for any reason, not just reasons triggered under the current LCR."

Three of NDWAC's recommendations, however, lack any public health justification. These are:

a. **"EPA should not require either partial or full lead service line replacement under the revised LCR"**

LSLs have long been established as a primary source of lead in drinking water.[30] For this reason, the LCR water-monitoring requirement mandates that water systems make it their priority to target homes with a LSL in order to increase the likelihood of finding worst-case lead-in-water levels. The LCR of 1991 states explicitly that:

> While corrosion control canbe an effective treatment for preventing or slowing the dissolution of lead from lead service, [*sic*] in many cases it will not be sufficient to reduce lead levels below the action levels [*sic*]. […] [Systems] with lead service lines have substantially higher lead levels than those without. […] [Lead] levels in homes with lead service lines compared to homes without lead service lines, in the same system, had higher lead levels. EPA believes that the information presented in Tables 7 and 10 suggests that lead service lines can contribute significant amounts of lead at consumers' taps.[31]

Today there is scientific consensus that, "The most effective way to reduce the total mass of lead measured at the tap is to replace the entire lead service line."[24,32]

b. "EPA should suspend enforcement of the lead service line replacement requirement"

LSLs pose a significant health risk to the public as long as they are in use. Water treatment changes, physical disturbances due to street work or other events, partial lead service line replacement, and changes in water use or outside temperature can all result in accelerated lead corrosion, *even when a water utility does not exceed the LAL. The LCR's LSL replacement requirement, when it results in full LSL replacement, is the rule's only requirement that eliminates permanently the primary source of lead in drinking water.*

The LCR of 1991 required water utilities in exceedance of the LAL to conduct full LSL replacement, unless they could show that they neither owned nor "controlled" some portion of the LSL.[§§] In response to a legal challenge by the American Water Works Association (AWWA) [*AWWA v. EPA*, 40 F.3d 1266 (D.C. Cir. 1994)], EPA's definition of "control" was remanded to EPA. *The court ruled not that the definition fell outside EPA's authority under the SDWA, but that EPA had not provided adequate opportunity for the public to comment on*

[§§] The Rule did not specify how the cost of the full LSL replacement would be covered.

the definition. Following a public comment period, EPA proceeded to equate "control" with "ownership" "in order to eliminate potential legal confusion and delays in implementing the Rule."[33] In practice, this decision changed the LCR's LSL replacement requirement from a full LSL replacement requirement to a partial LSL replacement requirement, despite the fact that EPA made it explicit that full LSL replacement was always preferable to partial LSL replacement for the protection of public health.[33]

Although disadvantages of partial LSL replacement are well documented, the absence of a LSL replacement requirement all together would turn the LCR into a law that stops short of eliminating the main source of lead in drinking water, even in jurisdictions with widespread and severe contamination. Under such a Rule, the responsibility to protect the public from lead at the tap would be left *almost entirely* to consumers, most likely through recommendations for routine water-use precautions. In light of the fact that such precautions can be costly, complex, and time-consuming, such a regulatory development would give rise to serious public health, legal, moral, and environmental justice concerns.

c. "EPA should not require homeowner sampling after the lead service line replacement"

According to the LCR minor revisions of 2000, within 72 hours after a partial LSL replacement water systems are required to collect one water sample that is representative of water sitting in the service line (prior to 2000, this requirement mandated sample collection within 14 days after partial LSL replacement) (http://water.epa.gov/lawsregs/rulesregs/sdwa/lcr/upload/2000_4_25_lcrmr_guidance_lcmr_lead_line_requirements.pdf). The LCR of 1991 specifies that, "[The] purpose of collecting the follow-up sample is to inform residents of precautions that may be needed temporarily such as flushing water at taps to avoid potential increases in lead levels."[34] In other words, *the purpose of the follow-up sample is purely health-protective*. If the LCR is going to continue to allow partial LSL replacement (a practice we strongly oppose), a one-time sample 72 hours after the replacement indeed has little meaning. Whether high or low, the result of this sample offers no information about lead-in-water levels in the short-term or long-term after the replacement. If EPA removes homeowner sampling after partial LSL replacement, then it must ensure that residents in

homes with such a replacement are fully protected from lead-in-water spikes in the short- and long-term. *Full protection, however, must not depend on measures that place undue burden – in terms of cost, time, and complexity – on residents, because such measures are not likely to be followed properly, if at all.*

RECOMMENDATIONS

GENERAL

- *All proposed revisions to the LCR should have a health-protective rationale and should be based on current scientific understandings about lead in drinking water.*

- The LCR's approach to lead in drinking water should constitute what is called "Science-Based Adaptive Management." This is an approach that allows timely updating of regulatory strategies to accommodate new insights, knowledge, and technologies that better address lead in drinking water.

DEFINITIONS

- In light of the clear and permanent public-health protective effect of full LSL replacement, the LCR's definition of "control" should be changed back to the 1991 definition. Only a return to the original definition will ensure that a) LAL exceedances in jurisdictions with LSLs trigger a full LSL replacement requirement, and b) the LCR's mandatory LSL replacement requirement is in fact the *remedial* measure it was intended to be.

INVENTORY REQUIREMENTS

- All public water systems should complete an inventory of intact LSLs and partially replaced LSLs in their jurisdictions, and submit this inventory to the State. The State should then report to EPA the number of intact LSLs and partially replaced LSLs for every public water system it oversees. *The State should also enter these numbers in a publicly accessible and easily searchable database.* For public water systems with LSLs, the number of reported intact LSLs and partially replaced LSLs should be updated annually to reflect any changes (due to new full and partial LSL replacements, regardless of whether these replacements occurred for LCR-compliance purposes or routine infrastructure work, *but the distinction should be indicated clearly*).

LCR-COMPLIANCE LEAD-IN-WATER MONITORING SCHEDULE

- Public water systems with intact LSLs and/or partially replaced LSLs should not be allowed to reduce monitoring to every three years unless those systems have 90th percentile lead <5 ppb.
- All reduced monitoring should require State approval.

LCR-COMPLIANCE LEAD-IN-WATER SAMPLING

- To capture worst-case lead-in-water levels:

- All samples should be taken during the three warmest months of the year *by all public water systems*, regardless of their monitoring schedule.
- No samples should be taken during temporary water treatment switches that are known to minimize lead corrosion and lead-in-water levels (e.g., annual month-long switches from chloramine to free chlorine).
- Site selection in jurisdictions with LSLs should consist 100% of single-family homes with intact LSLs and partially replaced LSLs. The pool of target homes must be listed on a publicly accessible database, and the type of service line these homes are believed to have should be clearly indicated. Changes to this pool from one monitoring cycle to the next, should be indicated and explained in the same database.
- No pre-stagnation flushing should be allowed (this practice is well-known as a remedial measure that reduces lead-in-water levels temporarily; in a 9/12/08 letter to Washington, DC residents, EPA made it clear that pre-stagnation flushing "goes against the intent of the monitoring protocol," letter available upon request).
- No aerator removal should be allowed (such removal would go against existing EPA guidance, http://www.epa.gov/safewater/lcrmr/pdfs/memo_tapsamples-aerators_10202006.pdf).
- No ceiling on stagnation time should be allowed (EPA's LCR guidance states explicitly that there is no cap on stagnation prior to sampling collection, http://web.archive.org/web/20080326160910/http://www.epa.gov/OGWDW/lcrmr/memo_nov23-2004.html).
- Sequential samples should be taken at each sampling site and the highest result should be used for the LCR-compliance 90th percentile calculation.
- *All* LCR-compliance samples collected should be analyzed and used in the 90th percentile calculation, unless they meet the invalidation criteria in the rule.
- *Every public water system's LCR-monitoring sampling protocol should be available online and easily accessible for public view.*

- Public education:

  - Public water systems should provide homeowners in the LCR sampling pool with:

    - All lead-in-water measurements corresponding to their property.

- A clear explanation about the meaning of these measurements in relation to public health (with an emphasis on the LCR's health-based MCLG of zero).
- A complete list of possible remedial measures available to residents, with a clear discussion about the pros and cons of each.

- Public water systems should make publicly available on their websites:

  - All LCR-monitoring lead-in-water measurements.
  - A clear explanation about the meaning for a jurisdiction as a whole of lead-in-water values >15 ppb in a) <10% of target homes and b) >10% of target homes.
  - A clear explanation about the meaning of these measurements in relation to public health (with an emphasis on the LCR's health-based MCLG of zero).
  - A clear explanation about all the sources of lead in drinking water.
  - A clear explanation of the fact that the LCR a) allows up to 10% of target taps to dispense any concentration of lead in drinking water, and b) requires public water system intervention when over 10% of taps test >15 ppb.
  - A clear explanation about the difference between soluble and particulate lead, and the health risks posed by the latter, even when lead-in-water measurements at a specific time and in a specific home are low.
  - A clear explanation about short- and long-term lead-in-water risks posed by LSLs (intact and partially replaced).
  - A clear explanation about lead-in-water risks posed by physically disturbed LSLs (intact or partially replaced).
  - A complete list of possible remedial measures available to residents, with a clear discussion about the pros and cons of each.

NON LCR-COMPLIANCE LEAD-IN-WATER SAMPLING

- On an annual basis, public water systems should post online any and all lead-in-water sampling results from homes sampled for non-LCR compliance purposes (e.g., "voluntary" samples sent by residents to the public water system for testing).

LSL REPLACEMENT REQUIREMENT

- The LSL replacement requirement should be triggered when the LAL is exceeded following corrosion control "optimization."

- When the LAL is exceeded, public water systems should be required to replace fully a certain percent of LSLs in their jurisdiction (e.g., 7%).
- "Testing-out" of LSLs should be prohibited.
- Homeowners should be given clear, complete, and scientifically accurate information about a) the health benefits of full LSL replacement, b) the health risks (short- and long-term) of intact LSLs and partially replaced LSLs; c) the health risks and erratic release of lead particles following partial LSL replacement; and d) financing options for full LSL replacement (*full LSL replacement should be financially accessible to all homeowners regardless of income and race*).[35]
- During LSL replacement, LSLs should be fully removed.
- All residents who have a full LSL replacement should be given clear and complete information about steps they can take to protect themselves from any lead-in-water spikes following replacement.
- In cases of scheduled infrastructure work, LSLs should be fully removed. In cases of emergency infrastructure work involving partial LSL replacement, when possible, residents should be given the option to have the private side of their LSL replaced (with the same menu of financing options as the one offered in cases of a LAL exceedance), and if they decline, they should be given a flow-through pitcher with a 6-month filter supply.

PUBLIC EDUCATION

ANNUAL CONSUMER CONFIDENCE REPORTS

- Public water systems should explain briefly and accessibly:

  - The LCR's treatment-technique requirement and 90th percentile trigger.
  - The number of homes last sampled.
  - For public water systems with LSLs, how many target homes had an intact LSL and how many had a partially replaced LSL.
  - The 90th percentile value.
  - How many samples exceeded the LAL.
  - The values of all samples >15 ppb.
  - A clear explanation about the meaning for a jurisdiction as a whole of lead-in-water values >15 ppb in a) <10% of target homes and b) >10% of target homes.
  - A clear explanation about the meaning of these measurements in relation to public health (with an emphasis on the LCR's health-based MCLG of zero).
  - A clear explanation about all the sources of lead in drinking water.
  - A clear explanation of the fact that the LCR a) allows up to 10% of target taps to dispense any concentration of lead in

drinking water, and b) requires public water system intervention when over 10% of taps test >15 ppb.

- A clear explanation about the difference between soluble and particulate lead, and the health risks posed by the latter, even when lead-in-water measurements at a specific time and in a specific home are low.
- A clear explanation about short- and long-term lead-in-water risks posed by LSLs (intact and partially replaced).
- A clear explanation about lead-in-water risks posed by physically disturbed LSLs (intact or partially replaced).
- A complete list of possible remedial measures available to residents, with a clear discussion about the pros and cons of each.

ADDITIONAL REQUIREMENT

- Public water systems should be required to:

  - Provide mandatory notification to residents in homes with an intact or partially replaced LSL that their service line is likely to be physically disturbed (or was recently disturbed) due to a clear routine (or emergency) infrastructure work. This notification should include explanation of what such a disturbance might mean in terms of lead-in-water spikes, and what remedial measures residents can take, including flushing out the loosened scale and sediment.

  - Provide mandatory notification to residents in homes with a known partially replaced LSL about short- and long-term spikes associated with such replacements and a complete list of possible remedial measures residents can take (including private-side replacement, accompanied by financing options), with a clear discussion about the pros and cons of each.

All public education materials must be accessible at all times through the public water system's website

ACKNOWLEDGMENTS

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LCR Long-Term Revisions

Background & Recommendations

Yanna Lambrinidou, PhD
Parents for Nontoxic Alternatives

Paul Schwartz, BA
Water Alliance

LCR Long-Term Revisions Meeting • Dec. 11-12, 2013 • Washington, DC

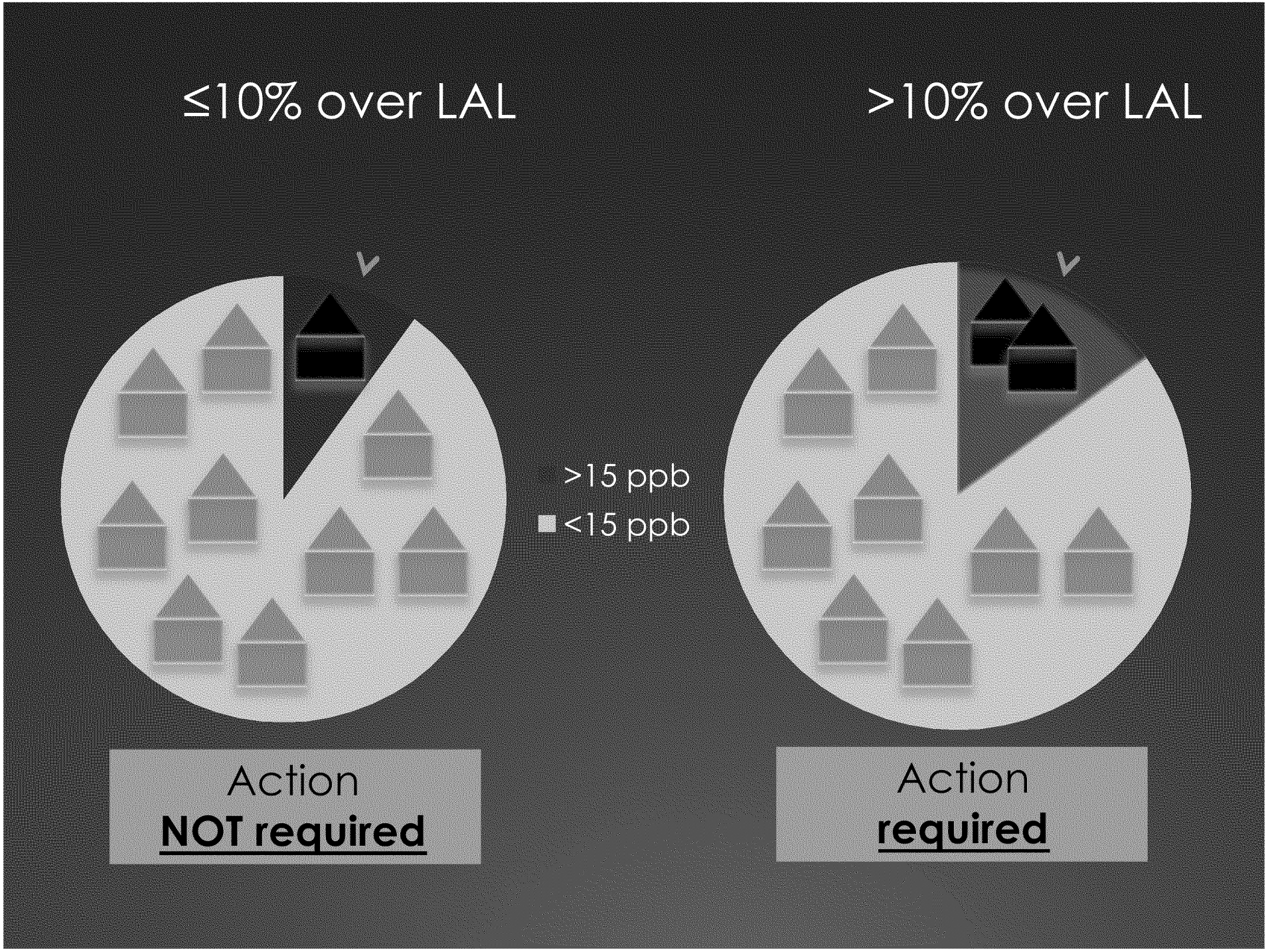
Lead Service Lines

- Estimates:
  - 10 million (EPA LCR 1991)
  - 3-5 million (other estimates)
- Associated with:
  - EBLLs (CDC 2011)
  - Fetal deaths (Edwards 2013)
  - Long-term lead spikes following physical disturbance (Del Toral, Porter, Schock 2013)
  - Short- and long-term lead spikes following partial LSL replacement (e.g., Triantafyllidou & Edwards 2011; Cartier et al. 2012)

Lead Action Level (LAL)

Standard	Designation	Enforceability
0 ppb	Maximum Contaminant Level Goal (MCLG)	Non-enforceable
15 ppb	Lead Action Level (LAL)	Enforceable

Although NOT a violation of the law


≤10% over LAL
>10% over LAL
>15 ppb
<15 ppb
Action
NOT required
Action
required

Prevalence of Lead in Water

* Lead-plumbing materials present in vast majority US homes
* Mandated LCR monitoring for lead is not capturing worst-case levels, as it is supposed to
* Public water systems use their own sampling protocols that often include steps known to miss lead

LEAD AND COPPER SAMPLING FORM

Instructions for Sampling Lead and Copper at Customer Tap

Please follow directions below to help us determine the lead and copper content of your drinking water.

1. The night before sampling, clean the aeration screen, if possible, and run cold water through the kitchen or bathroom tap (the kitchen faucet is the preferred choice). The cold-water should be run until you can feel a temperature change. This will take approximately 1 to 3 minutes. **Allow the water sit in the plumbing for a period of 6 to 8 hours. Use this faucet to obtain your water sample.**
2. On the morning of the sampling, do not run the water before sampling. The very first water to be used in the house should be the water to be collected in the 1-liter plastic bottle.
3. Slowly open the cold-water faucet and fill the 1-liter bottle to the top and put the lid on tight. There is no need to refrigerate the sample.
4. Please answer the questions below and fill out the bottom of the sheet and sign your name. Please put the filled sample bottle, along with the paper work in the plastic bag provided.

Independent monitoring in US city with highest concentration of LSLs => consistently >LAL

Prevalence of Lead in Blood

Recent studies documenting large scale harm:

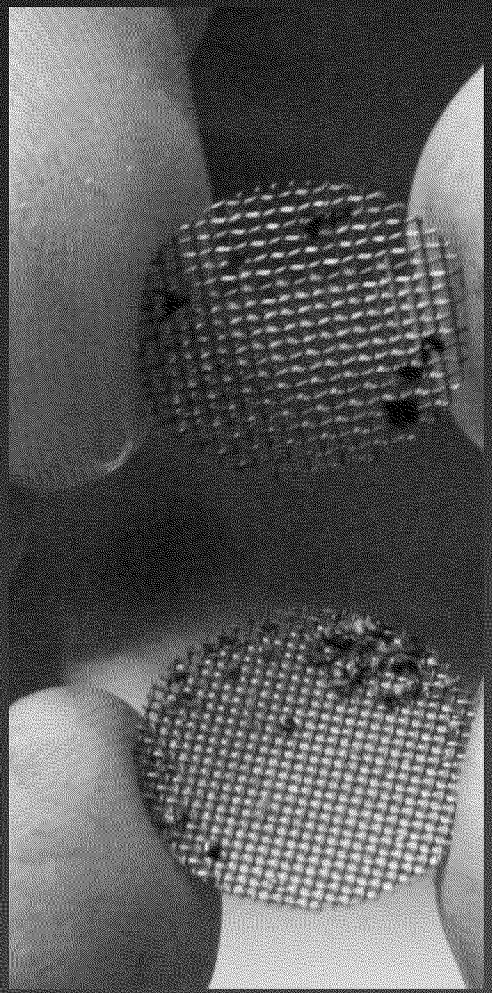
* Edwards 2013
* CDC 2011
* Edwards, Triantafyllidou, Best 2009

Routinely overlooked on a national scale:

* Fetuses (pregnant women)
* Infants dependent on formula
* Lead in water in EBL children's homes

Challenge of Lead Particles

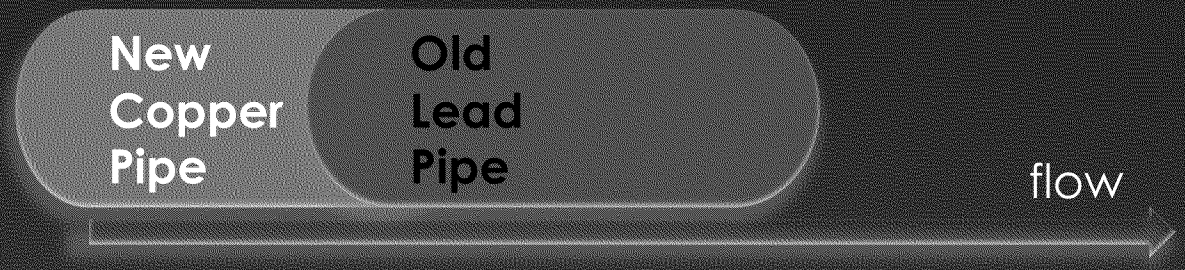
* Pieces of lead solder or rust
* Unpredictable and erratic release (Russian Roulette phenomenon) => NOT EASY TO CAPTURE AND DETECT
* Can pose acute health threat



Actual Lead Particles from Building with Child Lead Poisoning

Slide from Triantafyllidou et al. 2007

Why accelerated lead leaching?



Physical disturbance of old lead pipe

- Lead shavings and disturbed lead rust can fall into the water

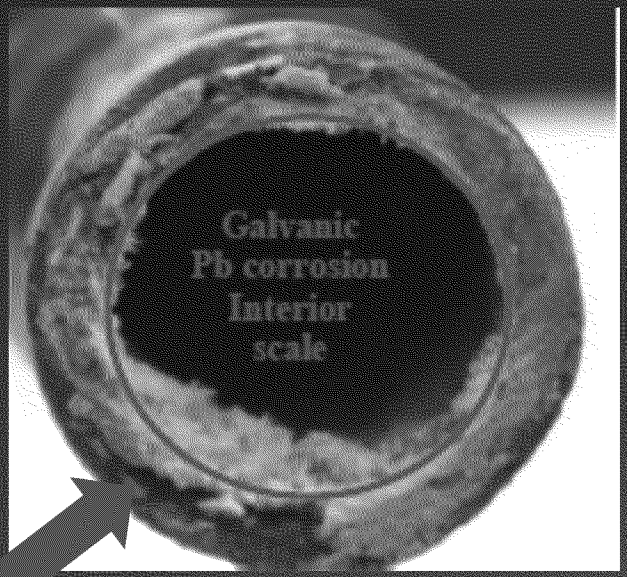
Galvanic corrosion of old lead

- In some waters, contact between old lead pipe and new copper pipe can create battery effect that accelerates corrosion of lead pipe above what would normally occur for lead pipe alone

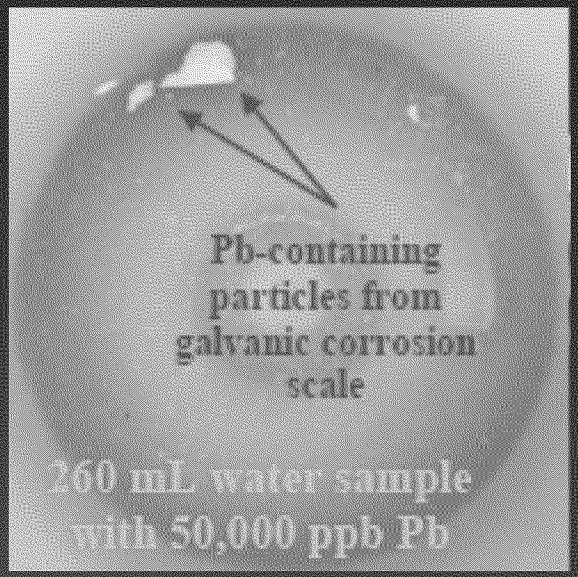
Deposition corrosion of old lead

- As the water flows from copper to lead, copper can attach to the old lead pipe and create small galvanic batteries that result in accelerated lead corrosion

2011: Triantafyllidou, S. and M. Edwards. Galvanic Corrosion after Simulated Small-Scale Partial Lead Service Line Replacements. *JAWWA*103:9, pp. 85-99.



Lead pipe area adjacent to copper junction after 1+ year of experimentation



Lead dose in one glass of water exceeding the CPSC "acute health threat" for lead 71 times

Recommendations

* 'First, do no harm.'
* Remember, above all, both the Safe Drinking Water Act (SDWA) and the Lead and Copper Rule (LCR) are about protecting public health.
* Every step of the way the LCR must protect, not harm, public health.

Get the Lead Out

* Full lead service line removal under LCR
* Stop "voluntary" partial lead service line removal (e.g. when infrastructure work is being done)

LCR Monitoring Must be Health Protective

- Develop a mandated monitoring schedule and sampling protocol that are designed to capture worst-case lead levels, *as is intended by the LCR*
- Close loop-holes that allow sampling protocols that both miss lead and mislead

Follow Sound Science

Look for lead particles,

not just soluble lead

Right to Know

* Disclose challenges and long-term health risk of partial lead service line replacement
* Educate about the new science on physical disturbances of lead service lines
* Give people full disclosure regarding tools for self protection

Thank You

December 12, 2013

ADDENDUM

NOTE TO NDWAC:

This addendum consists of 12 points about key issues discussed in the December 11, 2013 NDWAC meeting concerning long-term revisions to the federal Lead and Copper Rule (LCR). We are submitting this addendum in conformance with the NDWAC process, which states: *"Consistent with the Federal Advisory Committee Act, the Council holds open meetings and provides opportunities for interested persons to make statements within a designated time period at the two meetings or to file statements/comments before or after such meetings."*[1] Our points add to, clarify, disagree with, or reinforce some of the statements made at the meeting.

We hope NDWAC finds this addendum informative and takes it into consideration during its deliberations.

We are available to answer any questions.

Sincerely,

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1. **The LCR is a public health law, *not* a corrosion control law**

The LCR was enacted as a regulatory program under the Safe Drinking Water Act (SDWA) of 1974, which required regulation of drinking water contaminants *deemed harmful to human health*. Regulatory programs under the SDWA are required to specify:

- A Maximum Contaminant Level (MCL) for the contaminant(s) they target, "if it is economically and technologically feasible to ascertain the level of such contaminant in public water systems"[2]

or

- If it is not "economically and technologically feasible to ascertain the level of such contaminant in public water systems," a "treatment technique," "which leads to a reduction in the level of such contaminant sufficient to satisfy the requirements of section 1412."[1] Section 1412 specifies that regulatory programs under the SDWA *"shall protect health to the extent feasible, using technology, treatment techniques, and other means, which the Administrator determines are generally available (taking costs into consideration)…"*[3] (emphasis added).

For a variety of reasons, the LCR of 1991 regulated lead in drinking water through a "treatment technique." It is critically important to keep in mind two of the most central aspects of this approach:

a. **The treatment technique mandated by the LCR is *NOT* the LCR's end goal, as was stated by EPA during the NDWAC meeting. The LCR's treatment technique is simply a regulatory "mediator" aimed at leading to the LCR's end goal: *the protection of public health*. The LCR of 1991 states clearly that, "A treatment technique must 'prevent known or anticipated adverse effects on the health of persons to the extent feasible.'"[4] <u>No discussion about the LCR's treatment technique should ever be divorced from the rule's clear, indisputable, and ultimate purpose: public health protection</u>.**

b. **The LCR's "treatment technique" comprises a multi-pronged approach to the protection of the public from lead in drinking water. *Corrosion control is only one of four components of the LCR's treatment technique*. The other three components are:**

    - **Source water treatment (when lead is detected in source water);**

- **Lead service line replacement (when a jurisdiction has lead service lines); and**
- **Public education.**

Along with proper site selection at the highest risk sites and sampling procedures that capture worst-case lead levels, all of these regulatory components serve as synergistic "vehicles" for preventing consumer exposures to lead at the tap. The LCR of 1991 spells out clearly EPA's intent for the rule's treatment technique: "The Agency believes that the treatment technique approach contained in the final rule will achieve the public health goals of the SDWA…"[5] No discussion about the LCR's treatment technique should ever focus so narrowly on one component of this technique, that the health-protective intent of the rule's multi-pronged approach gets lost. By extension, any characterization of the LCR as a "corrosion control" rule is inaccurate and misleading.

2. **To date, there is no scientific basis for the frequently-made argument that drinking water constitutes a "secondary" source of exposure to lead**

The statement that lead-contaminated drinking water contributes, ***on average***, 10%-20% to a child's total lead intake is made frequently by experts in the field of public health. However, the use of an ***average*** total lead intake does not make sense for risk characterization. There are children that live in homes with lead service lines that will have a much higher lead-in-water intake, and there are children that live in homes without lead service lines that will have a lower lead-in-water intake, comparatively. By combining these two groups and presenting the lead intake from drinking water as an ***average*** intake, those who live in homes with lead service lines are given a false sense of security regarding the safety of their water. Even EPA's estimate that *"Infants who consume mostly formula mixed with lead-containing water can receive 40 to 60 percent of their exposure to lead from drinking water"*[6] does not make logical sense. For example, where would the other 60 to 40 percent of the assumed lead intake come from for infants that range in age from 0 to 6 months and a) are not consuming solid foods, and b) are not yet mobile enough to be in contact with lead-containing paint, dust, or dirt? It stands to reason that many infants from 0 to 6 months doing little more than drinking and sleeping would have a total lead exposure closer to 100 percent from the drinking water.

It is time for these estimates – as well as the data and analysis behind them – to be closely scrutinized and reassessed. Since the promulgation of the LCR, numerous technical presentations have been made at international conferences, and papers have been published suggesting that older estimates are largely based on inappropriate sampling protocols that would likely

underestimate actual lead levels and exposure potential.[7] Furthermore, as we discussed in the paper we submitted to NDWAC at the December 11, 2013 meeting, a) national blood lead screening requirements, and b) environmental risk assessment protocols for identifying sources of lead in homes of children with elevated blood lead levels, *are not designed to detect drinking water as a source of lead among the most vulnerable populations, even when drinking water may be the primary source of exposure.* Specifically, pregnant women (and, therefore, developing fetuses) and infants dependent on formula are rarely screened for lead in blood. Moreover, when young children (most often over the age of 1) are diagnosed with elevated blood lead levels, environmental risk assessments in their homes rarely sample drinking water. When they do, the sampling is almost always inadequate for capturing potential contamination, (e.g., due to inadequate stagnation prior to sampling, lack of sequential samples for the detection of lead particles). Coupling these facts with the latest science on lead in drinking water (e.g., concerning partially replaced lead service lines, acute health risks posed by ingestion of particulate lead, long-term lead spiking following physical disturbances to lead service lines outlined in our paper), suggests very significant exposures that have systematically gone undetected. **Consequently, it would be a mistake for anyone considering revisions to the LCR to presume that lead in drinking water poses a relatively minor threat to public health, and there is little or no modern data supporting that assertion.**

3. **Lead service lines were legally mandated in many US cities and homeowners had no choice but to accept them**

Municipal codes requiring the use of lead service lines were commonplace, starting in the mid-1800s.[8] Chicago, for example, the city with the largest known concentration of lead service lines, mandated the installation of lead pipes until 1986 (i.e., the year of the SDWA amendments that banned lead plumbing materials). In jurisdictions with plumbing codes requiring the use of lead pipe, homeowners could not request alternative materials, even if they were aware and concerned about lead's toxicity.[5,9] In *The Great Lead Water Pipe Disaster* (2008), professor of economics Werner Troesken explains that erroneous understandings about the safety of lead service lines were widespread not only among plumbers, but also among several groups of professionals, including public officials and medical experts. These erroneous understandings were often used to "educate" consumers and even dispel public fears about lead in plumbing. **This history raises serious moral and social justice questions about perpetuating a federal lead-in-drinking water law that places partial (or full) responsibility on the public for preventing exposures to lead at the tap, especially given that many of these exposures are rooted in legal mandates for which consumers had no recourse but to comply with the law.**

4. **A trend may have started among public water systems to "gift" lead service lines entirely to homeowners**

Recently and without a public announcement, the Washington, DC water utility began to claim that it owns no portion of any of the District's service lines. This occurred after many years of official agency statements (and a massive partial lead service line replacement program that cost over $100 million in ratepayer money) confirming the utility's partial ownership of service lines. Washington, DC does not seem to be an isolated case in this regard. In a 2011 survey of public water systems by the American Water Works Association (AWWA), 69% of the 805 water utilities that responded claimed that *they own no part of a service line in their jurisdiction* (AWWA presented these results at the 2011 AWWA Water Quality Technology Conference but did not post them in the conference proceedings and, to our knowledge, has not yet made them public).[10] This percentage dramatically exceeds the results from an earlier survey, as discussed in a 2007 paper,[11] which revealed that only 20% of water utilities claimed to own no part of a service line. A 2012 investigation about lead in US drinking water quotes an environmental engineer from Massachusetts, saying:

> We have had that occur in Massachusetts[Some communities around the nation] have passed bylaws saying this city or town is no longer responsible for the pipe. It's now the responsibility of the homeowner.

However, the basis upon which public water systems are making determinations about ownership is not always clear. The LCR of 1991 stated that,

> A water system is presumed to control the entire lead service line (up to the building inlet) unless the system demonstrates to the satisfaction of the State, […] that it does not have any of the following forms of control over the entire line (*as defined by state statutes, municipal ordinances, public service contracts or other applicable legal authority*): authority to set standards for construction, repair, or maintenance of the line, authority to replace, repair, or maintain the service line, or ownership of the service line[12] (emphasis added).

Just as water utilities were initially required to support through legal documentation claims that they lacked "control" of service lines, water utilities claiming lack of ownership of such lines should also be required to support this claim through legal documentation that they present to the States and post online for public viewing.

5. **Public water systems frequently interpret the meaning of service line "ownership" and "control" inconsistently and in a way that jeopardizes the public's health**

Public water systems frequently claim that they do not own the privately-owned portion of a lead service line and, as a result, have no authority to replace it. At the same time, however, when engaged in routine infrastructure work (e.g., replacing or repairing water mains), public water systems replace the portion of a lead service line that starts at the main and ends at the property line, *even when they claim to own no part of a service line*. Such partial lead service line replacements occur on a daily basis, and far outnumber the partial lead service line replacements that occur during LAL exceedances. This practice reveals a serious inconsistency in the meaning that public water systems assign to the terms "ownership" and "control" of service lines. If public water systems must *own* the portion of the service line that they replace, then public water systems that do not own *any* part of a service line should not be able to conduct *any* lead service line replacement during routine infrastructure work. On the other hand, if public water systems that do not own any part of a lead service line have the authority to conduct partial lead service line replacement during routine infrastructure work because they "control" service lines, then the same systems should have the authority to replace lead service lines fully during both infrastructure work and LAL exceedances (given that in most cases they have "control" of both the public and private portion of a service line). **In light of the serious public health risk posed by partial lead service line replacement, we urge NDWAC to look closely into this issue and consider recommending consistent and public-health protective interpretations by public water systems of the terms "ownership" and "control" vis-à-vis service lines.**

6. **The Centers for Disease Control and Prevention (CDC) recommends a) mandated full lead service line replacement and b) the creation of a "threshold concentration" that, when exceeded, would render a water utility out of compliance with the LCR**

In January 2011, the Centers for Disease Control and Prevention (CDC) sent to the EPA Office of Ground Water and Drinking Water a set of recommendations for revisions to the LCR (letter attached). The CDC letter said:

> CDC believes that leaving any part of the lead service line in place during remediation results in an unavoidable risk and we suggest you explore ways to facilitate full lead service line replacement.

In the same letter, the CDC also recommended that the LCR's 90th percentile trigger point be coupled with an enforceable "threshold concentration," to protect residents living in homes with high concentrations of lead in water, but in jurisdictions that meet the LAL:

> CDC believes that a 90th percentile action level should be combined with a threshold concentration above which the utility would be out of compliance. If the water sample from any high-risk home has a lead concentration that exceeds the threshold, the system would be considered out of compliance.

During the NDWAC meeting, EPA stated that the purpose of the LCR was to control corrosion, which is a clear misinterpretation and direct contradiction of the rule (see point #1 above). Even if that were the case, however, a review of the optimal water quality control parameter (OWQCP) treatment technique violations and LAL exceedances in EPA's Safe Drinking Water Information System compliance database highlights the futility of using the current OWQCP methodology for controlling lead levels. Since the promulgation of the LCR, there have been 6,375 LAL exceedances in community water systems (the total number of LAL exceedances in EPA's compliance database is actually much higher if non-transient non-community water system LAL exceedances are included). Yet over that same 20+ year period there have been only 157 OWQCP treatment technique violations across all community public water systems.* The concomitant small number of treatment technique violations suggests that the current LCR structure is grossly ineffective at ensuring effective corrosion control. **As a result, we urge NDWAC to take into serious consideration the need to a) strengthen all four components of the LCR's treatment technique and b) examine closely, and consider promoting, CDC's recommendations.**

7. **Lead corrosion experts assert that Madison, WI demonstrates the public-health benefit of full lead service line replacement**

Following the December 11, 2013 statement by EPA that Madison, WI exceeded the LAL after fully replacing the majority of the city's lead service lines, we contacted lead corrosion experts familiar with the case to learn more about it. We learned the following:

Madison, WI:

- Exceeded the LAL in 1992
- Exceeded the LAL again in 1997
- Undertook a city-wide full lead service line replacement program in 2001-2010
- In 2003, a researcher's non-LCR monitoring at 60 homes revealed a 90th percentile value >LAL (22 ppb)

* These numbers include LAL exceedances and treatment technique violations that occurred more than once in a single community public water system over the 20+ year period.

Additional research detected erratic release of lead particles, in some homes for over four years after full lead service line replacement. It also revealed that prior to lead service line removal, due to the presence of high levels of iron and manganese in the water, lead from the service lines attached to the iron and manganese and deposited internally in home plumbing. This created a reservoir of lead deposits. Subsequent to the complete removal of the lead service lines, these lead deposits leached into the water on an erratic basis, even though the principal lead source (the lead service line) had been fully removed. The experts explained that full lead service line replacement in plumbing systems that contain high levels of iron and/or manganese can be followed by lead spikes, until the lead that is attached to the manganese or iron releases fully. This process can be lengthy. However, they also cited the Madison, WI 2011 LCR-monitoring results as clear support for full lead service line replacement for two reasons:

- The 90th percentile value in two consecutive 2011 LCR-monitoring rounds was 2.6 ppb and 3.6 ppb respectively, and the average lead level for the 202 compliance samples collected was 1.75 ppb.
- Three years after the completion of the city's full lead service line replacement program, most Madison, WI homes are permanently free both of the principal lead source (the lead service line) and of lead residual in internal plumbing.

In a forthcoming paper, the authors assert that the Madison, WI case supports the EPA SAB's 2011 call for full lead service line replacement,[13] and that the long-term health benefits of such replacement must not be underestimated.[14]

8. **Qualitative research in Washington, DC and Providence, RI suggests that the LCR's lead service line replacement provision today raises serious environmental justice concerns**

Research conducted under a grant by the Robert Wood Johnson Foundation's (RWJF) Public Health Law Research (PHLR) program and DC Water revealed the following trends: a) cost is the primary obstacle preventing homeowners from agreeing to replace the private portion of their lead service line, b) full lead service line replacement is more prevalent among higher income and Caucasian homeowners, and c) 80% of homeowners who had a partial lead service line replacement would agree to full replacement if the cost were covered by the water utility (see attached slides)[15].

9. **Qualitative research in Washington, DC and Providence, RI suggests that the LCR's required notification requirement concerning planned lead service line replacement lacks basic, relevant-to-public-health information**

that would encourage homeowners to opt for full lead service line replacement

The aforementioned research revealed that 50% of homeowners who declined full lead service line replacement would be more inclined to pay for full replacement (or, at least, consider it more seriously) if the short- and long-term health risks associated with partial lead service line replacement had been made known to them.[10]

10. To date, lead in water in US schools and day care centers remains unregulated

Despite increasing efforts on a national scale to promote the consumption of tap water in US schools and day care centers, lead in water in the vast majority of US schools/day care centers is not regulated. Schools and day care centers test, analyze, report, and remediate lead-in-water problems on an entirely voluntary basis. Case study after case study show that, overall, US children are inadequately protected from lead in water available in the educational institutions they attend, *even in jurisdictions that meet the LCR LAL.*[1617] Yet the LCR is designed to address lead-in-water in single-family homes, which differ markedly from schools in relation to plumbing configurations and water use patterns. **We, therefore, recommend that NDWAC consider recommendations to EPA on the development of a separate federal lead-in-water regulation that covers specifically schools and day care centers.**

11. EPA has experts in lead corrosion, epidemiology, the LCR, and policy implementation, as well as an LCR workgroup, all of whom could play a critical role in supporting NDWAC to develop sound recommendations

At EPA, internationally renowned researchers in lead corrosion and epidemiology can bring NDWAC up to date on the latest scientific understandings about lead in drinking water. Similarly, experts on the LCR and on policy implementation issues can offer NDWAC both clarifying information and practical insights that can support the Council in its deliberations.

As part of the LCR long-term revisions process, EPA convened a workgroup of agency experts to develop recommendations for a proposed regulation. At the December 11, 2013 meeting, a member of NDWAC asked if the Council could obtain the workgroup's recommendations. In light of the fact that the EPA workgroup has been discussing proposed revisions for over two years, it seems to us of critical importance that workgroup members should be made available to NDWAC for consultation.

The LCR is a complex rule with strengths but also serious weaknesses and loopholes. As we explain in our paper, these weaknesses and loopholes have failed and are failing the public's health. Consideration of insights by agency experts seems like a potentially important step toward the creation of sound recommendations by NDWAC. Lines of communication between NDWAC and EPA's scientific and policy experts must be open and active throughout NDWAC's deliberation process. **To ensure the development of sound and public health protective recommendations by NDWAC, we strongly encourage NDWAC to request frequent and uncensored exchange of information with EPA's experts.**

12. **We strongly recommend that NDWAC consider including in its LCR-revisions workgroup a member of a grassroots, community-based organization that has been actively involved in protecting the public from lead in drinking water**

    On December 11, 2013, EPA invited NDWAC to suggest additional constituencies for inclusion in the Council's deliberations about the LCR. Although NDWAC includes members of NGO's with expertise on lead in drinking water, we believe that it lacks voices of community advocates with extensive experience working with communities to protect the public from lead at the tap. We encourage NDWAC to consider including such voices to the deliberating table.

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ACKNOWLEDGMENTS

Yanna Lambrinidou was supported by the Robert Wood Johnson Foundation (RWJF) under the Public Health Law Research (PHLR) program grant ID#68391 and by DC Water.

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
and Prevention (CDC)
Atlanta, GA 30341-3724

January 19. 2011

Mr. Eric Burneson
Acting Deputy Director
Office of Ground Water and Drinking water
United States Environmental Protection Agency
USEPA Headquarters
Ariel Rios Building
1200 Pennsylvania Avenue, N. W.
Mail Code: 4607M
Washington, DC 20460

Dear Mr. Burneson:

One of our goals at the National Center for Environmental Health (NCEH) of the Centers for Disease Control and Prevention (CDC) is the elimination of childhood lead poisoning in the United States. CDC and its funded programs conduct surveillance of the occurrence of childhood lead poisoning, establish guidelines for case-management of children with elevated blood lead levels, and make recommendations for the prevention of lead exposures from all possible sources. Our understanding of the current scientific literature on the effects of lead in children, and on the role of lead in water distribution systems -- including conclusions in a recently published study by CDC -- suggest changes are needed in the current "Lead and Copper Rule" (LCR). This letter provides CDC's recommendations for revisions to the LCR.

As you are well aware, CDC, EPA and our other Federal and state partners have spearheaded significant reductions in both the occurrence of lead poisoning and exposures to lead. EPA has promulgated effective regulations that have reduced lead emissions in air, water, and solid waste. During the past three decades, the percent of American children having blood lead levels above 10 micrograms per deciliter have been reduced from 88% to less than 1 percent. The EPA's LCR has had a significant impact on reducing lead poisoning via plumbing in the United States. The opportunity exists to further strengthen the rule and perhaps to simplify it.

We understand that EPA currently is reviewing its "Lead and Copper Rule" (LCR). This rule has formed the foundation of the national strategy to prevent drinking water exposures to lead.[1] We have supported the goals of this rule over the years.

[1] Lead and Cooper Rule: A quick Reference Guide. ISEPA Office of Water. EPA 816-F- 04-009. www.epa.gov/safewater

We believe that the LCR can and should be strengthened to further reduce exposures to lead through drinking water. The discussion below addresses three components of the LCR that CDC believes should be modified:

1. The EPA action level.
2. Lead service line (LSL) replacements.
3. Public information.

The EPA action level:

EPA currently sets the LCR action level as a 90th percentile sample (among high-risk homes) of 15 ppb lead or higher. The action level allows children and pregnant and breast-feeding women living in as much as ten percent of the high-risk homes to be exposed to levels of lead in drinking water in excess of 15 ppb. Under the current LCR, a utility is compliant if no more than one out of ten connections in the high-risk community exceeds 15 ppb or higher. Because the action level is based on a percentile rather than a tolerable limit, the LCR considers equally compliant two utilities having a 95th percentile level of 20 ppb or 2000 ppb - as long as the 90th percentile is below 15 ppb. CDC believes that a 90th percentile action level should be combined with a threshold concentration above which the utility would be out of compliance. If the water sample from any high-risk home has a lead concentration that exceeds the threshold, the system would be considered out of compliance. Under a combination of a 90th percentile action level and a threshold value, a system would be out of compliance if the 90th percentile exceeded the action level or any test exceeded the threshold value. Under these conditions, EPA would consider requiring the utility to notify the community, provide an alternative drinking water source or filtration, identify and mitigate lead sources, and/or conduct additional sampling.

CDC also believes that the 90th percentile threshold should be based on the concentration of lead in drinking water that results in an increase in blood lead levels of children and pregnant or breast-feeding women. However, EPA should not use the CDC blood level of concern for children (i.e.,10ug/dL) to establish its 90th percentile action level. We are currently reviewing this level at this time and are likely to make changes to it in the next few months. The size of the increase in the distribution of blood lead levels associated with a 90th percentile action level should be as small as possible and my staff and I are available to provide you with guidance on choosing an appropriate level.

Lead service line replacement

CDC has shared with EPA our analyses concerning partial lead pipe replacement since the fall of 2009. In December 2010, our analyses were published in the journal *Environmental Research*. We believe there is sufficient evidence to recommend that EPA halt partial lead

service line replacement until it has further assessed the efficacy of this remediation technique. CDC believes that leaving any part of the lead service line in place during remediation results in an avoidable risk and we suggest you explore ways to facilitate full lead service line replacement. Finally, if any section of a lead service line is replaced, CDC recommends that an alternative source of drinking water or filtration be provided until sampling documents that lead concentrations fall below the EPA action level.

Public information

We suggest EPA take steps to ensure that utilities inform customers about the location of lead service lines and the options for replacement. This information could be provided to customers with their billing statements or notices of water quality. Disclosing information about lead service lines would improve the public's understanding of the hazards of lead in water. Providing information to the public has proven a successful strategy in reducing exposures to hazardous substances. For example, section 1018 of the Residential Lead-Based Paint Hazard Reduction Act of 1992 directed HUD and EPA to require the disclosure of known information on lead-based paint and lead-based paint hazards before the sale or lease of housing built before 1978. These disclosures have led property owners to identify and mitigate existing lead hazards.

Finally, NCEH would like to offer two additional suggestions regarding lead exposures. First, as EPA considers modifications to the LCR, we ask that you carefully review the sampling strategies for home drinking water to ensure that the samples are collected uniformly and are directly pertinent to how people use water in the home. In addition, we ask that EPA coordinate across the various offices dealing with lead in water, soil, dust and paint so that every office uses the same risk assessment and relative source contribution information when they develop policies that prevent exposures to lead. NCEH is available to assist EPA as it deliberates the changes needed in the LCR. Should EPA wish to contact us further on this issue, our point of contact is Dr. Mary Jean Brown, Chief, Healthy Homes and Lead Poisoning Prevention Branch (phone (770) 488-7492; email: MJB5@cdc.gov).

Sincerely yours,

Christopher J. Portier, Ph.D.
Director, National Center for
Environmental Health, and
Agency for Toxic Substances and
Disease Registry

Empirical and Legal Evaluation of Public Health Protection Under the Federal Lead and Copper Rule

Yanna Lambrinidou, PhD
Parents for Nontoxic Alternatives

Submitted to EPA's National Drinking Water Advisory Council (NDWAC)
December 16, 2013

Homeowner Interviews

Type of LSLR

	Washington, DC	Providence, RI	Total
Full LSLR	18	1	**19**
Partial LSLR	13	7	**20**
Total	**31**	**8**	**39**

Demographics

	Washington, DC	Providence, RI	Total
White/Caucasian	17	6	**23**
Black/African American	10		**10**
Hispanic/Latino	2	2	**4**
Other	2		**2**
Total	**31**	**8**	**39**

Reasons homeowners "opted out" of private-side LSLR:

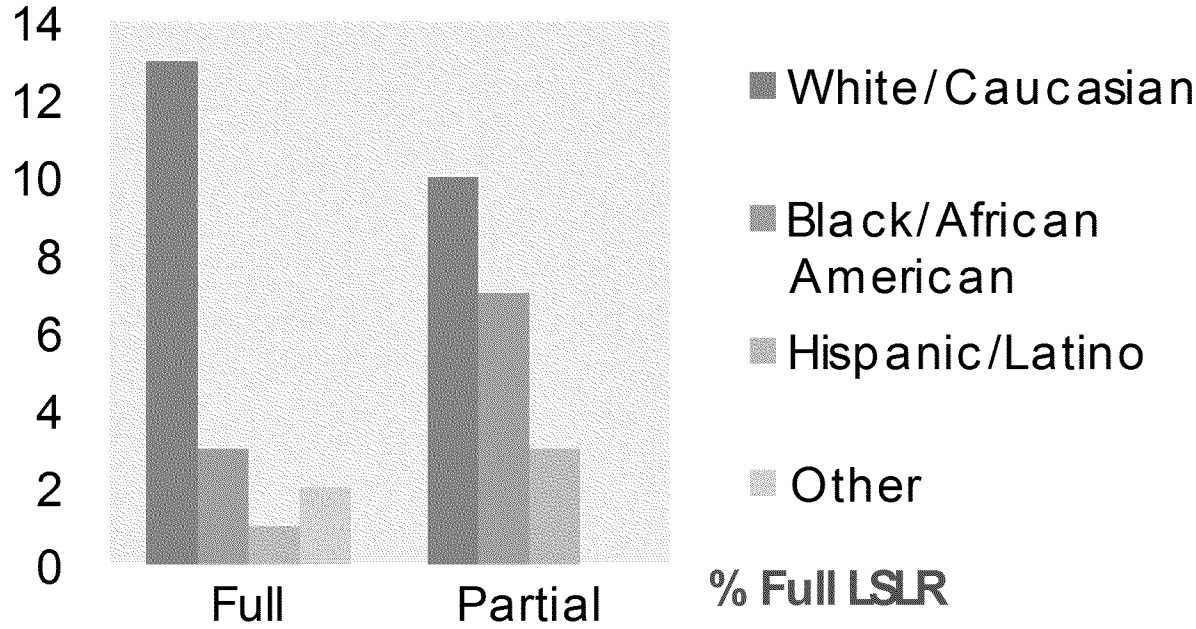
COST

* Concern across income levels
* Recalled estimate range: $1,000-$7,000

* If cost covered by utility:
    * 80% would agree to full LSLR
    * 20% would agree to a full LSLR if it were recommended for preventing *known* (rather than speculative) health harm

Type of LSLR by Income Level

Type of LSLR by Race



	Full	Partial	% Full LSLR
White/Caucasian	13	10	56%
Black/African American	3	7	30%
Hispanic/Latino	1	3	25%
Other	2		

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* The Robert Wood Johnson Foundation's (RWJF) Public Health Law Research program, and
* DC Water

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From: Robinson, Matt M.
Sent: Tue 4/1/2014 2:24:42 PM
Subject: Follow up from Working Group meeing
Action Items from March 2014 NDWAC LCRWG Meeting (3-31-14).docx

All,

The agenda for this afternoon is below. I've attached the action items and pasted the proposed timeline below. See you all at 2pm.

LCR Team Meeting Agenda

- Overall impressions of the first meeting, trends to continue, things to change
- Action Items and Follow-up
- The road to the second meeting, editing the timeline

Week of	TASKS	EVENTS	COMMENTS
3/24/2014		Meeting 1: Intro and OCCT	
		April	
3/30/2014	Work on Action items and follow up Hold Team Meeting; divide follow up tasks Schedule work EPA group meeting		
4/7/2014	· DD debrief, if needed Solidify Working Group members: EJ, grass roots Sample Site Primer out for Staff Review · Send action items and thank you email	Primer move to staff review	

4/14/2014	· Have speakers committed for second and third webinar · Have webinar details worked out	Primer move to mgt review	
4/21/2014	· FRN 3rd Meeting Notice Published		
4/28/2014	· Send meeting summary · Conference call with meeting presenters (LSLR, webinar and meeting)		
		May	
5/7/2014	Meeting materials to mgt. for review .		
5/12/2014	· DD Briefing; Send out materials for 2nd meeting (presentations, primers, etc.)	***Webinar for Meeting 2: Sample Site Selection***	
5/19/2014	OD Briefing		
5/26/2014	2nd meeting last minute details	***Meeting 2: Sample Site Selection***	5/26 is Memorial Day

Action Items from the NDWAC LCR Working Group Meeting March 25 and 26, 2014			
Row	**Action Item**	**Responsibility[1]**	**Timeframe**
1	Identify additional NDWAC LCRWG members. May include: 1. Hector Gonzalez *(He agreed since meeting was held.)* 2. Grassroots organization(s).	EPA/RESOLVE	ASAP
2	Create e-mail distribution list based on meeting attendees for distributing copies of the slides and meeting notes	RESOLVE	ASAP
3	Send slides and meeting calendar request to LCRWG.	RESOLVE	Completed (3/28/14)
4	Determine if webcasts can be recorded.	EPA	Prior to 1st webinar
5	Provide meeting summary to LCRWG.	EPA/Cadmus	Late April
6	Include time in future meeting agendas to address follow-up questions or outstanding issues from the previous meetings.	EPA/RESOLVE	Prior to each meeting
7	Determine whether definition of backsliding on public health is specific to one rule or can apply across multiple rules.	EPA	Prior to 1st webinar
8	Revise the mission statement in the Charge and Operational Protocols Document to: 1. Make it consistent with the goal stated in the white paper **Attorney Client / Ex. 5**	EPA/RESOLVE	ASAP
9	Provide already-developed background materials to LCRWG: 1. SBREFA recommendations to EPA. 2. Background information that informed the white paper. 3. Public education fact sheet based on the Short-Term Revisions and other lead public education materials. 4. Copper health effects information. 5. Studies that evaluate CCT effectiveness in managing lead release from LSLs. 6. CDC study on blood lead levels. 7. Lead level trends for some MA systems	EPA (1-4 & 6); EPA - Mike Schock (5); Steve Estes-Smargiassi (7)	• 1, 2, 5, & 7: Prior to 1st webinar. • 3 & 4: Prior to webinar for 3rd meeting. • 6: Prior to webinar for 4th meeting on LSLR.
10	Assemble and verify list of data requests with LCRWG *(see row 11 below for list).*	EPA/LCRWG	ASAP

11	Assess availability of other requested information/conduct analysis as needed. 1. National statistics on lead and copper ALEs to answer if there are systems for which CCT is not working? It will be important to distinguish systems that have exceeded the action level for leave versus exceeding the action level for copper. Of those systems that have exceeded action levels, how many have implemented other optimization requirements (or made adjustments in OCCT as required by primacy agencies?) 2. Source contribution of lead in homes and distribution systems and how they have changed over time. 3. Cost of lead and copper testing and lab availability and how they may vary geographically. 4. Description of LSLR process including steps, timing, and costs of partial and full LSLR. 5. Information from IEUBK model on impact of blood lead level on infants consuming lead at 15 µg/L. 6. List of real-world simultaneous compliance issues that occur most often. 7. Presentation on other treatment technique regulations to see if any successes can be applied to LCR. 8. Prospective studies that associate LSL and CCT with human body burden. 9. Flow diagram of sampling protocol that identifies where problems can occur. 10. List of stakeholders that are involved with lead and copper control (e.g., plumbing equipment manufacturers, building industry, public health agencies, water systems, regulatory agencies). 11. Primer on the history of the rule to the present. 12. List of on-going research projects. 13. How many systems have been required to begin a lead service line replacement program. 14. How many large, medium, and small systems are estimated to be required to re-optimize (i.e., how many will exceed the lead/copper action level) under new rule?	EPA (All); Input from plumbing manufacturers (2); Input from Regions/States (6)	• 1: ?? • 2: ?? • 3 & 9: Prior to webinar for 2nd meeting on site selection • 4, 5, & 7: prior to webinar for 4th meeting on LSLR[2] • 6? • 12?
12	Identify needed presentations and speakers for future webinars/meetings: 1. Plumbing manufacturers to discuss changes in leaded materials over time. 2. Individuals or utilities with sample collection experience to understand issues with current protocol.	EPA/LCRWG	• 1, 2, & 3: Prior to webinar for 2nd meeting (site selection)

	How systems determine service line material in the field (e.g., lead, galvanized pipe). 4. How people are dealing with easements for LSLR. 5. Presentation on what it takes to conduct full and PLSLR including timeframes. 6. How citizens have handled LSLR and lessons learned (e.g., DC residents).		4 - 6: Prior to webinar for 4th meeting on LSLR

Acronyms: µg/L = micrograms per liter; AL = action level; ALE = action level exceedance; CCT = corrosion control treatment; FACA = Federal Advisory Committee Act; IEUBK model = Integrated Exposure Uptake Biokinetic model; LCR = Lead and Copper Rule; LCRWG = LCR Working Group; LSL = lead service line; LSLR = lead service line replacement; NDWAC = National Drinking Water Advisory Council; PLSR = partial lead service line replacement; SBREFA = Small Business Regulatory Enforcement Fairness Act.

Notes:

[1] Unless otherwise stated, EPA refers to the Standards and Risk Management Division (SRMD).

[2] Webinar will also include LSLR procedure.

Blood Lead Levels in Children

What Do Parents Need to Know to Protect Their Children?

Protecting children from exposure to lead is important to lifelong good health. Even low levels of lead in blood have been shown to affect IQ, ability to pay attention, and academic achievement. And effects of lead exposure cannot be corrected.

The most important step parents, doctors, and others can take is to **prevent lead exposure before it occurs**.

Update on Blood Lead Levels in Children

- Children can be given a blood test to measure the level of lead in their blood.
- Until recently, children were identified as having a blood lead level of *concern* if the test result is 10 or more micrograms per deciliter of lead in blood. Experts now use a new level based on the U.S. population of children ages 1-5 years who are in the top 2.5% of children when tested for lead in their blood (when compared to children who are exposed to more lead than most children).
- In the past, blood lead level tests below 10 micrograms per deciliter of lead in blood may, or may not, have been reported to parents. The new, lower value means that more children likely will be identified as having lead exposure allowing parents, doctors, public health officials, and communities to take action *earlier* to reduce the child's future exposure to lead.
- What has *not* changed is the recommendation for when to use medical treatment for children. These new recommendations do not change the recommendation that chelation therapy be considered when a child is found with a test result of greater than or equal to 45 micrograms per deciliter of lead in blood.

Actions for Parents

Parents can take simple steps to make their homes more lead-safe.

- Talk to your local health department about testing paint and dust in your home for lead if you live in a home built before 1978.
- Common home renovation activities like sanding, cutting, and demolition can create hazardous lead dust and chips by disturbing lead-based paint. These can be harmful to adults and children.
- Renovation activities should be performed by certified renovators who are trained by EPA-approved training providers to follow lead-safe work practices.
- Learn more at EPA's Renovation, Repair, and Painting rule Web page: http://www.epa.gov/lead/pubs/renovation.htm.
- If you see paint chips or dust in windowsills or on floors because of peeling paint, clean these areas regularly with a wet mop.
- Wipe your feet on mats before entering the home, especially if you work in occupations where lead is used. Removing your shoes when you are entering the home is a good practice to control lead.
- Remove recalled toys and toy jewelry from children. Stay up-to-date on current recalls by visiting the Consumer Product Safety Commission's Web site: http://www.cpsc.gov/.

Lead can be found in a variety of sources. These include:

- **paint in homes built before 1978.**
- **water pumped through leaded pipes.**
- **imported items including clay pots.**
- **certain consumer products such as candies, make up and jewelry.**
- **certain imported home remedies.**

National Center for Environmental Health
Division of Emergency and Environmental Health Services

Background

Effect of a Different Blood Lead Level

- In the past, blood lead level tests below10 micrograms per deciliter may, or may not, have been reported to parents. Identifying a child's blood lead equal to or above 5 micrograms per deciliter means more parents should learn that their child has an elevated blood lead level.
- Even though no medical treatment is recommended for children with blood lead levels lower than 45 micrograms per deciliter, parents will know they need to learn about sources of lead exposure and find out if one or more unrecognized sources of lead are present in their home. Parents then can follow the Centers for Disease Control and Prevention (CDC)'s recommendations to control exposure to lead.
- No changes are recommended to the existing CDC guidelines for the evaluation and treatment of children requiring chelation (those with BLLs ≥ 45 micrograms per deciliter).

New Recommendations to Define Elevated Blood Lead Levels

- In January 2012, a committee of experts recommended that the CDC change its "blood lead level of concern." The recommendation was based on a growing number of scientific studies that show that even low blood lead levels can cause lifelong health effects.
- The committee recommended that CDC link lead levels to data from the National Health and Nutritional Examination Survey (NHANES) to identify children living or staying for long periods in environments that expose them to lead hazards. This new level is based on the population of children aged 1-5 years in the U.S. who are in the top 2.5% of children when tested for lead in their blood. Currently, that is 5 micrograms per deciliter of lead in blood. CDC's "blood lead level of concern" has been 10 micrograms per deciliter.
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- The committee also said, as CDC has long said, that the best way to protect children is to prevent lead exposure in the first place.

To learn more about preventing lead exposure, visit CDC's Web site at http://www.cdc.gov/nceh/lead/

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Lead and Copper Rule: Public Education & Other Public Information Requirements for Community Water Systems

Public Education Requirements

Utilities must ensure that water from the customer's tap does not exceed the action level for lead in drinking water (15 ppb) in at least 90 percent of the homes sampled. If you have a **lead action level exceedance** you must complete the following steps to comply with the Lead and Copper Rule (LCR) public education (PE) requirements.

Section 141.85 of the LCR regulations contains specific requirements regarding the content and delivery of your public education program. To learn more about the revisions to the public education requirements, refer to *Implementing the Lead Public Education Provision of the Lead and Copper Rule: A Guide for Community Water Systems*, Section 1, page 5.

Step 1: Develop the content of your written public education materials.

The following information must be included in your PE materials. The text in *italics* is mandatory and must be included as written. Headings in **bold** must be addressed, but can be customized. Fill-in-the-blank templates (in English and Spanish) are available at: www.epa.gov/safewater/lcrmr/compliancehelp.html. More information can be found in *Implementing the Lead Public Education Provision of the Lead and Copper Rule: A Guide for Community Water Systems*, Section 1, page 8: Required Content of Public Education Materials and Appendix B: Public Education templates.

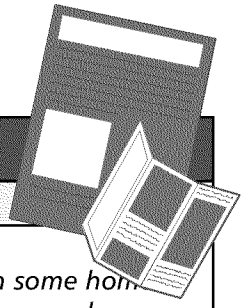

Table 1. Required Content and Language for Public Education Materials

Section	Language
Informational Statement * Mandatory language	*Important Information about Lead in Your Drinking Water* *[Insert name of water system] found elevated levels of lead in drinking water in some home buildings. Lead can cause serious health problems, especially for pregnant women and young children. Please read this information closely to see what you can do to reduce lead in your drinking water.*
Health Effects of Lead * Mandatory language	*Lead can cause serious health problems if too much enters your body from drinking water or other sources. It can cause damage to the brain and kidneys, and can interfere with the production of red blood cells that carry oxygen to all parts of your body. The greatest risk of lead exposure is to infants, young children, and pregnant women. Scientists have linked the effects of lead on the brain with lowered IQ in children. Adults with kidney problems and high blood pressure can be affected by low levels of lead more than healthy adults. Lead is stored in the bones and it can be released later in life. During pregnancy, the child receives lead from the mother's bones, which may affect brain development.*
Sources of Lead * Can be customized; Example language	Lead is a common metal found in the environment. The main sources of lead exposure are lead-based paint and lead-contaminated dust or soil, and some plumbing materials. In addition, lead can be found in certain types of pottery, pewter, brass fixtures, food, and cosmetics. Other sources include exposure in the work place and exposure from certain hobbies (lead can be carried on clothing or shoes). Brass faucets, fittings, and valves, including those advertised as "lead-free," may contribute lead to drinking water. EPA estimates that 10 to 20 percent of a person's potential exposure to lead may come from drinking water. Infants who consume mostly formula mixed with lead-containing water can receive 40 to 60 percent of their exposure to lead from drinking water.

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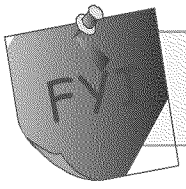
Table 1. Required Content and Language for Public Education Materials (continued)	
Section	**Language**
Steps you can take to reduce your exposure to lead in your water * Can be customized; Example language	**1. Run your water to flush out lead.** Run water for 15 - 30 seconds to flush lead from interior plumbing [or insert a different flushing time if your system has representative data indicating a different flushing time would better reduce lead exposure in your community and if the Primacy Agency approves the wording] or until it becomes cold or reaches a steady temperature before using it for drinking or cooking, if it hasn't been used for several hours. [It is likely that systems with lead service lines will need to collect data to determine the appropriate flushing time for lead service lines.][1] **2. Use cold water for cooking and preparing baby formula.** Lead dissolves more easily into hot water. **3. Do not boil water to remove lead.** Boiling water will not reduce lead. **4. Look for alternative sources or treatment of water.** You may want to consider purchasing bottled water or a water filter. Read the package to be sure the filter is approved to reduce lead or contact NSF International at 800-NSF-8010 or www.nsf.org for information on performance standards for water filters. **5. Test your water for lead.** Call us at [insert phone number for your water system] to find out how to get your water tested for lead. [Include information on your water system's testing program. For example, do you provide free testing? Are there labs in your area that are certified to do lead in water testing?] **6. Get your child's blood tested.** Contact your local health department or healthcare provider to find out how you can get your child tested for lead, if you are concerned about exposure. **7. Identify and replace plumbing fixtures containing lead.** Brass faucets, fittings, and valves, including those advertised as "lead-free," may contribute lead to drinking water. The law currently allows end-use brass fixtures, such as faucets, with up to 8% lead to be labeled as "lead free." Visit the NSF Web site at www.nsf.org to learn more about lead-containing plumbing fixtures.
What happened? What is being done? * Can be customized; Example language	[Insert information about how and when the exceedance was discovered in your community and provide information on the source(s) of lead in the drinking water, if known.] [Insert information about what your system is doing to reduce lead levels in homes in your community.]
For More Information * Mandatory language	*Call us at [Insert Number] or (if applicable) visit our Web site at [insert Web site Here]. For more information on reducing lead exposure around your home/building and the health effects of lead, visit EPA's Web site at www.epa.gov/lead, or contact your health care provider.* [We recommend you include the name of your system and the date that the information is being distributed, along with the state water system ID, somewhere on the notice.]

[1]The bracketed language does not need to be included, as worded, in your materials. It is designed to alert systems that, where applicable, lead service lines might affect the flushing time.



Different Language Communities. If significant proportions of the population in your community speak languages other than English, the PE materials must contain information in the appropriate language(s) regarding the importance of the notice or a contact where persons can obtain a translation or assistance.

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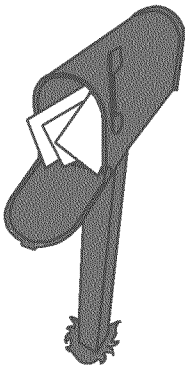
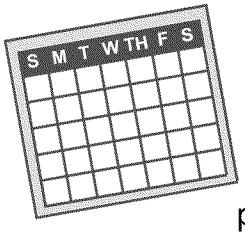
Step 2: Get State approval.

You must submit all written PE materials to the Primacy Agency prior to delivery. The Primacy Agency may require you to obtain approval of PE materials prior to delivery.

Step 3: Deliver your public education materials.





Timing: All public education materials must be delivered within 60 days after the end of the monitoring period in which the exceedance occurred and repeated once every 12 months, EXCEPT providing information on or in each water bill, which must be included in each billing cycle (no less than quarterly or the Primacy Agency can approve a separate mailing) and two press releases per 12 month period for as long as you exceed the lead action level. Also, the Primacy Agency can allow activities to extend beyond the 60-day requirement if needed for implementation purposes; however, this extension must be approved in writing in advance of the 60-day deadline. Note: This extension is only appropriate if the system has initiated public education activities prior to the end of the 60-day deadline.

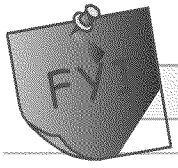
For more information go to *Implementing the Lead Public Education Provision of the Lead and Copper Rule: A Guide for Community Water Systems*, Section 1, page 9: Required Methods of Delivery for Community Water Systems.

Table 2. Required Methods of Delivery for Small and Large Community Water Systems

Small (<3,300 customers)	Large (>3,300 customers)
Deliver printed materials (pamphlets, brochures, posters) to all bill paying customers	Deliver printed materials (pamphlets, brochures, posters) to all bill paying customers
Deliver public education materials to the following facilities and organizations that are served by the system that are most likely to be visited regularly by pregnant women and children: 1. Local public health agencies[1] 2. Public and private schools or school boards 3. Women Infants and Children (WIC) and Head Start programs 4. Public and private hospitals and medical clinics 5. Pediatricians 6. Family planning clinics 7. Local welfare agencies	Deliver public education materials to the following organizations that are located within your service area, along with a cover letter encouraging distribution to all potentially affected customers or users: 1. Local public health agencies 2. Public and private schools or school boards 3. Women Infants and Children (WIC) and Head Start programs 4. Public and private hospitals and medical clinics 5. Pediatricians 6. Family planning clinics 7. Local welfare agencies

[1]If you do not have a local public health agency, you should contact your State Health Department.

Tip: To obtain a list of organizations in your area, contact your local Public Health Agency. Additional informational resources of associations and licensing agencies of these organizations may be found in *Implementing the Public Education Provision of the Lead and Copper Rule: A Guide for Community Water Systems*; Appendix C.



Systems are required to contact their local Public Health Agencies directly (either in person or by phone).

EPA United States Environmental Protection Agency

Table 2. Required Methods of Delivery for Small and Large Community Water Systems (continued)	
Small (<3,300 customers)	**Large (>3,300 customers)**
Make a good faith effort to locate the following organizations within the service area and deliver materials that meet the content requirements, along with an informational notice that encourages distribution to all potentially affected customers or users. The good faith effort to contact at-risk customers may include requesting a specific contact list of the organizations from the local Public Health Agencies, even if the agencies are not located within the water system service area:[2] 1. Licensed childcare centers 2. Public and private preschools 3. Obstetricians-Gynecologists and Midwives	Make a good faith effort to locate the following organizations within the service area and deliver materials that meet the content requirements, along with an informational notice that encourages distribution to all potentially affected customers or users. The good faith effort to contact at-risk customers may include requesting a specific contact list of the organizations from the local Public Health Agencies, even if the agencies are not located within the water system service area:[2] 1. Licensed childcare centers 2. Public and private pre-schools 3. Obstetricians-Gynecologists and Midwives
Provide information on or in each water bill (no less than quarterly or Primacy Agency can approve a separate mailing)[3,4]	Provide information on or in each water bill (no less than quarterly or Primacy Agency can approve a separate mailing)[3,4]
Submit press release to newspaper, television, and radio stations[5]	Submit press release to newspaper, television, and radio stations
Conduct one (1) activity from one of the following general categories:[6,7] • Public Service Announcements • Paid Advertisements • Display Information in Public Areas • Email to Customers • Public Meetings • Delivery to Every Household • Provide Materials Directly to Multi-family Homes • Other Methods Approved by the Primacy Agency	Conduct three (3) activities from one, two, or three of the following general categories:[6,7,8] • Public Service Announcements • Paid Advertisements • Display Information in Public Areas • Email to Customers • Public Meetings • Delivery to Every Household • Provide Materials Directly to Multi-family Homes • Other Methods Approved by the Primacy Agency
	Post material on a publicly accessible Web site (for systems serving >100,000 individuals)

[2]For further clarification of a good faith effort, you should consult with your Primacy Agency.
[3]Primacy Agency may allow a separate mailing if you cannot place information on the water bill.
[4]You may add additional pages (e.g., public education brochure) to the Consumer Confidence Report if timing is appropriate. However, it may be rare that timing will coincide, given that the CCR must contain compliance data collected in the previous calendar year and the report must be provided to consumers no later than July 1 (i.e., the report issued by July 1, 2007 contains compliance data collected in calendar year 2006).
[5]Primacy Agency may waive this requirement as long as you distribute notices to every household served by your system.
[6]You should discuss/verify with your Primacy Agency to ensure fulfillment of all requirements.
[7]Appendix B of *Implementing the Lead Public Education Provision of the Lead and Copper Rule: A Guide for Community Water Systems* contains customizable templates for PE materials that may be used to meet these requirements.
[8]For example, you may do 3 PSAs or 3 public meetings if the Primacy Agency allows.

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Table 3. Other Public Information Requirements – Regardless of An Action Level Exceedance
Consumer Confidence Report (CCR) Requirements[1]
Every report must include the following lead-specific information: *If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. [NAME OF UTILITY] is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at* http://www.epa.gov/safewater/lead.
A system may write its own statement in consultation with the Primacy Agency.
Notification of Results – Reporting Requirements[2]
Must provide a consumer notice of lead tap water monitoring results to all persons served at the tap from which the sample was taken.
Must provide consumer notice as soon as practical, but no later than 30 days after system learns of tap monitoring results.
Must include the following information: results of lead tap water monitoring, an explanation of the health effects of lead (you may use the health effects language found in Table 1), list steps consumers can take to reduce exposure to lead in drinking water, and utility contact information. This notice must also include the maximum contaminant level goal (MCLG) for lead and the action level (AL) for lead and the following definitions for these two terms: *The MCLG for lead is zero and the action level is 15ppb. The MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety. The action level is the concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.*
Must be provided to all persons served at the site by mail or other methods (subject to approval by the Primacy Agency). This includes those who do not receive a water bill.

[1]CWSs in States where EPA is the Primacy Agency or have adopted the Revisions by December 2008 must begin including the lead informational statement in CCRs that are due to consumers by July 1, 2009 (i.e. the 2008 CCR). Otherwise, CWSs must begin to include this information in the 2009 CCR.

[2]Consumer Notification of Results templates are available in *Appendix B* of *Implementing the Lead Public Education Provision of the Lead and Copper Rule: A Guide for Community Water Systems*

For Additional Information:

* *Implementing the Lead Public Education Provision of the Lead and Copper Rule: A Guide for Community Water Systems (EPA 816-R-08-007, June 2008).*
* EPA's Website on Lead in Drinking Water – Lead and Copper Rule www.epa.gov/safewater/lcrmr
* EPA's Safe Drinking Water Hotline: (800) 426-4791
* Your Primacy Agency

Disclaimer: This document is designed for Community Water Systems; the guidance contained in this document does not substitute for provisions or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances.

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ADVANCING THE SCIENCE OF WATER

EPA

Drinking Water Source Protection Through Effective Use of TMDL Processes

Subject Area: Water Resources and Environmental Sustainability

Drinking Water Source Protection Through Effective Use of TMDL Processes

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The Foundation's mission is to advance the science of water to improve the quality of life. To achieve this mission, the Foundation sponsors studies on all aspects of drinking water, including resources, treatment, distribution, and health effects. Funding for research is provided primarily by subscription payments from close to 1,000 water utilities, consulting firms, and manufacturers in North America and abroad. Additional funding comes from collaborative partnerships with other national and international organizations and the U.S. federal government, allowing for resources to be leveraged, expertise to be shared, and broad-based knowledge to be developed and disseminated.

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Drinking Water Source Protection Through Effective Use of TMDL Processes

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FOREWORD

The Water Research Foundation (Foundation) is a nonprofit corporation that is dedicated to the implementation of a research effort to help utilities respond to regulatory requirements and traditional high-priority concerns of the industry. The research agenda is developed through a process of consultation with subscribers and drinking water professionals. Under the umbrella of a Strategic Research Plan, the Research Advisory Council prioritizes the suggested projects based upon current and future needs, applicability, and past work; the recommendations are forwarded to the Board of Trustees for final selection. The Foundation also sponsors research projects through the unsolicited proposal process; the Collaborative Research, Research Applications, and Tailored Collaboration programs; and various joint research efforts with organizations such as the U.S. Environmental Protection Agency, the U.S. Bureau of Reclamation, and the Association of California Water Agencies.

This publication is a result of one of these sponsored studies, and it is hoped that its findings will be applied in communities throughout the world. The following report serves not only as a means of communicating the results of the water industry's centralized research program but also as a tool to enlist the further support of the nonmember utilities and individuals.

Projects are managed closely from their inception to the final report by the Foundation's staff and large cadre of volunteers who willingly contribute their time and expertise. The Foundation serves a planning and management function and awards contracts to other institutions such as water utilities, universities, and engineering firms. The funding for this research effort comes primarily from the Subscription Program, through which water utilities subscribe to the research program and make an annual payment proportionate to the volume of water they deliver and consultants and manufacturers subscribe based on their annual billings. The program offers a cost-effective and fair method for funding research in the public interest.

A broad spectrum of water supply issues is addressed by the Foundation's research agenda: resources, treatment and operations, distribution and storage, water quality and analysis, toxicology, economics, and management. The ultimate purpose of the coordinated effort is to assist water suppliers to provide the highest possible quality of water economically and reliably. The true benefits are realized when the results are implemented at the utility level. The Foundation's trustees are pleased to offer this publication as a contribution toward that end.

Roy L. Wolfe, Ph.D.
Chair, Board of Trustees
Water Research Foundation

Robert C. Renner, P.E.
Executive Director
Water Research Foundation

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EXECUTIVE SUMMARY

The Clean Water Act (CWA) is the primary federal law in the United States that protects the health of our nation's waters, including lakes and rivers The CWA's primary objective is to restore and maintain the integrity of the nation's waters by eliminating the discharge of pollut - ants into the nation's waters, and through achieving "fishable and swimmable" standards in the nation's waters "Designated uses" of water bodies are identified; ambient water quality criteria are developed to protect designated uses; and total maximum daily loads (TMDLs) are developed, as necessary, when water bodies are not achieving their designated uses The Safe Drinking Water Act (SDWA) was established to protect the quality of drinking water in the United States While the CWA focuses on surface water bodies, the SDWA focuses on current and potential sources of drinking water, including both above ground and underground sources The SDWA requires the U S Environmental Protection Agency (EPA) and states to implement and enforce drinking water standards to protect public health through the Public Water System Supervision (PWSS) program

Although the SDWA and CWA programs are typically implemented independently of one another, activities overlap under the two programs Water utilities should take advantage of this overlap, especially in times of resource constraints More than ever, it is in the interest of many drinking water utilities to get involved in their watershed protection process, including engaging themselves in the development of TMDLs, so their needs and concerns are accurately and ade - quately addressed In order for drinking water utilities to participate effectively in the development of TMDLs, however, they need to understand the process

The CWA requires states to provide opportunities for stakeholder involvement in the prepa ration of the 303(d) list of impaired water bodies where standards are not being met, and the subse quent TMDL development process These are opportunities for drinking water utilities to leverage non-SDWA programs to assist with the protection of public water supplies Greater involvement in TMDL processes can yield a number of benefits to drinking water utilities, including:

- Improved source water quality
- Reduced public health risks
- Reduced treatment processes and costs
- Decreases in the amount of chemicals necessary for treatment processes
- Reduced disinfection byproducts
- Increased reservoir volumes
- Good public relations
- More efficient regulatory interactions
- Improved availability of water quality information
- More effective planning

The goal of this project was to provide water utilities with information and tools that help them better understand and utilize the TMDL process so they can protect and improve their source water quality The project's goal was achieved by pursuing two objectives The first objective was to identify successful strategies used by utilities to protect their source waters through the TMDL regulatory process To do this, case studies were developed for utilities that have been involved or are preparing to get involved with the development of TMDLs for their source waters As part of those case studies, successful strategies used by the utilities were identified, as were missed

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opportunities, so readers could benefit from lessons the utilities learned during TMDL implementation. In addition, state drinking water and TMDL administrators were asked what recommendations they have for improving water utility involvement. Finally, user-friendly information and tools were developed to help utilities understand and navigate the CWA as it pertains to TMDLs.

The second objective of the project was to identify specific measures that are being used to include drinking water objectives in TMDLs. The tasks related to achieving this objective focused primarily on how the federal and state governments are implementing the TMDL requirement. Results of a recent study conducted by The Cadmus Group for EPA, known as the *WQS-CWS Baseline Project*, were summarized and reviewed with this objective in mind. In addition, a survey was conducted for this Water Research Foundation project of state drinking water and TMDL administrators, as well as personnel from EPA's regional offices, to learn if and how the drinking water and TMDL programs were integrated at the state level and how that integration could be improved.

AMBIENT WATER QUALITY CRITERIA FOR POTABLE WATER SUPPLIES

EPA has developed ambient water quality criteria under CWA Section 304(a) for 126 priority pollutants. For most of these pollutants, Section 304(a) includes criteria to protect fresh and saltwater species of aquatic life from both acute and chronic effects as well as criteria to protect human health. Human health criteria are further divided into criteria to protect human health based on the consumption of "organisms only" (primarily fish) from the water body and human health based on the consumption of "water and organisms" (drinking water and fish).

EPA has not set human health criteria under Section 304(a) for all contaminants regulated as federal MCLs—this is because not all regulated chemical MCLs are considered to be priority pollutants under the CWA. However, where EPA has set human health criteria, the criteria are set at levels that are equal to or, more often, lower than MCLs.

States and other jurisdictions may adopt the CWA Section 304(a) criteria, modify these criteria to reflect site-specific conditions, or use another scientifically defensible method to develop criteria. Although EPA has not completed its review of state water quality criteria (as part of the WQS-CWS Baseline Project), based on preliminary reviews of publicly available state water quality standards, the following observations can be made regarding jurisdictions' use of human health criteria and MCLs to protect drinking water sources:

- More than two thirds of jurisdictions adopt criteria that are generally equivalent to the Section 304(a) human health criteria for water and organisms as the water quality criteria that protect drinking water sources.
- Approximately 10 jurisdictions adopt water quality criteria for toxic contaminants that are generally equivalent to MCLs. In more than half of these cases, criteria for some contaminants (e.g., nitrates, nitrite) are not adopted, and criteria for other contaminants (e.g., arsenic) are out of date. In some of the ten jurisdictions, human health criteria for water and organisms apply in addition to criteria equivalent to the MCLs. Where a state drinking water program sets drinking water MCLs that are more stringent than federal MCLs, ambient criteria that are set at MCL levels are equivalent to the state (and not Federal) MCLs.
- In almost half of jurisdictions, criteria intended to protect aquatic life apply to all waters designated as drinking water sources. This happens because the aquatic life

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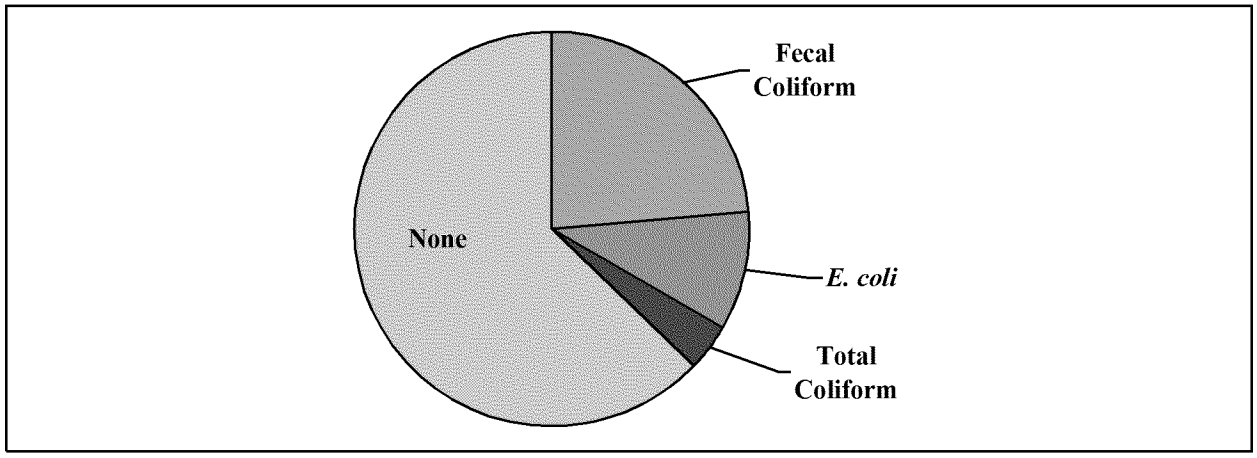

Figure ES.1 Microbiological criteria associated with states' water supply designated uses (not including Section 101(a) criteria that also apply to sources of drinking water)

criteria apply statewide, or because all drinking water sources are also designated for aquatic life.

With the recent passage of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), biological water quality criteria developed under the CWA provide an opportunity to improve source waters and avoid costly *Cryptosporidium* monitoring for smaller water systems. At this time, EPA provides recommended water quality criteria for bacterial indicators for waters designated for primary recreation (e.g., swimming), secondary recreation (e.g., boating), and shellfish harvesting. EPA has recommended states use *E. coli* or enterococci as the bacteria indicator for freshwater primary recreation waters and enterococci as the indicator for marine primary recreation waters since these indicators correlate more strongly to gastrointestinal problems than fecal coliform bacteria. Many states still use a standard for fecal coliform as the numeric criterion to protect water bodies designated for recreational uses.

EPA has not developed microbiological ambient water criteria specifically for drinking water sources. Several states, however, have adopted biological criteria that apply to drinking water sources, either directly or indirectly. Preliminary analysis of results from EPA's WQS-CWS Baseline Project provide the following observations regarding bacterial water quality criteria applying to drinking water sources (based on an analysis of publicly available state WQS):

- Nineteen of the 51 jurisdictions have established water quality criteria for bacterial indicators that directly support the drinking water designated uses. In the majority of these 19 jurisdictions, fecal coliform is the indicator organism used (see Figure ES.1).
- All but nine jurisdictions have established bacteriological water quality criteria that apply either "directly" (meaning they are associated specifically with drinking water use) or "indirectly" (meaning they are statewide or associated with another use such as recreation, but apply in all water bodies that also have a drinking water designated use) to drinking water sources.

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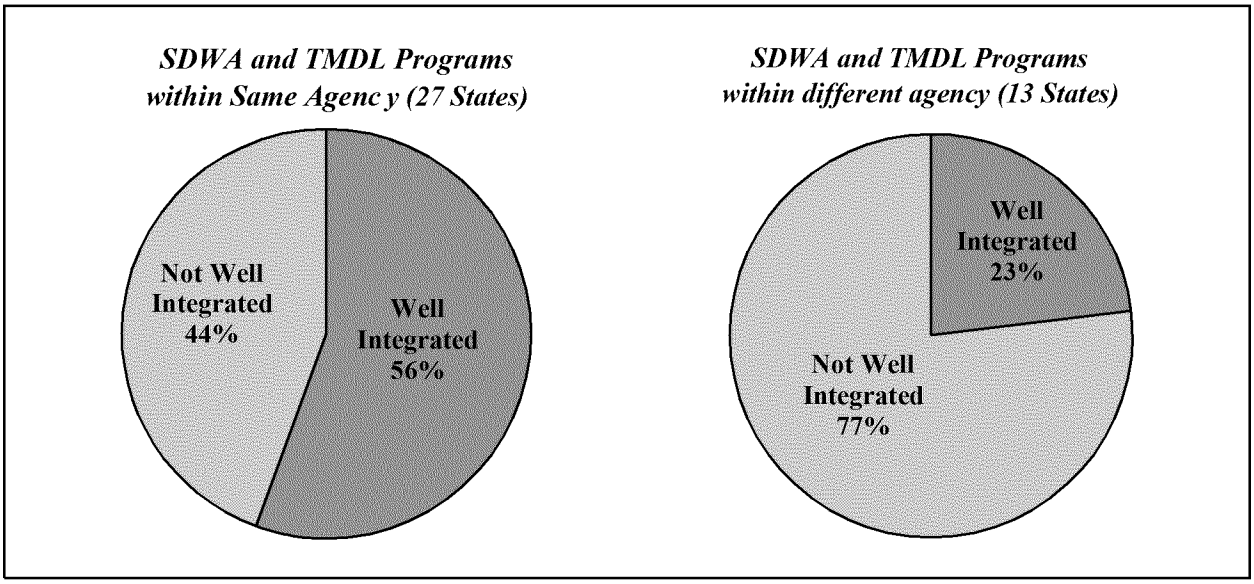

Figure ES.2 Survey responses regarding SDWA and TMDL program integration for states with SDWA and TMDL programs within the same agency (left) and different agencies (right)

SURVEY OF STATE DRINKING WATER AND TMDL ADMINISTRATORS

As part of the project, state drinking water administrators and state TMDL program managers were surveyed to solicit their input and experiences on current efforts to integrate particular aspects of the CWA and SDWA, and ways to further improve this integration. EPA Regional TMDL and SDWA personnel were also surveyed. In addition to obtaining information on integration efforts, the surveys elicited information on the following:

- If and how drinking water and source water protection interests are taken into account in the TMDL development process
- How drinking water uses and concerns are factored into TMDL prioritization
- What level of involvement drinking water utilities have in the TMDL development process.

Of the 40 states that responded to the surveys, 27 have both the drinking water and TMDL programs within the same state agency. Of these 27, 56 percent reported that the SDWA and TMDL programs were "well integrated." Of the 13 states with programs in different agencies, only 23 percent felt the programs were well integrated (Figure ES.2). In at least one state, the formerly separated programs have been combined into one division with a CWA and SDWA branch to facilitate coordination and integration.

Regardless of which agencies the two programs fall within, most states agree that it is important for staff to communicate across programs. As might be expected, this communication plays a large role in ensuring effective integration of the SDWA and TMDL programs.

One of the major challenges to improving integration of SDWA and TMDL programs is the dissimilarity between the two programs. The TMDL program focuses on exceedances of WQS in the water body, while the SDWA program focuses on the compliance of surface or groundwater with MCLs following treatment. As a result, WQS and MCLs are often developed using differing

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exposure and risk assumptions. Improvements in communication and integration are made more difficult when the SDWA and CWA programs are located in different agencies. Lack of funding and staff to provide coordination assistance and participate in cross-program activities further hampers integration efforts. Lack of policies and direction to promote integration as well as conflicting state programs and policies can exacerbate this situation.

While integration is improving in some areas, such as development of the CWA Section 305(b)/303(d) Integrated Report, improved communication between the programs is still needed. Since the CWA program is required to protect and report on drinking water uses, it is particularly important that the SDWA program contribute to accomplishing this task. Actions suggested by those surveyed that states can take are provided below.

Increase and Enhance Communication

- Conduct regular meetings among program staff as well as branch and division chiefs to facilitate coordination.
- Hold annual or semi-annual joint meetings of staff and directors from both programs.
- Investigate using an EPA-sponsored organization such as the Interagency Groundwater Committee or others as a tool for cross-program integration efforts.

Training

- Provide more cross-program training and presentations.
- Promote attendance at pertinent meetings, workshops, and trainings.
- Provide additional GIS training for staff in the CWA and SDWA programs.

Data Sharing/New Technologies

- Develop more data sharing mechanisms and GIS integration capabilities.
- Educate and train states and EPA Regions on EPA's new data systems, including the National TMDL Tracking System (NTTS) and Assessment, TMDL Tracking and Analytical Integrated National System (ATTAINS), which will offer enhanced capabilities for coordination between the CWA and SDWA programs.
- Use newer technologies like Web applications that can easily enable data sharing such as verification of intake latitudes and longitudes within a drinking water protection area.

Programmatic Integration

- Better utilize Source Water Assessment Program (SWAP) results when evaluating use support ratings within the 303(d) program.
- Develop a meaningful way to include drinking water criteria for use support ratings as well as elevating drinking WQS and criteria to the same level as aquatic organism protection.
- Include drinking water parameters such as *Cryptosporidium* and total organic carbon (TOC) as part of ambient monitoring programs for surface waters.

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Table ES.1
List of case studies of TMDLs involving drinking water utility

Columbus Water Works	Middle Chattahoochee River Watershed Fecal Coliform Bacteria TMDL
Winthrop Utilities, Maine	Upper Narrows Pond Total Phosphorus TMDL
Aqua America	Green Lane Reservoir Nutrients TMDL
Philadelphia Water Department	Wissahickon Creek Nutrients and Siltation TMDL
Santa Clara Valley Water District	Guadalupe River Watershed Mercury TMDL
Wilmington, Delaware	Christina River Bacteria and Sediment TMDL
Contra Costa Water District	Sacramento and San Joaquin TMDLs

- Increase awareness of TMDL development efforts across state programs as well as with utilities in impacted watersheds.
- Increase pooling and sharing of resources for joint projects.
- Educate each program on the objectives and limitations of the various funding sources.
- Continue sharing source water protection area information with CWA staff to ensure better decisions such as those related to permit issuance for wastewater discharges.
- Communicate and coordinate better when a facility is first proposed to ensure proper siting and minimize adverse regulatory effects on existing dischargers (e.g., prohibition of some discharges within a certain distance of a designated drinking water source).

CASE STUDIES

The case studies provided in this report describe how drinking water utilities have become involved in the TMDL process, the experiences they had during their involvement, the roles they played once involved, actions they took (or feel they should have taken) to steer the TMDL process to be more helpful in protecting drinking water, and lessons they learned from those experiences. A range of drinking water utility sizes, geographical locations and source water types were covered. Six of the seven utilities discussed have proceeded through most or all of the TMDL development process for their source waters. A seventh case study, for Contra Costa Water District (in Chapter 7), describes a drinking water utility in the process of charting a path for how to proceed with TMDL development. Table ES.1 lists the drinking water utilities for which case studies were prepared.

While some utilities participated actively during TMDL development, others were concerned primarily with staying informed and engaged. The following conclusions were drawn based on the utility case studies:

- Drinking water utility representatives can influence whether their source water body is listed on the state's 303(d) list.
- Involvement in the TMDL process helps water utilities keep up-to-date on watershed activities and decision-making about source water quality. It is also generally more constructive to provide input during the formulation and development of TMDL decisions rather than at the tail end of the process.
- It is important to participate in the TMDL stakeholder process as early as possible, especially where drinking water supplies are located downstream of regulated point

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source discharges. The importance of water quality sampling data, especially long-term, continuous water quality data, cannot be overstated.

- Older urban municipalities may be especially motivated to get involved in the TMDL process because they are often stakeholders in more than one way. They may be engaged in the watershed because of their water supplies, as managers of combined sewer overflows (CSOs) and municipal separate storm sewer systems (MS4s), as well as other permitted discharges. It is important that TMDLs developed for such a watershed are sufficiently protective of the source water quality for the water supply. It is also important, however, that pollutant loads assigned to permitted discharges are accurate and achievable.
- The state benefits from involving drinking water utilities in the TMDL process by achieving consensus from all interested parties as TMDL development progresses. This approach conserves state resources that would otherwise be spent on resolving differences among stakeholders about the conclusions of a TMDL report if it were prepared by one party.
- Every stakeholder looks at water quality from their own perspective. Drinking water utilities should approach the TMDL development process with an understanding of contaminant levels that can be tolerated without adverse impacts on their supply sources.
- The more data available to populate models used during TMDL development, the more accurately the TMDL will reflect conditions in the watershed. It is usually in the best interest of the water utility to gather data to fill gaps, or to provide to others additional data that the drinking water utility has already collected.
- Different water quality concerns under low flow and high flow conditions can be addressed by developing two TMDLs: one for water quality parameters under low flow conditions, and one for water quality parameters under high flow conditions.
- TMDL allocations can be modified if better water quality data are collected and presented to EPA and the states.
- It is often difficult to assess which of the beneficial projects and programs that have occurred in a watershed after the development of the TMDL might have happened anyway. Care should be taken by all stakeholders that projects or programs not be derailed or delayed on account of an adversarial atmosphere that may develop during TMDL preparation.
- A TMDL provides a measurable target. Whether the target is achievable, however, remains to be seen for most of the case studies. The TMDL can provide justification for more stringent limits on upstream discharges.
- TMDLs provide a way to prioritize limited funding for nonpoint BMPs in a watershed.

INVOLVING WATER UTILITIES IN THE TMDL PROCESS

During the project, tools were developed for utilities to use to help them navigate through the TMDL process. The tools are intended to provide helpful information about how the TMDL process works, provide definitions of terminology used, and help with decision-making. The following tools are included in this report:

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- Glossary of key terms and definitions
- Step-by-step description of the TMDL process and how utilities can get involved
- Flow chart to help utilities get started with the TMDL process
- Sample letter for utilities to use to request involvement in the TMDL process
- Useful TMDL web sites

The following recommendations are made to drinking water utilities based on the findings of the project's background review, surveys of state administrators, and case studies:

1. Educate yourselves. If you are confused by the TMDL process, refer to the tools provided in this report to learn the procedures involved with designating waters, developing 303(d) lists, setting ambient water quality criteria, setting WQS, and developing TMDLs. Call your state TMDL coordinator and ask any questions you may have. Embrace the philosophy that the only stupid question is the question you wanted answered but did not ask.
2. Understand that a TMDL may be under development for your source water based on impairment of a designated use other than it being a drinking water supply. Consider this an opportunity to get involved nonetheless. Engage in the process to ensure your water quality concerns are addressed, if possible. At a minimum, be involved enough to forestall any action that might interfere with your plans to protect your source water.
3. Check that your surface water source has been properly categorized by the state as a drinking water supply. Your source may have several designated uses, but check that drinking water supply, or potable water supply, is one of them.
4. Review the state ambient WQS for drinking water supplies to see if your source water fails to meet any of those standards. If it does, your source may be impaired and should perhaps be included on your state's 303(d) List of Impaired Waters. Review and (if necessary) comment on your state's draft 303(d) list to ensure your source water is appropriately represented. Water utility input on a 303(d) list can also result in higher prioritization of a drinking water source on the TMDL development list. The lists are submitted by states to EPA biennially.
5. Every participant and stakeholder looks at water quality from their own perspective. Approach the TMDL development process with an understanding of state WQS and how they relate to drinking water standards. In many states, acceptable levels of quality vary significantly between the CWA and SDWA programs. Utilities need to understand how the establishment of standards may impact water quality at their intakes. If you think your state's WQS are not protective enough, get involved in the state's triennial review process. You may be able to convince your state that different WQS should be adopted in order to protect potable water supplies more adequately.
6. Participate in the TMDL development and review process. If a TMDL is being developed for your source, provide source water quality data and any other input (e.g., intake location, susceptible areas) that may be instrumental for developing an accurate, protective TMDL.
7. Be proactive. Early involvement in the TMDL process will increase opportunities for water utilities to effectively communicate with interested parties and will allow the utility to provide input on its water quality goals and needs. By getting involved early, there will be greater opportunity for developing consensus among stakeholders during

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the TMDL process, rather than spending time and resources resolving differences after a TMDL has been developed.

8. Share data and information with participating organizations. Utilities often have water quality data that can help characterize the water body impairment(s) and help identify mitigation measures. Sharing this information can avoid duplication of effort, improve understanding, and conserve resources for new information collection activities. You may also have a recently completed source water assessment of the watershed or a sanitary survey that can provide helpful information for TMDL development. Although these are state-generated documents, offer to share this information in case it was not successfully transferred from the state's SDWA program to its TMDL program.
9. When participating in the TMDL process, you may be able to provide input on the selection of TMDL endpoints (which may need to be different in zones surrounding intakes), identification of potential sources of contamination, and selection of areas to focus pollutant reduction activities during the implementation of the TMDL. Encourage states to consider susceptible areas when allocating loads and developing reduction targets for TMDLs for potable water supplies. Susceptible areas are zones where potential contaminant sources or land use activities have the greatest potential to affect the water supply.
10. Finally, maintain reasonable expectations. Remember that a TMDL is basically a pollutant budget for a water body or segment of a water body. While TMDLs set loading caps for pollutants, they do not in themselves result in the attainment of those caps. Point source discharges are permitted and regulated based on their allocations in the TMDL. Most nonpoint sources, however, are not regulated and, as a result, most watersheds cannot enforce load allocations assigned for nonpoint sources.

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CHAPTER 1
INTRODUCTION

OVERVIEW

Drinking water is one of life's most important commodities. Our health and well-being depend on having a supply of safe drinking water. In much simpler times, this may have meant having a dependable well or a pristine stream nearby. The issue of clean drinking water is a lot more complex today. All across the country, surface water bodies (e.g., reservoirs, lakes, and rivers) are relied upon as sources of drinking water for drinking water utilities. Unfortunately, those water bodies are susceptible to contamination from a wide variety of pollutants originating from many different sources, including both anthropogenic (human-related or human-caused) and natural origins. Many of these contaminants can cause adverse health effects. Exposure to microbial pathogens in drinking water can lead to gastrointestinal illness, fever, diarrhea, and dehydration, among others. Extensive or repeated exposure to chemical contaminants can also cause a variety of adverse health effects, including cancer, neurological effects, reproductive and developmental outcomes, heart disease, diabetes, and immune system problems.

There are many reasons for drinking water utilities to be concerned about the quality of their source water. Controlling pollutants at their source (as opposed to removing them in the drinking water treatment process) can reduce potential human health risks, as well as reduce treatment costs. In terms of public health protection, good source water quality and development and implementation of source water protection programs are some of the multiple barriers that work together to provide safe water. From an operations perspective, the better the source water quality, the less money a drinking water utility will need to spend on treatment chemicals, equipment, and labor. While drinking water utilities can treat contaminated water and make it safe to drink, the treatment process can be expensive and associated costs are passed on to the water system's customers. Treatment for some contaminants can also be technically difficult and potentially result in unintended consequences. For example, all drinking water utilities that use surface water must disinfect to ensure pathogens are inactivated, but high organic content in surface water can combine with certain disinfectants and lead to an increase in disinfection-by-products (DBPs) that also pose health risks. Improved source water quality will also generally reduce customer complaints about taste and odor. Finally, compliance with drinking water regulations is made easier if source water concentrations of *E. coli*, *Cryptosporidium*, natural organic matter, nitrate, pesticides, metals, and other regulated contaminants are limited and controlled.

At the same time that utilities are becoming increasingly concerned about their source water quality, states are developing Total Maximum Daily Loads (TMDLs) for water bodies identified as not meeting water quality standards (WQS) for their designated uses as required by the Clean Water Act (CWA). Among these water bodies are those not meeting the designated use of potable water supply. There is a growing recognition that the management of drinking water systems and the development of TMDLs share some common goals, including addressing the quality and protection of water sources. In principle, it seems that the need for drinking water utilities to increase watershed protection is being answered by the development of TMDLs. In practice, however, efforts made by drinking water utilities and those made by watershed managers are often not in sync.

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Drinking water utilities tend to focus on the SDWA as the primary mechanism for protecting source waters. Although the SDWA and CWA programs are typically implemented independently of one another, there is a lot of overlap in activities between the two. This overlap should be taken advantage of by drinking water utilities, especially in times of resource constraints. For example, information and data developed as part of the TMDL assessment of a water body serving as a source for a public water supply can provide a basis for implementing local source water protection programs. The TMDL process (and other CWA programs) can serve as a powerful tool for protecting source waters from pollutants. Engaging themselves in the development of TMDLs and the watershed protection process will ensure that their utilities' needs and concerns are accurately and adequately addressed by both the SDWA and the CWA.

More than ever, it is in the interest of many drinking water utilities to get involved in their watershed protection process, including engaging themselves in the development of TMDLs, so their needs and concerns are accurately and adequately addressed. However, in order for drinking water utilities to participate effectively in the development of TMDLs, they need to understand the process. In 2003, the Water Research Foundation (the Foundation) and the Water Environment Research Foundation (WERF) sponsored a workshop that brought together regulators, drinking water utilities, and other stakeholders to discuss ways to better integrate the CWA and Safe Drinking Water Act (SDWA) programs. During the workshop, the importance of drinking water utility participation in the TMDL process was recognized as an area in need of additional research and development of tools. The Cadmus Group, Inc. (Cadmus) carried out a follow-up project sponsored by the Foundation to investigate and report on successful strategies used by drinking water utilities and other entities to protect source waters using the TMDL regulatory process.

PROJECT GOAL

The goal of this project is to provide drinking water utilities with information and tools that enable them to better utilize the TMDL process to protect and improve source water quality. The project goal was attained through the accomplishment of the following specific objectives:

- Investigate and report on successful strategies that have been used by drinking water utilities to protect source waters using the TMDL regulatory process; and
- Evaluate and describe specific measures that have been used to include drinking water objectives in TMDLs.

OVERVIEW OF THIS REPORT

Using the TMDL process to help protect drinking water sources can help assure that water bodies used as drinking water sources meet WQS protective of human health. Drinking water utility managers need to be concerned with all issues that affect their source water quality, and should utilize available tools to protect their water supplies. TMDLs are a tool drinking water utilities can use to protect the quality of their water supply and minimize expenses associated with drinking water treatment. Drinking water utility involvement, however, is key to ensuring that potable water bodies with impairments are given the appropriate focus and priority in the TMDL process. This report provides drinking water utilities with important information and useful tools that will enable them to engage in the TMDL process and better protect or improve their source water.

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CHAPTER 2
METHODS AND MATERIALS

This project was guided by a few general hypotheses. Efforts made during the project tried to address these hypotheses, as well as characterize additional features related to the project's goal. The hypotheses posed are:

- State programs responsible for implementing the TMDL and SDWA could work together more efficiently and effectively.
- WQS assigned to water bodies designated as potable water supplies could address the water quality concerns of drinking water utilities more directly.
- Tools and guidance materials need to be provided specifically for drinking water utilities to help them learn how to navigate the TMDL process.
- The inability to enforce load allocations for nonpoint sources can be a major impediment to TMDL implementation and, as a result, utilities may be skeptical about the effectiveness of TMDL implementation.

The following summarizes the activities that were carried out in order to meet the project objectives.

LITERATURE REVIEW AND SYNTHESIS

A detailed literature review was conducted on: 1) the range of pollutants for which TMDLs are currently being developed, and 2) the effects of TMDL regulations on drinking water quality. The literature review focused on publications and reports that specifically address drinking water quality, or source water quality issues that have a direct impact on drinking water quality. Chapter 3 summarizes some of the information obtained during the literature review, which includes the following topics: Designated uses, WQS and Maximum Contaminant Levels (MCLs), CWA Section 303(d) list development, and TMDL development; the chapter also provides a list of pollutants for which TMDLs are being developed.

The literature review also included a review of state WQS and the basis for states' WQS for the protection of drinking water supplies. As part of a different project, EPA's Office of Ground Water and Drinking Water and its Office of Science and Technology tasked Cadmus to provide EPA with support in the analysis of publicly available WQS regulations. The goal of that project (known as the *Water Quality Standards – Community Water Systems (WQS-CWS) Baseline Project*) was to determine the percentage of surface water intakes in waters designated as drinking water sources and to begin establishing a national inventory of WQS that support drinking water sources. For the current project, the relevant results of the *WQS-CWS Baseline Project* were reviewed and summarized in Chapter 4 of this report.

STATE SURVEYS

State drinking water administrators and state TMDL program managers were surveyed as part of the project to solicit their input and experiences on current efforts to integrate particular

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aspects of the CWA and SDWA, and ways to further improve this integration. EPA Regional TMDL and SDWA staff were also surveyed. In addition to obtaining information on integration efforts, the surveys also elicited information on the following:

- If and how drinking water and source water protection interests are taken into account during the TMDL development process
- How drinking water uses and concerns are factored into TMDL prioritization
- What level of involvement drinking water utilities have in the TMDL development process.

Three different versions of the survey were developed – one for state drinking water program administrators, one for state TMDL program managers, and one for EPA Regional drinking water and TMDL staff. Copies of each of the three surveys can be found in Appendix A. Input from the Association of State Drinking Water Administrators (ASDWA) was obtained when developing the survey of state drinking water program administrators. That survey was then modified for the state TMDL program managers. The EPA Regional survey was developed as a combined questionnaire, soliciting responses from drinking water and TMDL coordinators (or their program staff) for each region.

Hard copies of the state drinking water administrator surveys were initially distributed to attendees at the ASDWA Annual Conference in Boca Raton, Florida October 2–4, 2007. Following the conference, electronic copies were sent to states not approached or in attendance at the meeting. Electronic copies of the TMDL program manager's survey were initially distributed to states on October 22, 2007. The Regional drinking water and TMDL program manager surveys were sent electronically to the 10 EPA Regions on December 17, 2007. Follow-up was conducted between November 2007 and January 2008 with those states and Regions that had not yet returned a completed survey.

In order to promote full discussion of the issues, states and the EPA were informed that no specific references to individual states or regions would be included in this report or otherwise released. A summary of the survey responses is provided in Chapter 5 of this report.

DRINKING WATER UTILITY CASE STUDIES

The purpose of the case studies is to describe how drinking water utilities have become involved in the TMDL process, the experiences they have had during their involvement, the role they played once involved, the actions they took (or feel they should have taken) to steer the TMDL process to be more helpful in protecting drinking water, and lessons they learned from those experiences. Table 2.1 lists the drinking water utilities for which case studies were prepared. Chapter 6 provides the case studies, as well as a summary of key findings and themes found during their preparation.

TOOLS FOR DRINKING WATER UTILITIES

The findings of the state administrators' surveys and the results of the drinking water utility case studies, as well as discussion with this project's Project Advisory Committee, provided guidance on what tools and information would be helpful to develop for drinking water utilities trying to learn more about the TMDL process. The following information and tools were developed to

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Table 2.1
List of case studies of TMDLs involving drinking water utility

Columbus Water Works	Middle Chattahoochee River Watershed Fecal Coliform Bacteria TMDL
Winthrop Utilities, Maine	Upper Narrows Pond Total Phosphorus TMDL
Aqua America	Green Lane Reservoir Nutrients TMDL
Philadelphia Water Department	Wissahickon Creek Nutrients and Siltation TMDL
Santa Clara Valley Water District	Guadalupe River Watershed Mercury TMDL
Wilmington, Delaware	Christina River Bacteria and Sediment TMDL
Contra Costa Water District	Sacrament and San Joaquin TMDLs

help drinking water utilities get more involved in the TMDL process (these tools can be found in Chapter 7):

- Glossary of key terms
- Simplified illustration of the key steps in the TMDL process within the framework of the CWA along with opportunities for drinking water utility involvement during each step of the process
- Decision tree to assist drinking water utilities in figuring out if and when they should become involved with the TMDL development process for their source water
- Sample letter for drinking water utilities to use to request to the state that they be involved in the TMDL planning, development, and implementation process for their source water
- List of useful Web sites links for state, EPA, and other useful TMDL programs
- State TMDL contact information

In addition, an article explaining the fundamentals of the TMDL process was prepared and will be submitted for publication in AWWA's *Opflow*. This publication was chosen because it seems to be the journal that is read by most water drinking operators and managers, especially those who help run smaller utilities.

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CHAPTER 3
THE TMDL DEVELOPMENT PROCESS

Federal and state drinking water programs work to ensure that the water we drink is safe. Some of these programs provide opportunities to build on existing efforts to protect sources of drinking water from chemical and biological contamination. One example is through the development of TMDLs. Required by the CWA for impaired water bodies, TMDLs can be a useful tool to help protect source water. This chapter provides a summary of the TMDL process within the framework of the CWA (Figure 3.1). Chapter 7 ("Tools") identified and discusses potential opportunities for drinking water utilities involvement for each of the steps in Figure 3.1.

DESIGNATED USES UNDER THE CLEAN WATER ACT

Under the CWA, states, territories, and other jurisdictions* must establish designated uses, which are the functions each water body is intended to support within its boundaries.

Examples of designated uses include fishing, swimming, or use as a drinking water source. The designated uses reflect the activities that currently occur or that should be attained or achievable in the water body, regardless of whether conditions in a water body currently support the designated use. Ambient water quality criteria are then established to protect the designated uses. Therefore, a critical component of protecting drinking water sources through the TMDL process is ensuring that all surface water bodies that serve as drinking water sources are properly designated as such.

Commonly Referenced CWA Sections

§101(a) CWA goals and policies
§106 Pollution control program grants
§301(b) Effluent limitations
§303(c) WQS and implementation plans
§303(d) TMDL
§305(b) Water quality assessments
§304(a) Ambient water quality criteria
§306 National standards and performance
§319 State NPS management program
§402 NPDES

Recognizing the interconnection of CWA and SDWA goals, EPA's Office of Ground Water and Drinking Water and Office of Science and Technology recently analyzed state and other jurisdictions' designated uses and publicly available WQS regulations to establish a national inventory of WQS that support drinking water sources. Cadmus provided EPA with technical support for this study, which is known as the *Water Quality Standards – Community Water Systems (WQS-CWS) Baseline Project.* In addition to reviewing states' EPA-approved WQS regulations, the *WQS-CWS Baseline Project* involved the compilation of information on use designations designed to meet the CWA Section 101(a)'s "fishable," swimmable" goals. The *WQS-CWS Baseline Project* also compiled Section 303(c) public water supply use designations to determine how states describe sources designated as drinking water sources. More details about this study, including key findings, are discussed in detail in Chapter 4 of this report.

* For example, federally authorized tribes.

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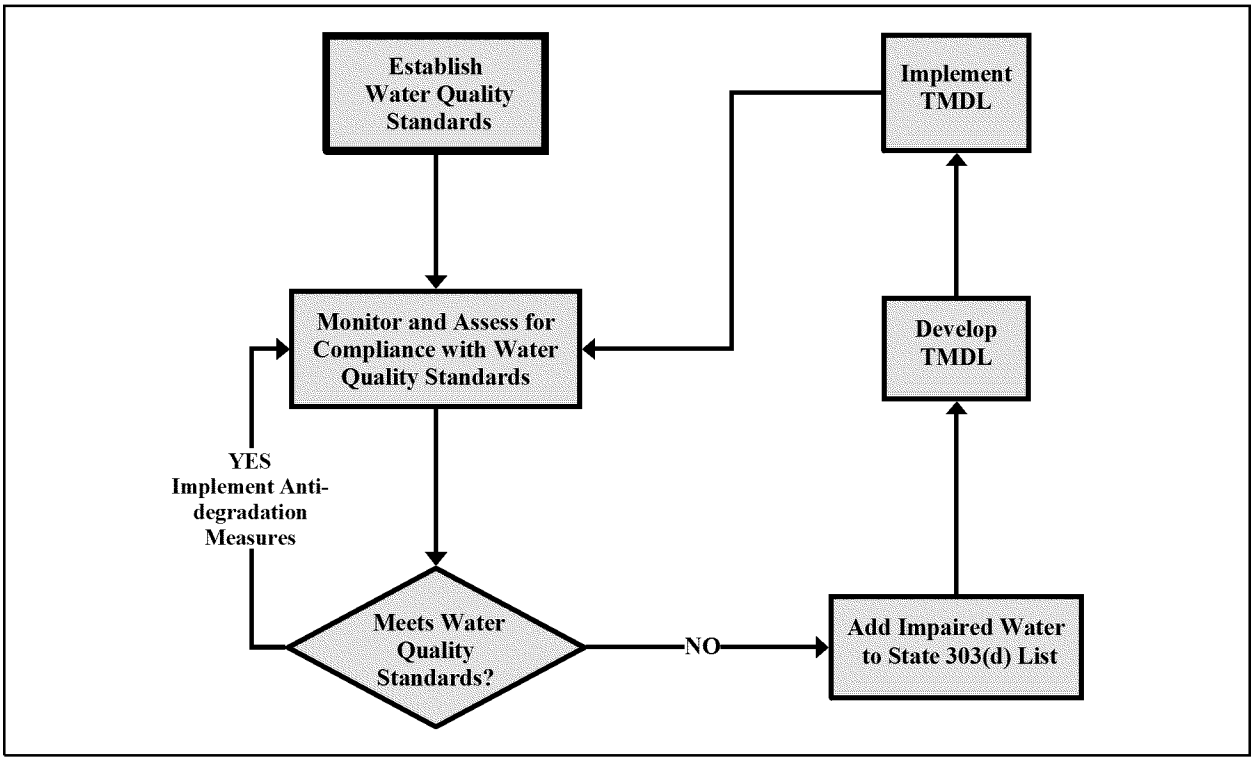

Figure 3.1 TMDL process within the Clean Water Act framework

WATER QUALITY STANDARDS AND MAXIMUM CONTAMINANT LEVELS

In addition to designated uses, states must also establish ambient water quality criteria that protect these designated uses. CWA Section 303(c) requires states to adopt WQS that protect public health or welfare. WQS define the goals for all of the state's surface water bodies. This is accomplished by designating the use or uses to be made of the water body, by setting criteria necessary to protect the uses, and by protecting water quality through antidegradation regulatory provisions. WQS serve dual purposes: in addition to establishing the water quality goals for a specific water body, WQS also serve as the regulatory basis for establishing water quality-based controls and strategies beyond the technology-based levels of wastewater treatment required by CWA Sections 301(b) and 306 (EPA 1994).

The CWA requires states to adopt numeric criteria for 126 priority toxic pollutants, for which the Agency has published criteria under Section 304(a) of the CWA, if the discharge or presence of the pollutant can reasonably be expected to interfere with designated uses. In adopting criteria, states may utilize the human health and aquatic life criteria that EPA publishes under Section 304(a) of the CWA, modify these criteria to reflect site-specific conditions, or use another scientifically defensible method to develop criteria. States typically adopt both numeric and narrative criteria. Narrative criteria describe goals associated with the health of the water quality. Examples of narrative criteria that might protect drinking water sources include "free from conditions injurious to human or aquatic health" or "no toxics in toxic amounts." Such criteria provide an additional level of protection for drinking water sources. There have been many TMDLs developed for water bodies in which a violation of narrative WQ criteria triggered the 303(d) listing, primarily for nutrient criteria. In such cases, one of the first steps in the TMDL development

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process involves translating the narrative criteria into a site-specific numeric target for the TMDL for that particular water body.

The CWA requires each state to review its WQSs, including designated uses and water quality criteria, every three years. The review must consider the use and value of the water as a drinking water supply. When WQS are adopted to protect public water supplies and prospective supplies, these standards can be enforced under state or federal laws to control pollution. Some states adopt ground WQS that work much like the Federal WQS program for surface water.

The SDWA was established, among other reasons, to ensure that public drinking water systems are free of potentially harmful materials. This mandate is carried out through National Primary Drinking Water Regulations which include imposition of wellhead protection requirements, MCLs, monitoring requirements, treatment standards, and regulation of underground injection activities. MCLs represent the highest level of a contaminant allowed in drinking water at the tap.

Identifying the Level of Protection That Applies at Drinking Water Intakes

States identify and define levels of protection for source waters in their WQS regulations. These are generally located in the water quality area of state Web sites. EPA-approved WQS for each jurisdiction can be found at http://www.epa.gov/waterscience/standards/wqslibrary/. These WQS define the protection provided for drinking water sources in each jurisdiction and describe which water bodies are protected.

EPA's Water Quality Standards Database (WQSDB), located at http://www.epa.gov/wqsdatabase/, includes state-approved information on designated uses for all states, the District of Columbia, two territories, and one tribe. Of those, 33 jurisdictions also have tables of designated uses by water body, and of those, 30 also have maps of those uses.

The ambient water quality criteria developed for waters designated as drinking water sources can be effective pollution management tools. They can help prevent public water systems (PWS) that use surface water from exceeding MCLs as a result of preventable pollution. For some PWS, this could mean both reduced monitoring and reduced need for new or more expensive treatment technologies.

SDWA regulations focus on finished water that is safe for human consumption (as opposed to WQS, which focus on source waters). In many cases, MCLs for finished drinking water and WQS for untreated surface waters for the same contaminant are different on account of the differing basis upon which they were established and the differing points of compliance. However, states are increasingly taking steps to adopt MCLs as numeric criteria to protect surface water bodies designated as public water supplies. Adoption of MCLs as ambient water quality criteria helps to:

- Reduce the likelihood that source waters for public water systems will degrade to levels that exceed an MCL and cause public water system noncompliance problems.
- Assess water quality conditions and establish protective discharge limitations for point source discharges where appropriate.
- Ensure that numeric criteria are available when needed (e.g., for TMDL development) for all substances regulated under the SDWA or addressed by the CWA.
- Reduce the potential for over-burdensome drinking water utility treatment costs.

Despite significant efforts to develop WQS that are protective of drinking water uses, there are still many contaminants for which the human health criterion (upon which a WQS is based) is less stringent than the MCL.

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EPA Region 8 developed a document titled, *List of MCLs Recommended for Adoption into State/Tribal Water Quality Standards to Protect the Water Supply Designated Use* for the Region's states to use when reviewing and updating numeric criteria for water bodies designated for water supply (EPA 2004). This list (Appendix B) identifies MCLs for priority and non-priority pollutants where either the MCL is more stringent than the CWA human health criterion, or an MCL has been promulgated but no CWA human health criterion is available. Although in many cases it is appropriate to adopt MCLs as numeric criteria to protect water supply use, it is important to note that there are cases where EPA does not recommend the adoption of MCLs as state WQS. For example, some MCLs may be less stringent than the available human health-based water quality criterion on account of the MCL being based on non-health factors, such as the cost and availability of treatment or the detection limit of an analytical method. Where human health-based criteria are available and are lower than an MCL, states should avoid adoption of MCLs developed on a non-health basis. Drinking water utilities should make it a priority to get involved with their state's triennial review process to ensure their source waters are properly designated as a drinking water source and water quality criteria are adopted that adequately protect their source waters.

CWA SECTION 303(D) LIST DEVELOPMENT AND TMDL PRIORITIZATION

CWA Section 303(d) requires states to identify all waters that do not meet WQS. Water bodies not meeting WQS are considered impaired and listed on a state's CWA Section 303(d) List of Impaired Waters, which is submitted to EPA for review and approval on a biennial basis. In August 1999, EPA issued proposed revisions to the TMDL regulations; the proposed rule was formally released by EPA in July 2000 (EPA 2000). The Proposed Rule was highly controversial, receiving about 32,000 comments. On account of its overwhelming unpopularity, EPA withdrew the proposed rule in December 2002. Among other things, the proposed rule would have required that high priority be given to water body segments that served as public drinking water supplies, where water suppliers were continuing to violate MCLs. EPA received many comments objecting to the requirement that states take into account contribution to a violation of an MCL in a source water designated for public water supply use. The most common criticism of the public water supply ranking factor was that the EPA proposal seemed to be applying the SDWA MCL to the raw water supply, rather than to the tap. Some comments, however, indicated that it was imperative to consider such situations as high priority, regardless of other, possibly mitigating, factors.

Regardless of the outcome of the proposed rule, states are still required to publish an updated list of impaired water bodies not meeting their designated uses every two years. When developing their 303(d) lists, states, territories, and authorized tribes establish a priority ranking of the listed water bodies that takes into account the severity of impairment and the uses of the water (e.g., fishing, swimming, and drinking water). It is imperative that drinking water utilities review and (if necessary) comment on draft 303(d) lists. Drinking water utility input on a 303(d) list can result in higher prioritization of a drinking water source on the TMDL development list.

TMDL DEVELOPMENT

CWA Section 303(d) requires states to develop TMDLs for water bodies on the 303(d) list. A TMDL is a calculation of the maximum amount of a pollutant a water body can receive and still meet WQS. TMDLs serve as a tool for implementing WQS. The TMDL targets or endpoints represent a number where the applicable WQS and designated uses (e.g., such as public water supply,

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contact recreation, and the propagation and growth of aquatic life) are achieved and maintained in the water body of concern. TMDLs identify the level of pollutant control necessary to meet WQS and support the designated uses of a water body. Common pollutants for which TMDLs are developed include sediments, fecal coliform bacteria, pH, nutrients, metals, and toxic chemicals.

The CWA requires states to provide opportunity for stakeholder involvement in the development of the 303(d) list, as well as TMDLs. This is a key opportunity for drinking water utilities to leverage non-SDWA programs to assist with the protection of public water supplies for which TMDLs are needed. Greater involvement in TMDL processes can yield a number of benefits to drinking water utilities, including:

- Improved source water quality
- Reduced risks to public health through reduced source water contamination
- Reduced treatment processes and costs including decreases in the amount of chemicals necessary for treatment processes
- Reduced disinfection byproducts
- Increased raw water reservoir volumes through reduced sediment loads in the source
- Good public relations
- More efficient regulatory interactions
- Improved availability of water quality information
- More effective planning

By participating in the TMDL process, drinking water utilities can provide input on the selection of TMDL endpoints, the identification of potential sources of pollution, as well as the selection of areas to focus pollutant reduction activities during the implementation of the TMDL. Drinking water utilities can also encourage states to consider susceptible areas when allocating loads and developing reduction targets for TMDLs for potable water supplies. Susceptible areas are zones where potential contaminant sources or land use activities have the greatest potential to affect the water supply. Susceptible areas take into account the location of potential contaminant sources with respect to hydrologic features, soil permeability, and land use.

SUMMARY OF POLLUTANTS FOR WHICH TMDLs ARE DEVELOPED

Since October 1, 1995 approximately 33,778* TMDLs have been developed (and approved by EPA) for greater than 200 different types of pollutants (EPA 2008a). Table 3-1 lists the major groups for which TMDLs have been established and the number of TMDLs within each group (at the time this report was developed).

As illustrated in Table 3-1, TMDLs have been developed for a wide range of pollutants. The following is a description of the pollutant groups most applicable to public water systems. The pollutant groups include: pathogens, nutrients, inorganic compounds, sediments, pesticides, and temperature.

* As of June 1, 2008.

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Table 3.1
Major categories of pollutants for which TMDLs have been established since October 1, 1995 (information accurate as of June 1, 2008)

Pollutant	Number of TMDLs	Percentage of All TMDLs
Mercury	6043	17.9
Pathogens	6012	17.8
Metals (other than Mercury)	5563	16.5
Nutrients	3507	10.4
Sediment	2657	7.9
Organic Enrichment/Low Dissolved Oxygen	1638	4.8
Salinity/Total Dissolved Solids/Chlorides/Sulfates	1402	4.2
pH	1388	4.1
Temperature	1312	3.9
Ammonia	959	2.8
Pesticides	927	2.7
Turbidity	762	2.3
Chlorine	336	1.0
Polychlorinated Biphenyls (PCBs)	278	0.8
Other Cause	196	0.6
Toxic Inorganics	184	0.5
Cause Unknown - Impaired Biota	124	0.4
Toxic Organics	124	0.4
Total Toxics	92	0.3
Habitat Alterations	83	0.2
Algal Growth	67	0.2
Trash	44	0.1
Noxious Aquatic Plants	22	<0.1
Radiation	21	<0.1
Dioxins	17	<0.1
Oil and Grease	12	<0.1
Taste, Color and Odor	5	<0.1
Nuisance Exotic Species	2	<0.1
Fish Consumption Advisory	1	<0.1

Source: EPA 2008a.

Pathogens

With more than 6,000 TMDLs, pathogens is one of the top impairments for which TMDLs have been developed (EPA 2008a). This group includes indicators of fecal contamination (fecal coliform, *Escherichia coli*, total coliform, and enterococci), as well as beach closures and specific pathogens. Pathogens are microorganisms that cause disease. They include certain bacteria, viruses, protozoa, and other organisms. Some pathogens are commonly found in surface water, frequently as a result of untreated or partially treated fecal matter entering the water body from sewage discharges, leaking septic tanks, and nonpoint source runoff. Ingestion of waterborne pathogens can cause diseases such as hepatitis, giardiasis, and dysentery. Testing water for each of these contaminants would be difficult and expensive. Instead, water quality and public health officials measure coliform levels as an indicator of pathogens. The presence of coliforms in water suggests that there may be disease-causing agents in the water.

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In terms of the SDWA and its regulations, The Total Coliform Rule established both the health goals (MCLGs) and legal limits (MCLs) for total coliform levels in finished drinking water in public water systems (EPA 1989) There have been waterborne disease outbreaks in which researchers have found very low levels of coliforms; therefore any level indicates some potential health risk As a result, in the Total Coliform Rule, EPA set the MCLG for total coliforms at zero EPA also set an enforceable limit on total coliforms of no more than 5 percent of the samples taken at a water system in a month may be positive for total-coliforms Exceeding this limit represents a failure to meet the drinking water standard and is a total coliform MCL violation If total coliforms are detected, then the sample medium must be further analyzed to determine if fecal coliform or *E. coli* are present If present, the system must determine if a violation has occurred and report violation information to the state and the public (EPA 2006b)

The primary treatment methods for removing pathogens from water include some degree of filtration, often with chemical coagulation to form particulates large enough that they can be removed through the filtration process The Long Term 2 Enhanced Surface Water Treatment Rule (EPA 2006a) requires surface water systems to provide source water monitoring for *E. coli* and/or *Cryptosporidium* and to provide additional treatment for systems with high source water *Cryptosporidium* levels A reduction in the concentration of pathogens in the untreated source water would help water utilities avoid these additional treatment needs

The primary treatment methods used for the inactivation of pathogens in water are chlorine, ozone, and ultraviolet irradiation (UV) There are numerous alternative disinfection processes that are less widely used, including chlorine dioxide, chloramines, and peroxone (ozone/hydrogen peroxide) Some of these disinfectants can react with naturally-occurring materials in the water to form DBPs such as trihalomethanes (THMs), haloacetic acids (HAAs), chlorite, and bromate (EPA 2006b) Most of these DBPs are suspected carcinogens and may lead to increased health risks if consumed in excess of EPA's standards over many years While EPA has developed rules to protect public health by limiting exposure to these DBPs, another obvious method to protect against exposure to DBPs, as well as pathogens, is to minimize the amount of pathogens entering the source water supplies to, in turn, minimize the disinfectant necessary to inactivate those pathogens

Nutrients (and Organic Enrichment)

More than 3,500 TMDLs have been established for nutrients, which include phosphorus, nitrogen, nitrates, nutrients, and eutrophication, among others The Organic Enrichment/Low Dissolved Oxygen Pollutant Group includes measures of pollution such as dissolved oxygen, biological oxygen demand (BOD), and total organic carbon (TOC) levels Nitrogen and phosphorus are nutrients and are necessary to support life in aquatic ecosystems However, excess nutrients are detrimental to water quality and cause excessive algal and plant growth, which creates problems for many uses of water resources, including drinking water Wastewater treatment plant discharge, nonpoint source runoff, and atmospheric deposition are the primary causes of increased levels of nutrients in surface waters Excess nutrients in source water can result in an overabundance of algae, which can cause unpleasant tastes and odors in drinking water As a result, the costs associated with treating drinking water for taste and odor increase

Excessive nitrogen in drinking water supplies can also result in high levels of nitrates or nitrites that pose a threat to public health Nitrates and nitrites can be very toxic at high enough concentrations Excessive amounts of nitrate and nitrite can cause methemoglobinemia in infants, also known as "blue-baby syndrome " To safeguard the public from nitrates and nitrites, the

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federal MCLs for nitrate and nitrite in public water systems are 10 mg/l and 1 mg/l, respectively. Fertilization of agricultural and urban land (i.e., lawns and golf courses) with ammonium nitrate and runoff from livestock operations are the key sources of nitrate contamination.

Elevated levels of nutrients and organic matter in raw water supplies can also indirectly contribute to significant health effects caused by DBP's. Disinfectants, such as chlorine, that are added to drinking water may combine with organic matter to form DBPs. The Stage 1 D/DBP Rule requires surface water systems using conventional treatment to measure and remove from their water TOC, a DBP precursor. Excessive nutrient loading can increase TOC concentrations in source water and, as a result, increase the cost of treatment for TOC removal.

Many states do not currently have numeric criteria for nitrogen or phosphorus. Instead, states address nutrient impairments on a case-by-case basis, using narrative criteria or a surrogate target (e.g., chlorophyll *a*) as the basis for a TMDL endpoint. Narrative criteria are challenging to assess because the relationships between nutrient levels and impairment of designated uses are not clearly defined. For example, New Mexico's narrative criteria for nutrients reads as follows: *"Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in a dominance of nuisance species in surface waters of the state"* (NMAC 2005). Some argue that having numeric standards for nitrogen and phosphorus would result in greater reductions in sources of nutrient pollution, as well as increased efforts to modernize aging wastewater treatment plants. Looking across the border, the Canadian Ministry of Environment has established a stringent 10 mg/L phosphorus criterion for lakes used as sources of drinking water in order to minimize treatment costs and reduce risk of taste and odor problems associated with algae (Chambers et al. 2001). If drinking water utilities believe it is in the best interest of their water supplies that numeric nutrient criteria be developed to protect their source of water, they should engage with state staff working on WQS and criteria.

Inorganic Compounds

Inorganic compounds (IOC) consist of substances that do not have carbon in their composition. Two major classes of inorganic compounds are metal and non-metals. A top pollutant category for established TMDLs is the National Metals (other than Mercury) Pollutant Group. This group includes several of the IOCs regulated in finished drinking water of public water systems. Most IOCs occur naturally in the environment and are soluble in water; however, not all IOCs originate from natural sources. Industrial activities such as metal finishing, textile manufacturing, mining operations, electroplating, and manufacturing of fertilizers, paints, and glass also generate IOCs.

IOCs are toxic to humans at certain levels. Cadmium, chromium, and selenium can cause damage to the kidneys, liver, nervous and circulatory systems. Barium has been associated with high blood pressure and mercury has also been shown to damage kidneys. Antimony, arsenic, beryllium, cyanide, nickel, and thallium have been shown to damage the brain, lungs, kidneys, heart, spleen, and liver. IOCs can also cause aesthetic or nuisance problems for drinking water supplies. Some metals can form deposits in pipes, reducing their capacity and creating the potential for problems associated with sloughing of metal-rich scales under variable flow conditions. Manganese and iron can lead to offensive tastes and appearances in drinking water, as well as staining laundry and fixtures.

IOCs can be removed from drinking water using various available technologies such as coagulation/filtration, lime softening, reverse osmosis, ion exchange, chlorine oxidation, and

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activated alumina. Increased levels of IOCs in drinking water source waters can in turn result in increased treatment costs.

Surface water quality criteria for metals can be more or less stringent than health-based MCLs because the water quality criteria are typically developed to support uses related to aquatic life. It is important that a drinking water utility ensures its source is assigned the proper designated use as a drinking water supply so it is assessed using the appropriate WQS.

Sediments and Turbidity

Nearly 4,000 TMDLs have been established for sediment and turbidity impairments. The primary pollutants in the sediment group are sediment and siltation. In the turbidity group, the primary pollutants are total suspended solids (TSS) and turbidity. The groups are of similar importance to water sources used by public water systems because they reflect the solids load to be removed by the water treatment processes.

Turbidity is a measure of the cloudiness of water and is used to indicate water quality and filtration effectiveness (EPA 2006a). Higher turbidity levels can be associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria. High turbidity resulting from increased soil runoff can significantly burden drinking water treatment systems.

Excessive suspended sediment in water bodies with drinking water intakes can damage water treatment pumps and other equipment, resulting in periodic shutdowns for plants and increased treatment costs to remove the sediments from the drinking water. In addition, excessive sedimentation also reduces reservoir capacity, resulting in a more frequent need for dredging of the raw water reservoir.

Excessive sediments are most commonly delivered to surface waters by overland runoff. Installing erosion control measures, buffers, and implementing other best management practices (BMPs) are the key methods for minimizing runoff of sediments from land. While it is not the sole responsibility of drinking water utilities to ensure that their water supplies are protected by BMPs and buffers, it is in their best interest to work with the state and local agencies on their installation and maintenance. Preventive practices (such as BMPs) are a more cost-efficient approach to reducing sediment loads than removing and disposing of the sediments during the treatment process.

Pesticides

The range of pesticides for which TMDLs have been established includes several pesticides regulated in drinking water, and several others that are not regulated. Pesticides are chemicals used to control insects, weeds, bacteria, fungus, rodents, fish, or other troublesome organisms. Pesticides make their way into surface water drinking supplies via several pathways. Pesticides run off or leach into water bodies from nearby farms, yards, and golf courses. Even if applied correctly, pesticides may wash away from the application site if rain events occur before they have a chance to bind or degrade. Pesticides also make their way into surface water bodies through aerial application. Atrazine, a common herbicide used in corn production to control weeds, has regularly been detected in water supplies across the country. Atrazine has been linked with reproductive disorders and with breast tumors. Atrazine TMDLs are becoming more common.

Ingestion of pesticides in drinking water can be harmful to human health. Specific health effects of pesticides depend on their chemical characteristics. Many pesticides contain ingredients that may pose carcinogenic or other health risks to the population served by the water supply.

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Some pesticides can also cause adverse reproductive effects. Pesticides can be expensive and difficult to remove from drinking water. There have been cases where pesticide contamination has resulted in the abandonment of the drinking water supply.

Temperature

TMDLs for water temperature include temperature effects caused by industry as well as riparian shade and other thermal modifications. Increases in water temperature can contribute to increased algae growth, as well as lead to accelerated corrosion of water supply pumps, piping, and equipment. Common causes of increases in water temperature include elimination of shade provided by trees and other vegetation along the shoreline and thermal discharge from wastewater treatment facilities.

HOW DRINKING WATER UTILITIES CAN GET INVOLVED IN THE TMDL PROCESS

The following are ideas for ways in which drinking water utilities can get involved with the TMDL process. Chapter 6 provides case studies of the roles that six different drinking water utilities played in the development of TMDLs for their source waters, as well as additional examples of several TMDLs developed for pollutants impacting drinking water supplies.

- Check that your surface water source has been properly categorized by the state as a drinking water supply. Your source may have several designated uses, but check that drinking water supply, or potable water supply, is one of them.
- Review the state ambient WQS for drinking water supplies to see if your source water is not meeting any of those standards. If it isn't, your water body may be impaired and perhaps should be included on your state's 303(d) List of Impaired Waters.
- If you think your state's WQS are not protective enough, get involved with the state's triennial review process. You may be able to convince the state that different WQS should be adopted in order to protect potable water supplies more adequately.
- Review and, if warranted, comment on your state's 303(d) List of Impaired Waters to ensure your source water is represented. The lists are submitted by states to EPA biennially.
- Participate in the TMDL development and review process. If a TMDL is being developed for your water source, provide source water quality data and any other input (e.g., intake location, susceptible areas) that may be instrumental to developing an accurate, protective TMDL. Figure 3.1 provides a flowchart that explains the TMDL development process.

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CHAPTER 4
FINDINGS OF EPA COMPILATION OF WATER QUALITY STANDARDS

Recognizing the interconnection of CWA and SDWA goals, EPA's Office of Ground Water and Drinking Water and its Office of Science and Technology tasked Cadmus to provide EPA with support in the analysis of publicly available WQS regulations. The goal of the project was to determine the percentage of surface water intakes in waters designated as drinking water sources and to begin establishing a national inventory of WQS that support drinking water sources. This study, known as the *Water Quality Standards – Community Water Systems (WQS-CWS) Baseline Project*, was a part of EPA's Strategic Plan.

To assure this project served the common interests of all participants, a national workgroup was established with representatives from states and EPA regions to make recommendations to senior EPA management of the WQS and Source Water Protection programs regarding the analyses and use of these data. EPA's analysis focused on these questions:

- Do states and other jurisdictions define designated uses for public water supplies?
- How are these designated uses described?
- Are drinking water intakes located in water bodies that benefit from these designations?
- What ambient water quality criteria apply to water bodies that are designated as drinking water sources?
- To what extent do ambient water quality criteria that protect drinking water sources address the range of parameters regulated by MCLs?

STATES' DRINKING WATER DESIGNATED USES

Copies of states' EPA-approved WQS regulations, current as of December 2006, were reviewed. The review included information on Section 101(a) use designations (designed to meet the CWA's "fishable," swimmable" goals), as well as Section 303(c) public water supply use designations, to determine how jurisdictions* describe sources designated as drinking water sources. Although EPA has not finalized the results of the study, preliminary analysis of publicly available WQS indicates the following:

- All states and Puerto Rico have established designated uses for drinking water. These drinking water supply designations are phrased in various ways (e.g., "domestic water supply," "public water supply," "potable water supply," etc.).
- One jurisdiction's WQS regulations protect all waters in the jurisdiction as drinking water sources. Most other jurisdictions list protected water bodies by name or location, but some regulations designate waters based on their actual use. For example, regulations might include blanket statements that all waters located within a certain number of feet of a drinking water intake are protected as drinking water sources.

* EPA's analysis of water quality standards included all 50 states and Puerto Rico, but it did not include other territories or Tribes that are also required to develop Water Quality Standards under the Clean Water Act. The District of Columbia was not included in the analysis because drinking water for DC community water systems is not drawn from the District's water bodies—D.C. residents are served by intakes that are located in Maryland water bodies.

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- WQS regulations in eleven jurisdictions define multiple designated uses for drinking water sources. One of these eleven jurisdictions distinguishes between water bodies that are a source for public water supplies vs. private supplies. In the other ten jurisdictions, waters receive different designated uses because they are protected for different levels of drinking water treatment. For example, one jurisdiction defines three designated uses for drinking water—for sources of drinking water that receive treatment by disinfection only, treatment by disinfection and filtration only, and "complete treatment." Another jurisdiction defines designated uses for waters that receive conventional filtration, waters that receive conventional filtration and softening, and waters that receive treatment in addition to conventional filtration and softening.

Intakes Located Outside of Designated Drinking Water Sources

Ideally, all drinking water intakes should be located in water bodies that benefit from a drinking water designation under the CWA, but it is known that some intakes are located in improperly designated waters. This means that the ambient water quality criteria that are intended to protect drinking water sources—criteria that often drive conditions in National Pollutant Discharge Elimination System (NPDES) discharge permits as well as the bases of TMDLs—may not be applied as intended. In addition, since waters are assessed to determine whether they meet their designated use, the health of improperly designated water bodies that are actually drinking water sources may not be properly assessed and addressed.

EPA estimated the percentage of known drinking water intakes that are located in water bodies that are designated as drinking water sources. As a first step, EPA compiled intake information from the Federal version of the Safe Drinking Water Information System (SDWIS-Fed) and, where feasible, indexed intakes to the national hydrography dataset. Intake information was pulled from SDWIS-Fed for a statistical sample of 100 intakes of active community water system intakes in 28 states. Based on EPA's interpretation of state code, the locations of these intakes were mapped against WQS designated uses to determine whether the intakes appeared to be located in waters that are designated as drinking water supplies.

Based on this statistical study, EPA estimated that 23 percent of intakes are located in water bodies that are not designated as sources of drinking water (EPA 2008b). EPA conducted a follow-up study and analyzed 4,026 intakes located in 32 states. The follow-up assessment indicated that 19 percent of intakes (more than 750 of the 4,026 intakes analyzed) were located in waters that were not designated as drinking water sources. Like the initial analysis of 100 intakes, the analysis of 4,026 intakes was based on EPA's interpretation of state codes for intakes that have been indexed to the national hydrography dataset, and the results were not reviewed by states or EPA's Regional offices (EPA 2008b).

If state agencies or drinking water utilities determine that intakes are located in improperly designated water bodies, the designation can be raised as an issue during the public involvement periods when WQS are updated (this should occur at least every three years under the CWA). Water utilities should check that their intakes are in waters that have been properly designated; more information about how to do this is provided in Chapter 7.

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Scope of Drinking Water Designations

As noted above, EPA's study of designated uses for drinking water supplies focused on compiling definitions of the drinking water supply designations and on beginning to determine whether drinking water intakes are physically located in water bodies that carry these designations. Other aspects of how drinking water supply designations are defined and implemented may also affect the extent to which the supplies are protected, but these aspects were not addressed by the EPA WQS-CWS Baseline Project.

Expanding beyond the questions addressed in EPA's study might help communities understand how WQS protect their intakes. Additional issues to consider include:

- ***Upstream protection.*** The EPA study did not collect comprehensive information on upstream protection provided through drinking water designated uses. However, it was observed that some designated uses appear to apply only at the point at which water was drawn; others appear to apply standards upstream from drinking water intakes (e.g., 500 yards).
- ***Impact of interstate waters.*** EPA did not analyze how water quality from water bodies in other jurisdictions might impact intakes across state lines.
- ***Level of protection.*** As noted, several jurisdictions define multiple designated uses that are intended to protect drinking water supplies receiving different levels of treatment. EPA did not conduct analyses to determine whether the level of protection is appropriate for the treatment provided. For example, the study did not assess whether intakes associated with unfiltered sources are located on waters that are protected for this use.
- ***Identification of designated waters.*** Most WQS regulations include a listing of waters and their designated uses. However, some WQS regulations define designated uses based on the actual use of the water body (e.g., by indicating in the regulations that waters used as drinking water sources receive that level of protection). The study did not evaluate whether, in practice, these designated uses are accurately applied when the waters are assessed and when TMDLs or NPDES permit conditions are developed.

AMBIENT WATER QUALITY CRITERIA FOR DRINKING WATER SOURCES

States and other jurisdictions must develop ambient water quality criteria (AWQC) that protect the defined designated uses. These criteria establish the water quality goals for the water body. They also serve as the basis for establishing TMDLs, water quality-based NPDES permit conditions, and other strategies to protect drinking water sources.

The WQS-CWS Baseline Project compiled information on AWQC that support drinking water designated uses. The study did not compile AWQC for all water quality criteria; it was limited to contaminants that EPA regulates as National Primary Drinking Water Regulations except for *Giardia*, heterotrophic plate count (HPC), *Legionella*, viruses, chloramines, chlorite, chlorine dioxide, acrylamide, and epichlorohydrin.* The study also compiled data on TOC, methyl tertiary-butyl ether (MTBE), dachtal, perchlorate, and contaminants that are regulated by the state drinking water programs, but not by EPA. Criteria that support Section 101(a) designated uses

*Chlorite, chlorine dioxide, acrylamide, and epichlorohydrin were excluded because it was determined that contamination is not associated with source water quality.

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(designated uses that support the "fishable," "swimmable" goals of the CWA) were evaluated in addition to the criteria that protect drinking water sources.

CWA Section 304(a) Human Health Criteria vs. MCLs for Toxic Contaminants

As noted earlier, EPA has developed AWQC under CWA Section 304(a) of the CWA for 126 "priority pollutants." For most of these pollutants, Section 304(a) includes criteria to protect fresh and saltwater species of aquatic life from both acute and chronic effects as well as criteria to protect human health. Human health criteria are further divided into criteria to protect human health based on the consumption of "organisms only" (primarily fish) from the water body and human health based on the consumption of "water and organisms" (drinking water and fish). These human health criteria are derived based on studies of the carcinogenic and neurological effects of chemicals to mammals, such as mice, which are then extrapolated to estimate the potential effects to humans.

As shown in Table 4-1, EPA has not set human health criteria under Section 304(a) for all contaminants regulated as Federal MCLs—this is because not all regulated chemical MCLs are considered to be "priority pollutants" under the CWA. However, where EPA has set human health criteria, the criteria are set at levels that are equal to or, more often, lower than MCLs. AWQC are more analogous to MCL Goals (MCLGs). The MCLG is the maximum level of a contaminant in drinking water delivered to consumers at which no known or anticipated adverse health effects occur, allowing for an adequate margin of safety. As implied by the name, an MCLG is a health-based goal. It is not an enforceable standard but it is used by EPA together with other factors (such as costs, treatment, monitoring feasibility) to set the enforceable drinking water standard. AWQC for human health under CWA 304(a) are developed by EPA using the same methodology for assessing the known or anticipated adverse health effects of water contaminants. The primary difference between the calculation of an MCLG and an AWQC to protect human health is that the derivation of the AWQC explicitly considers additional exposure factors regarding fish consumption and bioaccumulation of the contaminant from water to fish in determining the water concentration value (factors which the MCLG does not explicitly consider). As a result, the AWQC value may in some cases be a numerically lower water concentration value than the MCLG for a given contaminant.

States and other jurisdictions may adopt the CWA Section 304(a) criteria, modify these criteria to reflect site-specific conditions, or use another scientifically defensible method to develop criteria. The EPA has not completed its review of state water quality criteria. However, based on preliminary reviews of publicly available state WQS, the following is observed regarding jurisdictions' use of human health criteria and MCLs to protect drinking water sources based on the WQS-CWS Baseline Project's findings:

- More than two thirds of jurisdictions adopt criteria that are generally equivalent to the Section 304(a) human health criteria for water and organisms as the water quality criteria that protect drinking water sources.
- Approximately 10 jurisdictions adopt water quality criteria for toxic contaminants that are generally equivalent to MCLs. In more than half of these cases, criteria for some contaminants (e.g., nitrates, nitrite) are not adopted, and the criteria for other contaminants (e.g., arsenic) are out of date. In some of the ten jurisdictions, human health criteria for water and organisms apply in addition to criteria that are equivalent to the MCLs. Where a state drinking water program sets drinking water MCLs that

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Table 4.1
Comparison of federal MCLs and CWA Section 304 criteria for human health, water, and organisms for toxic pollutants regulated by MCLs

Contaminant	Federal MCL (µg/L)*	EPA CWA 304(a) criterion for human health, water and organisms (µg/L)
Antimony	6	5.6
Arsenic	10	0.018
Asbestos	7 MFL	7 MFL
Barium	2,000	1,000
Beryllium	4	
Cadmium	5	
Chromium (total)	100	
Copper	Action Level	1,300
Cyanide (as free cyanide)	200	140
Fluoride	4,000	
Lead	Action level	
Mercury	2	0.05
Nitrate (measured as Nitrogen)	10,000	10,000
Nitrite (measured as Nitrogen)	1,000	
Selenium	50	170
Thallium	2	0.24
Alachlor	2	
Atrazine	3	
Benzo(a)pyrene (PAHs)	0.2	0.0038
Carbofuran	40	
Chlordane	2	0.0008
2,4-D	70	100
Dalapon	200	
1,2-Dibromo-3-chloropropane (DBCP)	0.2	
Di(2-ethylhexyl) adipate	400	
Di(2-ethylhexyl) phthalate	6	1.2
Dinoseb	7	
Dioxin (2,3,7,8-TCDD)	0.00003	0.000000005
Diquat	20	
Endothall	100	
Endrin	2	0.059
Ethylene dibromide (1,2 Dibromoethane)	0.05	
Glyphosate	700	
Heptachlor	0.4	0.000079
Heptachlor epoxide	0.2	0.000039
Hexachlorobenzene	1	0.00028
Hexachlorocyclopentadiene	50	40
Lindane (hexachlorocyclohexane gamma)	0.2	0.98
Methoxychlor	40	100
Oxamyl (Vydate)	200	
Polychlorinated biphenyls (PCBs)	0.5	0.000064
Pentachlorophenol	1	0.27
Picloram	500	
Simazine	4	

(continues)

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Table 4.1 (Continued)

Contaminant	Federal MCL (µg/L)*	EPA CWA 304(a) criterion for human health, water and organisms (µg/L)
Toxaphene	3	0.00028
2,4,5-TP (Silvex)	50	
Benzene	5	2.2
Carbon tetrachloride	5	0.23
Chlorobenzene	100	130
o-Dichlorobenzene (1,2-Dichlorobenzene)	600	420
p-Dichlorobenzene (1,4-Dichlorobenzene)	75	63
1,2-Dichloroethane	5	0.38
1,1-Dichloroethylene	7	330
cis-1,2-Dichloroethylene	70	
trans-1,2-Dichloroethylene	100	140
Dichloromethane	5	4.6
1,2-Dichloropropane	5	0.5
Ethylbenzene	700	530
Styrene	100	
Tetrachloroethylene	5	0.69
Toluene	1,000	1300
1,2,4-Trichlorobenzene	70	35
1,1,1-Trichloroethane	200	
1,1,2-Trichloroethane	5	0.59
Trichloroethylene	5	2.5
Vinyl chloride	2	0.025
Xylenes (total)	10,000	

Source: 40 CFR § 141. National Primary Drinking Water Regulations; USEPA. 2006c. National Recommended Water Quality Criteria. Office of Water and Office of Science and Technology.
*All Federal MCLs (except asbestos) are expressed in mg/L in the National Primary Drinking Water Regulations (40 CFR 141) but are translated to µg/L in this table to ease comparison with the human health criteria.

are more stringent than Federal MCLs, ambient criteria that are set at MCL levels are equivalent to state (not Federal) MCLs.

- In almost half of jurisdictions, criteria intended to protect aquatic life apply to all waters designated as drinking water sources. This happens because the aquatic life criteria apply statewide, or because all drinking water sources are also designated for aquatic life.

The WQS-CWS Baseline Project did not collect information on the methods used to implement numeric water quality criteria. Most states develop implementation guidance that describes how numeric criteria are analyzed to determine whether the water body is meeting its designated use. Understanding the analytical methods used, the number and location of samples taken, and the protocols for averaging sample results for purposes of assessing the waters can help improve the understanding of how ambient water quality criteria for drinking water sources help protect the sources.

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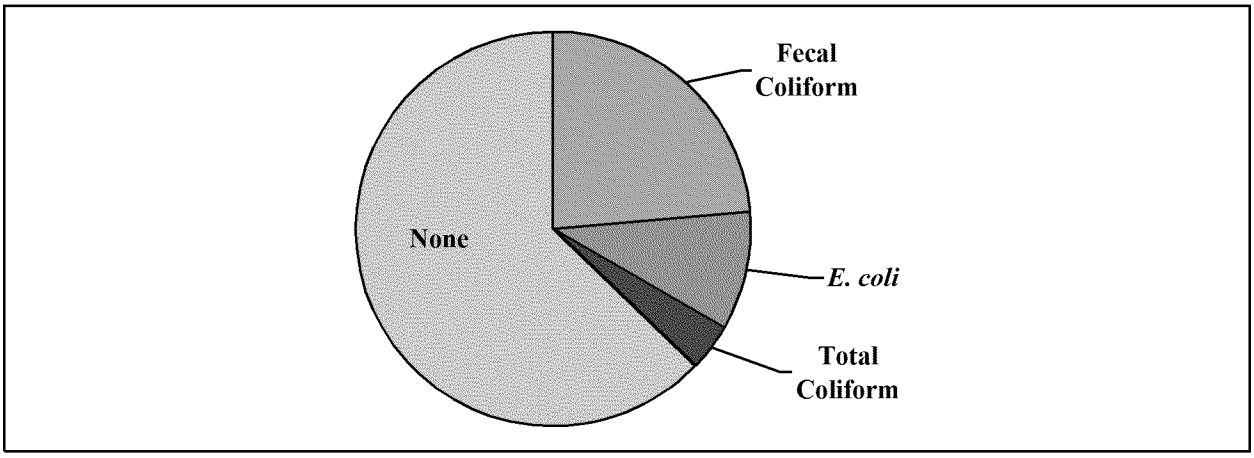

Figure 4.1 Microbiological criteria associated with states' water supply designated uses (not including Section 101(a) criteria that also apply to sources of drinking water)

Indicator Criteria for Microbiological Contaminants

With the recent passage of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), biological water quality criteria developed under the CWA provide an opportunity to improve source waters and avoid costly treatment. At this time, EPA provides recommended water quality criteria for bacterial indicators for waters designated for primary recreation (e.g., swimming), secondary recreation (e.g., boating), and shellfish harvesting (see http://www.epa.gov/OWOW/monitoring/calm/calm_ch7.pdf). Since 1986, EPA's recommendation has been to use *E. coli* or enterococci as the bacteria indicator for freshwater primary recreation waters and enterococci as the indicator for marine primary recreation waters. Many states still use the pre-1986 standard for fecal coliform as the numeric criterion to protect water bodies designated for recreational uses. However, EPA recommends that jurisdictions transition to *E. coli* or enterococci criteria as indicators for the bacterial health of recreational water bodies since these indicators correlate more strongly to gastrointestinal problems than the fecal coliform indicator.

EPA has not developed ambient water criteria specifically for drinking water sources. However, several states have adopted biological criteria that apply to drinking water sources, either directly or indirectly. The WQS-CWS Baseline Project has not finalized the results of its study. However, the following has been observed regarding bacterial criteria that apply to drinking water sources based on an analysis of publicly available state WQS:

- Nineteen of the 51 jurisdictions have established water quality criteria for bacterial indicators that directly support the drinking water designated uses. In the majority of these 19 jurisdictions, fecal coliform is the indicator organism used (see Figure 4.1).
- All but nine of the jurisdictions have established water quality bacterial criteria that apply either "directly" (meaning that that they are associated specifically with the drinking water use) or "indirectly" (meaning that they are statewide or associated with another use such as recreation, but apply in all water bodies that also have a drinking water designated use) to drinking water sources (see Figure 4.2).

Although the WQS-CWS Baseline Project collected information on the indicator used to evaluate the bacterial health of a water body, the study did not comprehensively evaluate the

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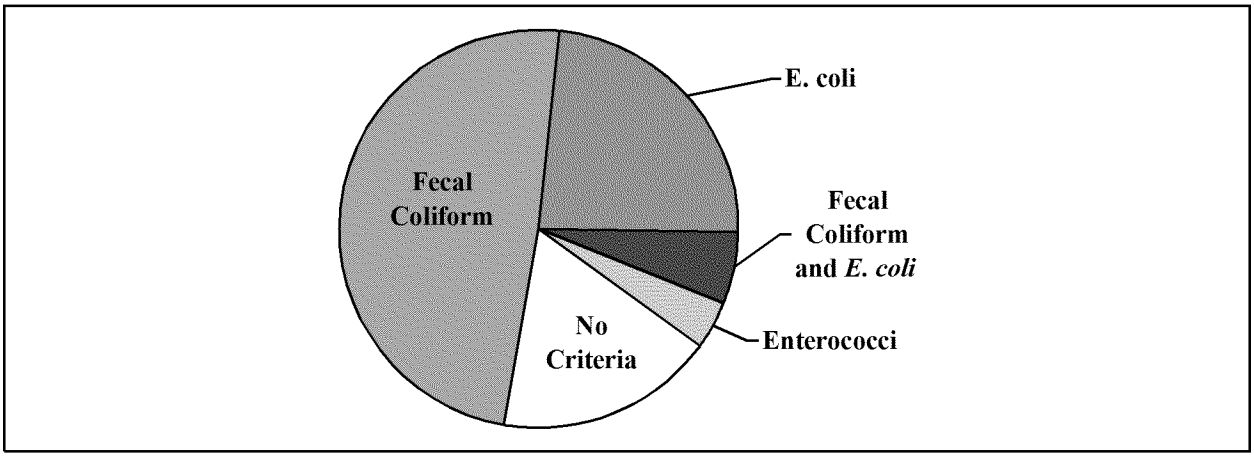

Figure 4.2 Microbiological criteria associated with states' water supply designated uses (not including Section 101(a) criteria that also apply to sources of drinking water)

specific criteria that are applied. The concentration of indicator used may impact the extent of protection provided to drinking water sources. For example, the recommended criteria for *E. coli* as an indicator for primary contact recreation (e.g., swimming) is as follows:

> "Freshwater geometric mean: not to exceed 126 CFU per 100 mL, based on no fewer than five samples equally spaced over a 30-day period. Freshwater single-sample maximum: no sample should exceed a one-sided confidence level (CL)* calculated using 235 CFU/100 mL (designated bathing beach) 75% CL; 298 CFU/100 mL (moderate use for bathing) 82% CL; 406 CFU/100 mL (light use for bathing) 90% CL; 576 CFU/100 mL (infrequent use for bathing) 95% CL; based on a site-specific log standard deviation, or if site data are insufficient to establish a log standard deviation, then using 0.4 as the log standard."

Criteria to support secondary recreation (e.g., boating), which are more likely to apply statewide, are generally less stringent.

The LT2ESWTR, which addresses enhanced treatment requirements for *Cryptosporidium*, bases its *Cryptosporidium* treatment requirements on the quality of the source water at each drinking water utility. The LT2ESWTR allows filtered water systems serving fewer than 10,000 people to monitor their source waters for *E. coli* instead of *Cryptosporidium*. In contrast to the recommended criteria for *E. coli* stated above, the LT2ESWTR sets the following *E. coli* concentrations as thresholds:

- For systems using lake or reservoir sources, the annual mean *E. coli* concentration exceeds 10 *E. coli* per 100 mL.

* If a range of values for a statistical variable is being considered, one may wish to assign a probability that its actual value lies within the given range. Such a probability is the "confidence level". If the range is "one-sided", that is to say, there is a limit to the range only on one side, then one speaks of a one-sided confidence level. Examples are: "The confidence is X% that the value is above Y", and "The confidence is X% that the value is below Y". Two-sided confidence levels are usually used when the range is limited to lie between two specified limits. For example: "The confidence is 90% that the value is between Y and Z."

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- For systems using flowing stream sources, the annual mean *E. coli* concentration exceeds 50 *E. coli* per 100 mL.

If the appropriate threshold is exceeded by a drinking water utility, the utility must then monitor its source water for *Cryptosporidium*, which is a significantly more expensive test. The LT2ESWTR, a federal regulation, does allow states to approve alternative *E. coli* thresholds to those provided in the federal rule. The LT2ESWTR also allows states to approve monitoring for an indicator of *Cryptosporidium* other than *E. coli* (only for drinking water utilities serving fewer than 10,000 people).

CONCLUSION

Based on publicly available WQS, all states and Puerto Rico have established designated uses for drinking water. More than two-thirds of jurisdictions adopt criteria that are generally equivalent to the Section 304(a) human health criteria for water and organisms as the water quality criteria that protect drinking water sources. While the intent of drinking water designated uses is to ensure that all drinking water intakes receive adequate protection under the CWA, EPA's assessment found that 19 percent of drinking water intakes (more than 750 of the 4,026 intakes analyzed) were located in waters that were not designated as drinking water sources. If state agencies or drinking water utilities determine that intakes are located in improperly designated water bodies, the designation can be raised as an issue during the public involvement periods when WQS are updated (this should occur at least every three years under the CWA).

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CHAPTER 5
SUMMARY OF STATE AND EPA REGIONAL DRINKING WATER AND TMDL PROGRAM SURVEY RESPONSES

As part of the project, state drinking water administrators and state TMDL program managers were surveyed to solicit their input and experiences on current efforts to integrate particular aspects of the CWA and SDWA, and ways to further improve this integration. EPA Regional TMDL and SDWA staff were also surveyed. In addition to obtaining information on integration efforts, the surveys elicited information on the following:

- If and how drinking water and source water protection interests are taken into account in the TMDL development process
- How drinking water uses and concerns are factored into TMDL prioritization
- What level of involvement drinking water utilities have in the TMDL development process

STATE SURVEY RESULTS AND FINDINGS

Chapter 2 provides a summary of how the survey was developed and distributed. Cadmus received completed surveys from 28 state drinking water programs and 21 state TMDL programs, covering 40 different states. In general, states discussed integration efforts related to communication and coordination, data sharing, cross-program linkages, and funding. In addition to integration efforts, states also discussed the development of WQS and compliance with those standards, as well as drinking water utility involvement in the TMDL process.

SDWA and CWA Program Integration

Of the 40 states that responded to the surveys, 27 have both the drinking water and the TMDL programs within the same state agency. Of these 27, 56 percent reported that the SDWA and TMDL programs were "well integrated." Of the 13 states with programs in different agencies, only 23 percent felt that the programs were well integrated (Figure 5-1). In at least one state, the formerly separated programs have been combined into one division with a CWA and SDWA branch to facilitate coordination and integration.

Regardless of which agencies the two programs fall within, most states agree that it is important for staff to communicate across programs. As might be expected, this communication plays a large role in ensuring effective integration of the SDWA and TMDL programs.

Communication, Coordination, and Data Sharing

Several states noted that staff from both programs are encouraged by management to work together on a regular basis. Some of the issues discussed between staff in the two programs include: priorities for drinking water sources, criteria for listing waters as impaired for water supply, sharing of information regarding protection programs for water supply sources, and identification of areas for effective integration. Where programs and staff are located in close proximity to one another, these discussions are further facilitated. Planned periodic meetings at the staff level, as

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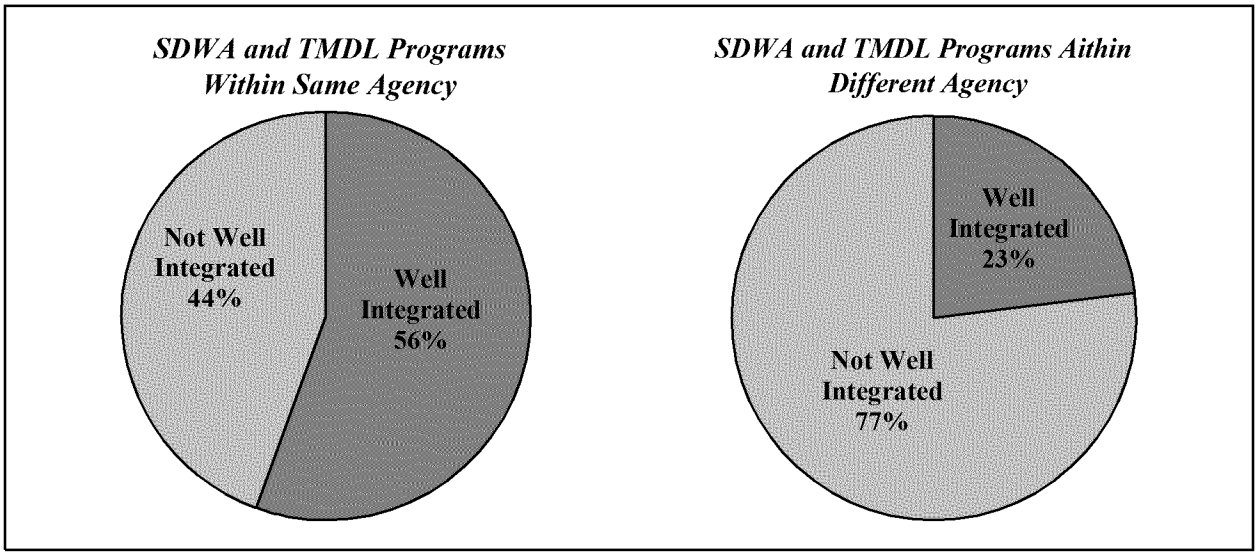

Figure 5.1 Survey responses regarding SDWA and TMDL program integration for states with SDWA and TMDL programs within the same agency (left) and different agencies (right)

well as section chief and director levels, also help to further reinforce the benefits of integration Joint meetings with outside groups such as local watershed organizations (some established to address TMDL issues) can further promote integration efforts

Some states discussed examples of effective joint committees where staff from both programs are included in program planning such as developing source water protection strategies or watershed management frameworks, which can assist with TMDL development Joint committees to coordinate WQS among groundwater, surface water, and drinking water programs also exist Other committees exist to improve communication between Source Water Assessment Programs (SWAPs) and state revolving loan fund programs Some states coordinate on discharge and water allocation permit decisions and wastewater reuse projects In other states, staff from one program serve on regulatory development committees of the other program and vice versa Several states noted that both programs include each other in developing new laws and revising legislation and regulations

Similar to the issue of communication, data sharing can enhance integration and provide pooled resources and information that can improve implementation of both programs Examples of data sharing identified by the states include:

- Cross-program geographic information systems (GIS) mapping with data layers available for use in several programs
- Exchanging and sharing data on water quality and source water assessments
- Comparing customer complaints
- Providing access to databases and Web sites
- Coordination on ambient monitoring at intakes
- Integrating groundwater monitoring with an overall water monitoring strategy
- Integrating drinking water monitoring needs into the CWA state monitoring plan

Several states noted the importance of training across programs such as providing presentations on the drinking water SWAP to TMDL staff to highlight the potential use of SWAP results

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as a tool for protecting water quality. Some of those surveyed mentioned that joint attendance at workshops on topics like source water protection can also facilitate communication and highlight potential integration opportunities.

Cross Program Linkages and Funding

A number of states identified cross-program linkages that have furthered integration efforts among the two programs. Many of these involved prioritizing source waters in the state monitoring plans and assessment processes, as well as in TMDL development. Others were focused on aligning WQS to more closely reflect MCLs and ensuring that all surface water sources of drinking water are properly designated for drinking water beneficial use. Consideration of source water protection areas during NPDES permitting and integration of the source water protection program into the state's Nonpoint Source Management Plan were also successful strategies for some states. A number of efforts found ways to integrate groundwater use assessments and drinking water system compliance into 305(b) assessment reports. Examples of specific state actions include:

- Drinking water staff involvement in triennial water quality standard review
- Pilot watershed assessments that included groundwater and drinking water
- Prioritizing public water system wellhead area watersheds for protection
- Cooperative work on watershed planning and management
- Both programs being involved in reservoir protection programs including project selection, development, and implementation of TMDLs
- Identification of drinking water systems and intakes within water bodies

Several states have also found ways to use funds provided by the two programs to further promote integration. Examples of this include:

- Funding two positions in the CWA program to assist public water system officials (using surface water) in the development of local source water protection plans.
- Using state grant funds and CWA Section 319 funds for watershed projects to protect a drinking water utility's source waters
- Using CWA Section 106 funds to support groundwater and drinking water protection activities by funding one SDWA position to work with the CWA program and coordinate on WQS, TMDLs, monitoring activities, public water supply beneficial use designations, assessment methodology for the public water supply beneficial use and the state's 305(b)/303(d) Water Quality Assessment Integrated Report
- Using state and Federal funds for wellhead protection watershed projects
- Funding source water protection programs via the Drinking Water State Revolving Loan Fund
- Funding the CWA Program to complete Source Water Assessment Reports for all public water systems using surface water sources

Developing and Evaluating Compliance With WQS

Thirty states (75% of respondents) reported working between programs, at least sometimes, to develop WQS under CWA Section 303(c). Examples of contaminants for which WQS have

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been developed jointly between the two programs include: priority pollutants and toxics, bacteria, metals, and organic and inorganic contaminants. More information on WQS development is provided in Chapter 3 of this report. Some states have adopted drinking water MCLs into their WQS. However, other states expressed concern that using drinking water MCL standards in ambient water may make water body restoration goals unattainable.

Common causes of water body impairments for drinking water sources, as reported by the states

Sediment	Chlorides
Nutrients	pH
Fecal coliform	Chlorides
Temperature	Dioxin
Atrazine	PCBs
Mercury	Color
Manganese	Radium
Lead	Taste
Iron	Odor
Total dissolved solids	Pesticides
Oil	Copper

When asked "to what extent drinking water regulations are considered when the state develops its WQS," 90 percent of respondents reported that consideration is given always or sometimes. A similar proportion of states indicated that the two programs work together to identify water bodies for designation as drinking water supplies. Several of the remaining states noted that all water bodies in the state are designated for drinking water use, eliminating any need for additional coordination. However, six states indicated that not all sources used for drinking water supply have been appropriately designated.

Of the states that responded, 76 percent reported they work together, at least sometimes, to identify water bodies that are drinking water supplies that do not meet WQS. Interestingly, in four states where surveys were completed by both the drinking water and TMDL program managers, the programs had opposite opinions with one saying they work together and the other saying they do not. The surveys found 54 percent of states reported they share and review draft 303(d) lists with the drinking water program. A key reason provided for not sharing the reports was that few of the impaired waters support drinking water as a designated use and that criteria are based on aquatic life rather than drinking water standards. Other reasons included staffing limitations, lack of priority, and lack of communication or request for input.

Although a number of states did not know if any of their drinking water sources were listed as impaired on state 305(b)/303(d) Water Quality Assessment Integrated Reports, nineteen states reported a total of 280 impaired water bodies used as a source of drinking water. Seven states reported no water body impairments for sources used for drinking water.

Impairments of drinking water sources cover a spectrum of contaminants, with many posing serious health risks to the communities served by the water supply. Atrazine and mercury, in particular, are sources of impairments in 21 percent and 37 percent, respectively, of states reporting impaired drinking water sources.

Drinking Water Staff and Drinking Water Utility Involvement in the TMDL Process

Only 10 state drinking water programs reported working with their counterparts to develop TMDLs for impaired water bodies used as drinking water sources. Many of the TMDL respondents indicated, however, that drinking water use is given a high priority in their prioritization process. In a few states, TMDLs are driven by consent decrees or the use of a basin approach rotation cycle

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that dictates the order in which water bodies will have TMDLs developed. To facilitate TMDL development, 24 state drinking water programs noted they shared source water assessment information with their CWA counterparts. Of the four states that have not yet shared this information it is typically because they are trying to get it into a format that can best be used by the CWA staff. All 26 states that responded indicated they have access to map coordinates (i.e., latitude and longitude) for all drinking water intakes in the states so that mapping is possible. Fourteen of those states have developed map overlays in GIS format that identify designated uses and WQS for surface waters in which drinking water intakes are located.

Reasons for lack of drinking water program involvement in TMDLs include failure to be asked, lack of impaired water bodies that are designated as sources of drinking water, lack of time, and lack of resources and technical expertise. Where SDWA staff do participate, it may be in sharing monitoring data or results; participating in committees; keeping drinking water utilities apprised of the TMDL development process; being consulted on present and future water body use; assisting in responding to comments; reviewing and commenting on TMDLs that impact drinking water sources; and identifying source water protection areas and withdrawal information. It is noteworthy that most drinking water program respondents did not perceive they have a major role in developing TMDLs, while the TMDL coordinators saw a more important and robust role for drinking water staff.

When asked about drinking water utility involvement in the TMDL process, 22 states reported that utilities are involved, although not always. Nine states reported that utilities are not involved, and two states were not sure. In cases where utilities have been involved, their roles included: review of TMDL draft reports and participation in public meetings; sharing of intake water chemistry data for use in developing a TMDL; acting as a catalyst to develop watershed groups to take part in TMDL implementation; funding or recommending BMPs in the watershed; or providing input on watershed management issues. The most significant role has been as a source of water quality data beyond what is required by the SDWA regulations. Drinking water utilities have also provided forums for stakeholder input in the TMDL development process. While some states may actively seek drinking water utility participation, many seem to view utilities as one of several stakeholders that can comment along with everyone else.

Reasons provided for why utilities are not more involved include the fact that few TMDLs have been completed for water bodies used for drinking water; lack of time and resources; and lack of utilities' technical expertise except in some of the larger utilities. One state noted that since the majority of utilities are local municipalities, they may be involved in the TMDL process because they are concerned about increasing compliance costs if impairments are found to be caused by municipal point source discharges and/or stormwater.

EPA REGIONAL SURVEY RESULTS AND FINDINGS

None of the three EPA Regions that responded felt like the two programs were well integrated at the EPA Regional level, although a number of suggestions were made regarding steps currently underway to improve integration efforts. Many of these suggestions related to enhanced communication, coordination, and data sharing.

Of the EPA respondents, it was indicated that EPA staff meet on a regular basis to discuss all important issues related to the SDWA and CWA programs (and several other related programs). Section Chiefs and Branch Chiefs from both programs participate in many of these meetings and minutes are made available to all water management division staff. Also, quarterly meetings occur

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for water management division employees to inform staff of on-going issues, including SDWA and CWA program issues. SDWA and CWA staff meet on occasion to discuss TMDL coordination for politically sensitive locations; senior management from both EPA and state water programs meet on an annual basis to coordinate activities.

In some regions, EPA staff have rotated through both the TMDL and SDWA programs, which enhances the comprehensive understanding of these programs. In one Region, a Watershed Coordinator has been appointed for each of the states to ensure cross-program integration and contacts between the CWA and SDWA programs (among other programs). EPA encourages the states to be fully integrated partners when administering the SDWA and CWA programs. State Workgroups have been formed with TMDL and SDWA staff that meet on a regular basis and discuss mutual issues.

The following are specific examples of data sharing and cross-program linkages identified by the responding EPA Regions:

- SDWA and CWA programs share drinking water data (monthly operating reports) and source water assessment information.
- TMDL and NPDES information is placed into the National TMDL Tracking System and is accessible on-line by the public.
- EPA has extensive national and regional water-related Web sites that provide information about both the SDWA and CWA programs.
- GIS coverages of 303(d) streams and drinking water intakes have been developed.
- SDWA and CWA programmatic activities are integrated within the Regional Office of Watersheds.
- Grant tasks and other activities are coordinated with the CWA Section 106 water pollution control program grant and Underground Injection Control (UIC) programs.
- Water quality program shares the draft state 303(d) list with the SDWA program for review/comment.
- Proposed TMDLs are sent to the Drinking Water Section for review and comment.

Cross-program training is available through EPA's Watershed Academy and Drinking Water Academy, both of which are on-line training modules. Elective training courses are offered to introduce issues related to both the SDWA and the CWA. Tours of NPDES treatment facilities and water plants have been offered by both the NPDES, TMDL, and SDWA programs. In one EPA Region, the water management division has a mandated central core of training classes that all employees must undergo to ensure they have a fundamental understanding of the basic elements of the CWA and SDWA programs. Briefings have been arranged by EPA attorneys to keep SDWA and CWA employees informed of any pertinent Supreme Court decisions.

RECOMMENDATIONS FOR SDWA AND CWA STATE PROGRAM INTEGRATION

One of the major challenges to improving integration of SDWA and CWA/TMDL programs is the dissimilarity between the two programs. The TMDL program focuses on exceedances of WQS in the water body, while the SDWA program focuses on compliance of surface or groundwater with MCLs following treatment. As described in Chapter 3, WQS and MCLs are developed using differing exposure and risk assumptions. Improvements in communication and integration are made more difficult when the SDWA and CWA programs are located in different agencies.

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Lack of funding and staff to provide coordination assistance and participate in cross-program activities further hampers integration efforts. Lack of policies and direction to promote integration as well as conflicting state programs and policies can exacerbate this situation.

While integration is improving in some areas, such as development of the CWA Section 305(b)/303(d) Integrated Report, improved communication between the programs is still needed. Since the CWA program is required to protect and report on drinking water uses, it is particularly important that the SDWA program contribute to accomplishing this task. Actions suggested by those surveyed that states can take are provided below.

Increase and Enhance Communication

- Conduct regular meetings among program staff as well as branch and division chiefs to facilitate coordination.
- Hold annual or semi-annual joint meetings of staff and directors from both programs.
- Investigate using an EPA-sponsored organization such as the Interagency Groundwater Committee or others as a tool for cross-program integration efforts.

Training

- Provide additional cross-program training and presentations.
- Promote attendance at pertinent meetings, workshops, and trainings.
- Provide additional GIS training for staff in the CWA and SDWA programs.

Data Sharing/New Technologies

- Develop additional data sharing mechanisms and GIS integration capabilities.
- Educate and train states and EPA Regions on EPA's new data systems, including the National TMDL Tracking System (NTTS) and Assessment, TMDL Tracking and Analytical Integrated National System (ATTAINS), which will offer enhanced capabilities for coordination between the CWA and SDWA programs.
- Use newer technologies like Web applications that can easily enable data sharing such as verification of intake latitudes and longitudes within a Drinking Water Protection Area.

Programmatic Integration

- Better utilize SWAP results in evaluating use support ratings within the 303(d) program.
- Develop a meaningful way to include drinkable criteria for use support ratings as well as elevating drinking WQS and criteria to the same level as aquatic organism protection.
- Include drinking water parameters such as *Cryptosporidium* and TOC as part of ambient monitoring programs of surface waters.
- Increase awareness of TMDL development efforts across state programs as well as with utilities in impacted watersheds.
- Increase pooling and sharing of resources for joint projects.

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- Educate each program on the objectives and limitations of the various funding sources.
- Continue sharing source water protection area information with CWA staff to ensure better decisions such as those related to permit issuance for wastewater discharges.
- Communicate and coordinate better when a facility is first proposed to ensure proper sitting and minimize adverse effects by state rules on the existing dischargers (e.g., prohibition of some discharges within a certain distance of a designated drinking water source).

Holistic Integration

- Work with EPA to establish pragmatic regulatory approaches.
- Focus on water quality data and identify what statewide or national regulatory efforts need to be put in place.
- Examine all water (surface and ground) not just surface water, and find creative ways to manage these waters as one resource. Managing at the watershed level could allow management activities to address public water systems (wells and surface water intakes) that are located in watersheds of impaired water bodies. BMPs implemented to reduce contaminants in impaired water bodies in order to comply with TMDLs can also benefit drinking water sources within the watershed.

RECOMMENDATIONS FOR DRINKING WATER UTILITY INVOLVEMENT IN THE TMDL PROCESS

Based on state survey responses, it appears the drinking water utility's role in the development of TMDLs has in the past been limited. Several reasons have been suggested: there are currently few TMDLs being developed on surface waters with drinking water beneficial use designations; there is a lack of resources and technical expertise at utilities to actively participate in the process; utilities are viewed as just another stakeholder that can comment along with everyone else.

In those cases where utilities have been involved, their roles include: reviewing TMDL draft reports and participating in public meetings; sharing of intake water chemistry data for use in developing a TMDL; acting as a catalyst to develop forums or watershed groups to take part in TMDL implementation; funding or recommending BMPs in the watershed; or providing input on watershed management issues.

The following are recommendations for enhancing drinking water utility involvement in the TMDL process based on the state survey responses.

- ***Be Proactive.*** Early involvement in the TMDL process will increase opportunities for drinking water utilities to effectively communicate with interested parties and will allow the drinking water utility to provide input on its water quality goals and needs. By getting involved early, there will be greater opportunity for developing consensus among stakeholders during the TMDL process, rather than spending time and resources resolving differences after a TMDL has been developed.
- ***Do Your Homework in Advance.*** Every participant and stakeholder looks at water quality from their own perspective. Drinking water utilities should approach the TMDL development process with an understanding of state WQS and how they relate to drinking water standards. In many states, acceptable levels vary significantly between

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the two programs Utilities need to understand how varying levels will impact water quality at their intakes in order to protect their supply's drinking water quality

- ***Share Data and Information with Participating Organizations.*** Utilities often have historical water quality data that can help characterize the water body impairment(s) and help identify mitigation measures Sharing this information can avoid duplication of effort and conserve resources for new information collection activities The drinking water utility may also have a recently completed source water assessment of the watershed or a sanitary survey that can provide helpful information for TMDL development

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CHAPTER 6
DRINKING WATER UTILITY CASE STUDIES

The purpose of the case studies is to describe how drinking water utilities have become involved in the TMDL process, the experiences they have had during their involvement, the role they played once involved, the actions they took (or feel they should have taken) to steer the TMDL process to be more helpful in protecting drinking water, and lessons they learned from those experiences.

Six case studies are provided in this chapter (Table 6-1). The case studies cover a range of drinking water utility sizes, geographical locations and source water types. All of the utilities showcased here have proceeded through most or all of the TMDL development process for their source waters. A seventh case study, for Contra Costa Water District, is provided in Chapter 7. Contra Costa Water District has already begun to engage in the TMDL process for their watersheds. Chapter 7 provides tools for utilities in situations comparable to Contra Costa, and the case study applies some of those tools to show how a drinking water utility could become more informed and get involved.

Some utilities in this participated actively during TMDL development. Others were primarily concerned with staying informed and engaged. Brief summaries and a summary table describing the case studies are provided here.

The case study for Columbus Water Works (CWW) highlights the development of TMDLs for fecal coliform bacteria in the Middle Chattahoochee River Watershed (in the Columbus, GA area). TMDLs have also been developed in the Columbus area to address biota impairments and PCBs (a legacy issue limiting fish consumption). This report's case study focuses on the fecal coliform bacteria TMDL.

The case study for Winthrop Utilities District highlights the development of TMDLs for total phosphorus (TP) in Upper Narrows Pond (in the Winthrop, ME). Excess TP loading in the pond has resulted in plant and algal growth, which reduces water clarity. When the plants and algae die, they settle to the bottom of the pond where they are decomposed by aerobic microbes—a process which can deplete the dissolved oxygen in the water. In addition to causing the adverse effects of limited dissolved oxygen, excess phosphorus promotes nuisance algal blooms that can clog filters and result in taste and odor problems.

The case study for Philadelphia Water Department (PWD) highlights the development of two TMDLs for Wissahickon Creek, for nutrients and siltation. PWD's interest in TMDL development for the Wissahickon Creek was driven by concern for its water supply and because the City of Philadelphia has a permitted discharge into the creek. PWD has intermittent taste and odor episodes due to geosmin and MIB, two compounds produced by blue-green algae. PWD is also concerned about high nitrate concentrations. These water quality concerns may be alleviated by reducing nutrient concentrations in the creek.

The case study for Aqua Pennsylvania provides an example of a drinking water utility involved in gathering data that were used by the State during the development of the TMDL for Green Lane Reservoir. The reservoir has a history of nuisance algae blooms. Sedimentation has also filled in some upper portions of the reservoir, but has not yet appreciably affected the storage capacity of the 4.5-billion-gallon reservoir. A nutrients TMDL was developed for Green Lane Reservoir to address the organic enrichment.

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Table 6.1
Case study overview

Water utility	Water quality concerns	Reasons for involvement	Results of involvement	Lessons learned
Columbus Water Works	Fecal coliform bacteria	CWW is responsible for water utility, wastewater utilities, CSO treatment facilities	City of Columbus and CWW jointly submitted the TMDL; helped develop TMDL implementation plan; got state regulators to consider additional data and an alternate protocol	It can take a long time to convince regulators to take a different approach; regulators on TMDL committee did not influence regulators making decisions
Winthrop Utilities	Low dissolved oxygen, nuisance algae, reduced water clarity	Concerns with high turbidity clogging their slow sand filters	TMDL report may address water quality needs for drinking water supply separately from water quality needs for other uses (i.e., swimming and fish habitat)	Stakeholders look at water quality from their own perspective; have a water quality goal in mind at the beginning of the TMDL process
Philadelphia Water Department	Nitrate, taste and odor, algae, siltation	Concerns with high nitrate and taste and odor at water intake; city is a source of siltation (erosion)	Contributed water quality data and research results that affected the outcome of the TMDL	Participate in TMDL process as early as possible; long-term water quality data collection is important
Aqua, Pennsylvania	Organic enrichment	Aqua was already a key stakeholder in ongoing watershed protection efforts	Provided water quality data; utility's laboratory analyzed samples; provided comments during TMDL development process	TMDL process was probably more adversarial than it needed to be; TMDL provides way to prioritize funding for nonpoint source BMPs
City of Wilmington, Delaware	Sediment, bacteria (fecal coliform in PA, enterococcus in DE)	High influent turbidity, City of Wilmington is also responsible several CSOs	Collected additional data to establish updated storm event mean concentrations for CSOs resulting in revised TMDL; played active role in integrating TMDL into ongoing programs	TMDL allocations can be modified if better water quality data are collected and presented to EPA and the states; separate TMDLs can be developed for low- and high-flow conditions
Santa Clara Valley Water District	Mercury	Reservoir is used for recreational fishing	Provided funding for data collection and technical reports; co-chaired the mercury workgroup; formed and funded a technical review committee	Collaborative approach helps participants be informed and educated at same pace; conducting comprehensive and sound-science based data collection is key to developing a TMDL with the best chance of achieving its end goal of restoring water quality; active participation results in incorporating control measures into existing projects and programs, which is the most cost-effective approach

The case study for Santa Clara Valley Water District discusses the development of a mercury TMDL developed for the Guadalupe River Watershed. The Guadalupe River is surrounded by dense urban development, and passes through the heart of the City of San Jose, California. The river receives nonpoint source inputs from surface erosion within the upper watershed, and from urban drainage within the lower valley. The river is used for recharge of public water supply aquifers, as well as supports an important anadromous fishery. High levels of mercury have impacted the fish populations in the river.

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The City of Wilmington's case study provides an example of a municipality that became involved in the development of a TMDL for sediment and bacteria in the Christina River Basin to improve the quality of its water supply, as well as to participate in the decision-making process regarding the permitting and management of combined sewer overflows (CSOs) and municipal separate storm sewer systems* (MS4s) in its jurisdiction. One major challenge to the development of this TMDL was that the watershed contains land in three states (Pennsylvania, Maryland, and Delaware) and numerous counties. As a result, the TMDL had to address issues such as having different water quality criteria in different states, defining and meeting water quality criteria at state boundaries, and orchestrating a large and varied interstate group of stakeholders.

COLUMBUS WATER WORKS, COLUMBUS, GEORGIA

Drinking Water Utility Contact

Cliff Arnett, Senior Vice President and Manager of Operations
Columbus Water Works

Introduction

This case study for Columbus Water Works (CWW) highlights the development of TMDLs for fecal coliform bacteria in the Middle Chattahoochee River Watershed (in the Columbus, GA area). TMDLs have also been developed in the Columbus area to address biota impairments and PCBs (a legacy issue limiting fish consumption); however, those TMDLs are not discussed in this case study.

Background

CWW is a municipally-owned, board-managed drinking water and wastewater utility serving approximately 250,000 people in Columbus, Georgia. CWW also serves Georgia's Harris and Talbot Counties as wholesale drinking water customers, and has privatized the Fort Benning water and wastewater system. CWW provides drinking water to its customers using the Chattahoochee River as the source of supply. Water is withdrawn from Lake Oliver, a 2,150 acre "run-of-the-river" reservoir operated by Georgia Power Company and located within Columbus city limits. The river water is treated at a 90-MGD conventional treatment plant using chlorine dioxide for THM and manganese control, alum coagulation, sedimentation, filtration, chlorine disinfection, lime addition for pH adjustment, and fluoride addition for dental health. A schematic of the water treatment process is shown in Figure 6.1.

CWW is centrally located in the Middle Chattahoochee River Watershed, which encompasses fifteen counties and 2,400 square miles of land in Georgia and Alabama. The Chattahoochee River begins as a small spring in the Blue Ridge Mountains of North Georgia and flows for 434 miles until it combines with the Flint River, forming the Appalachiola River at the Georgia/Florida border (Figure 6.2). Although all tributaries to the Chattahoochee River are free-flowing,

* A municipal separate storm sewer system (MS4) is a conveyance or system of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man made channels, or storm drains, that is owned or operated by certain public entities (including cities), which discharges into waters of the United States. 40 CFR 122.26(b)(8).

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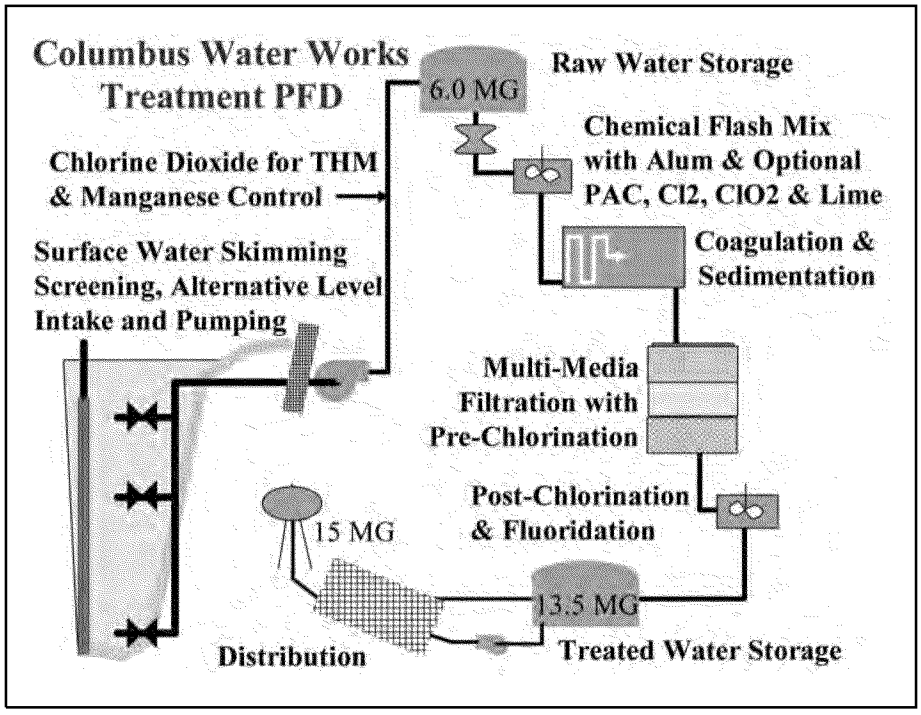
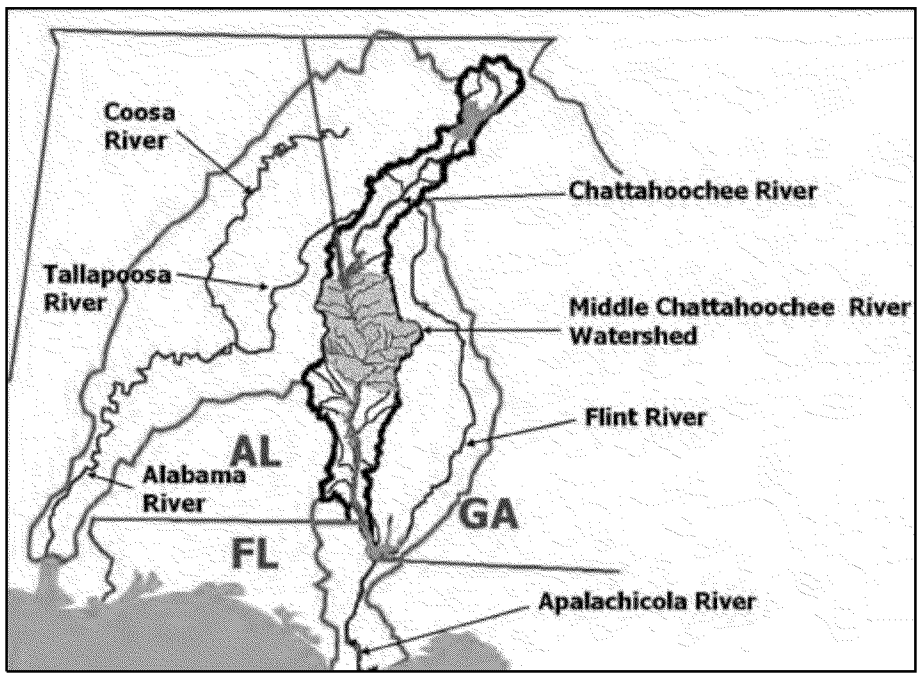


Source: Columbus Water Works.

Figure 6.1 Columbus Water Works treatment plant schematic



Source: Columbus Water Works.

Figure 6.2 Chattahoochee and Alabama river systems and Middle Chattahoochee watershed boundary

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there are greater than a dozen hydroelectric dams in the Chattahoochee basin Nine dams are located in the 80-river mile stretch from West Point Reservoir to Columbus

Flows in the Chattahoochee River average 6,500 cubic feet per second (cfs) at Columbus, GA with the highest flows occurring in late winter and early spring (February to April) Average summer flows are approximately 3,500 cfs Lowest flows occur in September The minimum daily regulated flow at Columbus is 1,160 cfs with an instantaneous minimum of 800 cfs Hydropower generation will typically cause flow fluctuations from 1,000 cfs to 10,000 cfs once or twice per day

A source water assessment and protection plan has been completed for the 9 water purveyors located in the in the upper half of the Middle Chattahoochee Watershed The SWAP includes potential hazardous source inventories; dry and wet weather water quality monitoring; aquatic biology surveys; cryptosporidium, *Giardia* and bacteria indicator sampling; watershed modeling; time of travel studies; and, susceptibility determinations The long-term source water management plan includes: 1) regional organization of drinking water utilities, jurisdictions, river operators and stewards; 2) development of regional ordinances and watershed guidance; 3) implementation of a watershed-wide real-time internet-based monitoring and communications network; and 4) demonstration of adaptive technologies to improve water quality and protect drinking water sources

Problem Definition

Water in the Chattahoochee River Watershed is increasingly under demand for agriculture, municipal and industrial water supply, navigation, power generation, recreation, and the environment The U S Geological Survey (USGS) found in its National Water Quality Assessment (NWQA) study that the Chattahoochee River is impacted by, among other pollutants, elevated bacteria, with levels higher in urbanized areas Monitoring and modeling studies conducted in the Middle Chattahoochee River Watershed found that fecal coliform and *E. coli* bacteria were ubiquitous in all subwatersheds during wet weather conditions Cryptosporidium was not found to be an issue in the source water watersheds

The State of Georgia identified seventy-nine (79) stream segments located in the Chattahoochee River Basin as water quality limited due to fecal coliform bacteria; as a result, the stream segments were placed on Georgia's 303(d) list Fecal coliform bacteria are used as an indicator of the potential presence of pathogens in a water body A stream is listed as "not supporting" its designated uses if more than 10% of the water samples exceed the fecal coliform bacteria standards listed in Table 6 2

The potential cause(s) of the fecal coliform bacteria impairment in the Columbus area are assumed to include urban and non-point source runoff, wildlife, domestic animals, rodents, soil, agricultural operations, leaks from sanitary sewer systems, and CSOs The CWW implemented a $95 million CSO control program that demonstrated through post-construction monitoring and modeling that the CSOs do not cause or contribute to WQS exceedances and that the Chattahoochee River at and below Columbus is not impaired with respect to fecal coliform bacteria

Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6- 03(6)(a), 391-3-6- 03(6)(b), and 391-3-6- 03(6)(c) sets forth WQS for surface waters of the state The Chattahoochee River is subject to all WQS for fecal coliform bacteria specific to its designated uses as outlined in Table 6 2

Using fecal coliform data collected during calendar years 2000 and 2001, 30-day geometric means were calculated for stream segments in the Chattahoochee River (where at least 4 samples existed in a 30-day period) Georgia DNR attempts to collect a sufficient number of

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Table 6.2
Applicable water quality standards for Georgia

Pollutant	Designated uses	Criteria	Period
Fecal coliform bacteria	Drinking water and fishing	<200 per 100 mL (30-day geometric mean)	May-October
		<1,000 per 100 mL (30-day geometric mean)	Nov-April
		<4,000 per 100 mL (single sample)	Nov-April
		< 500 per 100 mL (30-day geometric mean) when studies show non-human sources of bacteria cause occasional excursions	May-October
Fecal coliform bacteria	Recreation	<200 per 100 mL (30-day geometric mean)	Year round
Fecal coliform bacteria	Drinking water, fishing and recreation	Compliance is based on at least 4-samples collected over a 30-day period at intervals not less than 24-hours	Any 30-day period

Source: Georgia Department of Natural Resources (2003)

samples to support the calculation of at least four geometric means in one year (two in winter and two in summer). For the Chattahoochee River, Georgia DNR used the highest geometric mean of the data set to assess when an exceedance of the standard existed and to calculate the allocation and necessary load reductions.

As with many states, the current sampling and listing process has an inherent problem. Only four ambient water quality samples are taken on a scheduled basis during a 30-day period and it is by chance that samples will at times be taken during wet weather runoff conditions. Even in undeveloped natural watersheds, wet weather conditions will significantly elevate bacteria levels. If only 4 samples are taken in a 30-day period for a 30-day geometric mean criteria and one or more of the samples were taken during wet weather runoff conditions, the calculated geometric mean has a much greater probability of exceeding the criteria than if 30-days of samples are taken to calculate the geometric mean.

This process results in listing waters that may not be impaired according to the 30-day criteria. Four-sample geometric means are less likely to be representative of the 30-day period. Once the water segment is listed as impaired for bacteria, the TMDL is prepared and no allowable frequency of excursion is considered because the frequency criteria is defined in the Georgia WQS (frequency of excursions are only defined in the listing protocol). In essence, because sampling programs are not comprehensive and not representative, all stream segments will eventually be added to the impaired water list and TMDL allocations and load reductions will be required for all streams.

The GA DNR is currently considering a water quality criteria rule change through the triennial review process that will clarify the definition of a natural variability for various constituents including among others, fecal coliform bacteria. Accordingly, a 10% excursion frequency will be allowed to determine compliance with water quality criteria. The 10% frequency of excursions is consistent with the GA DNR impaired water listing process and is supported by EPA Region 4.

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Participants and Stakeholders in the TMDL Development Process

CWW is one of the founding members of the Middle Chattahoochee Water Coalition, which includes individuals, environmental organizations, local and regional businesses, jurisdictions, educators, watershed stewards, river system operators, state regulators and water and wastewater utilities that have an interest in the Chattahoochee River, from the headwaters of West Point Lake, near LaGrange, GA, to the Florida state line. The purpose of the coalition is to ensure that the river is protected and available to meet the needs of all the groups for multiple uses such as recreation, water supply, and power generation. The Coalition is pursuing national watershed designation and an EPA Watershed Initiative grant to assist in the implementation of its adaptive TMDL framework and source water protection plan including an internet-based monitoring and communications network to facilitate a watershed based permit for the Middle Chattahoochee.

Role of the Drinking Water Utility in the TMDL Process

CWW has a vested interest in the development of TMDLs for fecal coliform bacteria primarily because they own, operate, and maintain the water and wastewater systems in the Columbus area extending through multiple jurisdictions. CWW also owns, operates and maintains the CSO treatment systems within the City of Columbus. The TMDL directly affects infrastructure requirements under the NPDES permits for these facilities. The TMDL process also affects infrastructure requirements imposed under the MS4 stormwater permit, which is the responsibility of the City Public Works Department.

Beyond infrastructure requirements necessary to meet TMDL allocations on a stormwater or wastewater utility, CWW is particularly concerned about the protection of its source water supplies. The Columbus source waters extend 80 river miles upstream and encompass approximately 1,200 square miles of watershed area. If upstream watersheds are not protective enough to meet WQS, the result will directly affect the safety of the Columbus water supply and ultimately result in additional infrastructure needs for greater reliability of its water treatment and distribution system. For these reasons, CWW took a keen interest in facilitating a comprehensive stakeholders group and promoted sound science approaches to watershed monitoring and modeling and source water assessment and protection strategies.

Development of the TMDL

The initial TMDL for the Chattahoochee River was developed in 2002; the Chattahoochee River TMDL was then updated in 2007. CWW and other stakeholders conducted a comprehensive watershed monitoring and modeling study to evaluate water quality in the Middle Chattahoochee River Watershed and to develop the TMDL. This study was completed in 2001, was peer reviewed and published by the Water Environment Research Foundation with quality assurance reviews by the EPA Office of Research and Development. Subsequent to the Middle Chattahoochee River Watershed Study, CWW prepared a TMDL for the Columbus area (Columbus TMDL), which was considered a second phase to the GA DNR TMDL for the Chattahoochee River Basin.

The Columbus TMDL was jointly submitted by the City (who holds the MS4 Stormwater Permit) and CWW (who operates the water, wastewater and CSO treatment facilities). This TMDL was developed using the monitoring and modeling study results and demonstrated that the segment of the Chattahoochee River at and below Columbus was in fact not impaired for fecal coliform

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bacteria. This determination used the calibrated BASINS model based on over 6,000 bacteria samples and a continuous model output for a nine-year period to demonstrate that the 30-day geometric mean criteria would have less than 3% excursions and the maximum value criteria would have less than 1% digressions from their respective criteria. This is far less than the 10% frequency considered in the GA DNR impaired water listing protocol.

The process of developing fecal coliform TMDLs for the Chattahoochee River Basin included determination of the following (Georgia Department of Natural Resources Environmental Protection Division 2003):

- The "current" critical fecal coliform load to each listed stream segment under "current" conditions;
- The TMDL for similar conditions under which the "current" load was determined; and
- The percent reduction in the "current" critical fecal coliform load necessary to achieve the TMDL.

The calculation of the fecal coliform load at any point in a stream requires the fecal coliform concentration and stream flow. The availability of water quality and flow data varies considerably among the listed segments. Two different approaches were used to calculate the fecal coliform load depending on data availability: Loading Curve Approach and Equivalent Site Approach. The average stream flow for the critical period was used to determine the TMDL and the corresponding monthly average discharge from each wastewater treatment facility was used to determine the wasteload allocation (WLA). The required reductions in fecal load for each stream segment to meet the TMDLs ranged from 0 to 99 percent.

The WLA is the portion of the receiving water's loading capacity that is allocated to existing or future point sources. WLAs are provided to the point sources from municipal and industrial wastewater treatment systems and CSOs that have NPDES effluent limits. There are 29 active NPDES permitted outfalls with fecal coliform permit limits in the Chattahoochee River Watershed that discharge into listed stream segments. The WLAs were calculated based on the permitted or design flows and average monthly permitted fecal coliform concentrations or a fecal coliform concentration of 200 counts/100 mL as a 30-day geometric mean. If a facility expands its capacity and the permitted flow increases, the WLAs for the affected facilities will increase in proportion to the flow. For this TMDL, these were expressed as 30-day geometric mean, presented as units of counts per 30 days.

The load allocation (LA) is the portion of the receiving water's loading capacity that is attributed to existing or future nonpoint sources or to natural background sources. Based on data available at the time of TMDL development, it was not possible to partition the load allocation by specific source. Therefore, the LA was calculated as the remaining portion of the TMDL load available after allocating the WLA and the MOS. The load reduction calculation included a margin of safety (MOS) so that the highest value would be below the stream criteria (generally to be below the 200 colonies per 100 ml summer geometric mean criteria). For this TMDL, an explicit MOS of 10 percent of the TMDL was used.

Georgia's fecal coliform criteria are seasonal. One set applies to the summer season, while a different set applies to the winter season. To account for seasonal variations, the critical loads for each listed stream segment were determined from sampling data obtained during both summer and winter seasons, when possible. However, in some cases, the available data were limited to a single season for the calculation of the critical load. The TMDL and percent reduction for each listed

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segment was based on the season in which the critical load occurred. Analyses of the available fecal coliform data and corresponding flows show that the fecal coliform violations occur during both high (wet weather) and low (dry weather) flow conditions.

TMDL Implementation

An initial TMDL Implementation Plan was developed and includes a list of BMPs and provides for an initial implementation demonstration project to address one of the major sources of pollutants identified in the TMDL. The initial plan also includes a process whereby EPD and/or Regional Development Centers (RDCs), or EPD contractors, will develop expanded TMDL Implementation Plans. State and local agencies continue to work with local stakeholders to develop a revised TMDL implementation plan.

The watershed management strategy includes the application of adaptive technologies to: 1) attenuate stormwater runoff (reducing watershed velocities and the associated sediment loads), and 2) reduce flushed pollutants (reducing organic loading). The strategy for protecting public health is to locate and remove sources of dry weather bacteria and to reduce wet weather bacteria loads through the same adaptive technologies applied for improving aquatic biology.

Benefits of Involving the Drinking Water Utility in the TMDL Process

It was obvious in the case of Columbus that CWW be a major player in the development of the TMDL process. CWW operates both the water and wastewater systems in the basin. From the drinking water utility perspective, they are the largest utility in the Middle Chattahoochee River Watershed and are located at the most downstream point in the source water watershed. Half of the watershed (1,200 square miles) is designated as drinking water supplies and the drinking water utilities are in the best position to assess water quality impacts especially related to potential pathogens. They are also a metropolitan water supplier, providing water to several jurisdictions including Ft Benning. Not only does CWW monitor and assess indicator organisms such as fecal coliform and *E. coli*, but they also sample and assess the impacts of *Cryptosporidium* and *Giardia*.

Problems Faced, Conflicts Resolved, and Obstacles Overcome

The initial, primary problem encountered with the water quality programs facilitated and implemented by the CWW was finding the funds to support the various projects. Funds were garnered through presentations and requests to local and regional businesses, Alabama and Georgia regulators, Congressional delegations, jurisdictions, project participants for in-kind services, EPA and other federal agencies, WERF, Water Research Foundation, and equipment suppliers. Much of the funds were also supplied by the CWW including significant levels of in-kind support of staff conducting field activities, operations and laboratory services.

A secondary and more perplexing problem that continues today is the difficulty in convincing Georgia regulators that the comprehensive and sound science approach taken by CWW and supported by expert peer review and an EPA quality assurance process with tens of thousands of samples and calibrated modeling should supersede the simplified handful of data approach used by the state to determine impairments and thus set initial TMDL allocations. This debate is in its sixth year of discussion and seems to be slowly moving towards resolution through water quality standard rule clarifications to be submitted in the 2007 triennial review process.

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Lessons Learned

Even though CWW facilitated the watershed stakeholder process, made sure a steering committee was formed in the beginning stage, and composed the steering committee of key players with decision making capacity (including both Georgia and Alabama regulators), the continuity between some of the members and their employer was not consummated. As a result, for example, even though steering committee members such as the regulators made or accepted decisions on data collected and protocols for analyses, acceptance and even use of the collected data were subsequently not considered by the state during the TMDL process. This led to a major delay in the TMDL implementation planning in Columbus.

WINTHROP UTILITIES DISTRICT, WINTHROP, MAINE

Drinking Water Utility Contact

Daniel Wells
Winthrop Utilities District

Introduction

This case study for Winthrop Utilities District highlights the development of TMDLs for total phosphorus (TP) in Upper Narrows Pond (in the Winthrop, ME). Excessive TP loading in the pond has resulted in plant and algal growth, which reduces water clarity. When the plants and algae die, they settle to the bottom of the pond where they are decomposed by the aerobic microbes – a process which removes oxygen from the water. In addition to the effect of limited dissolved oxygen, excess phosphorus in lakes, ponds, and reservoirs promote nuisance algae growth and algal blooms.

Background

The Winthrop Utilities District is located in south central Maine and serves approximately 3,240 people in the towns of Winthrop and Monmouth through 1,080 service connections. The current water demand is 0.27 million gallons per day (MGD) with a peak demand of 0.56 MGD (Maine Rural Water Association 2007). The sole supply of water is Upper Narrows Pond, which has a calculated safe yield of 1.7 MGD. The District treats the water using slow sand filtration, disinfection with chlorine and chloramines, pH adjustment for corrosion control, and fluoride addition for dental health. The water distribution system includes more than 20 miles of transmission and distribution mains, more than 100 hydrants, and three finished water storage facilities.

The Upper Narrows Pond, shown in Figure 6.3, is located in the town of Winthrop in Kennebec County. It has a surface area of 239 acres, a mean depth of 26 feet, a maximum depth of 59 feet, and a hydraulic residence time (how long water stays in the pond) of 243 days (Maine Rural Water Association 2007). Upper Narrows Pond is a non-colored lake (average color 18 standard platinum units [SPUs]) with an average secchi disk transparency of 5.9 meters (19.5 ft). During most summers, dissolved oxygen levels in the pond's hypolimnion range from 2 to 5 ppm (Maine DEP 2004). The water supply intake is located within the area marked by buoys in Figure 6.3. The water supply intake is protected within a 400 foot diameter "closed area" where no access is allowed. The Upper Narrows Pond has a direct watershed area of 2,729 acres

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Source: Catherine Schmitt

Figure 6.3 Upper Narrows Pond

(4.3 mi^2). Approximately 80% of the watershed is undeveloped woodland and 14% is agricultural land. The Winthrop Utilities District owns approximately 250 acres of land abutting the western shore of the pond adjacent to the water supply intake. This ownership protects approximately one mile of the total 4.2 mile shoreline from development (Drumlin Environmental 2003). The watershed boundary is outlined in black in Figure 6.4.

Problem Definition

As presented in Table 6.3, the Upper Narrows Pond is presently considered to be in an impaired state since it does not always meet WQS for water clarity depth (> 2 meters) (Maine Department of Environmental Protection 2004). Although the pond has an average Secchi disk transparency of 5.9 meters (19.5 feet), the lowest Secchi disk transparency recorded since 1976 was 2.4 meters in 1985.

Upper Narrows Pond was included on Maine DEP's 2002 303(d) list, as well as the State's Nonpoint Source Priority Watersheds list due primarily to a declining trend in dissolved oxygen levels in deep areas of the lake over the past three decades (Maine DEP 2004). Oxygen depletion has increased due to the activity of aerobic microbes that decompose organic matter in lake sediment. This activity has been linked to phosphorus levels in the pond. Phosphorus is a limiting nutrient for plant and algae growth; therefore, excessive levels of phosphorus lead to plant and algal growth, which reduces water clarity. When the plants and algae die, they settle to the bottom of the pond where they are decomposed by the aerobic microbes – a process which removes oxygen from the water. When large quantities of plant material decompose at the bottom of a lake or pond, oxygen can become depleted. In addition to the effect of limited dissolved oxygen, excess phosphorus in lakes promote nuisance algae growth and algal blooms that can result in violation of WQS as measured by water clarity depths of less than 2 meters.

The average annual total phosphorus concentration in Upper Narrows Pond is 10 ppb. In the epilimnion, total phosphorus ranges from 5 to 17 ppb (Maine DEP 2004). Phosphorus is found in area enters the pond by way of streamflow and overland drainage during storm events.

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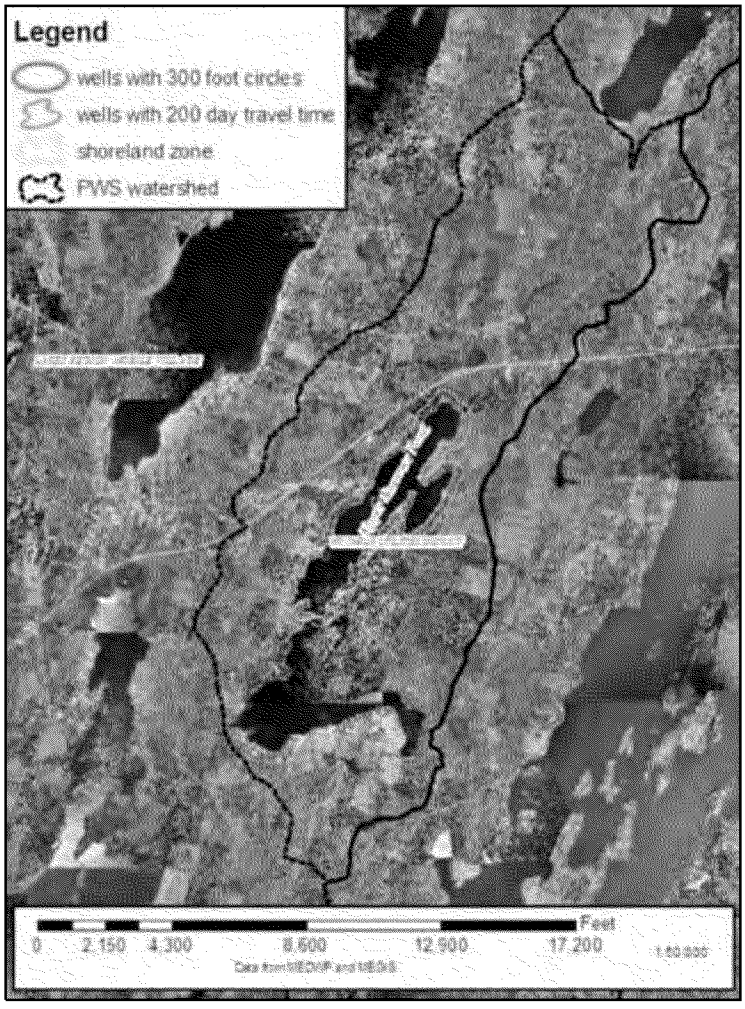

Source: Maine Department of Health and Human Services

Figure 6.4 Upper Narrows Pond Watershed

The sources of total phosphorus entering the pond from the watershed include developed land (estimated to contribute 67% of the total phosphorus), non-developed land (26% of the total phosphorus) and atmospheric deposition onto the pond surface (7% of the total phosphorus) (Maine DEP 2004). In addition, Carlton Pond, located upstream, also contributes total phosphorus to the Upper Narrows Pond.

Upper Narrows Pond is designated as a Great Pond Class A water in the Maine DEP state water quality regulations. Designated uses for Great Pond Class A waters in general include water supply, swimming, fishing, navigation, and fish and wildlife habitat. The Maine State Water Quality Standard for nutrients specifically states that "*Great Ponds Class A waters shall have a stable or decreasing trophic state (based on appropriate measures, e.g., total phosphorus, chlorophyll a, secchi disk transparency) subject only to natural fluctuations, and be free of culturally induced algae blooms which impair their potential use and enjoyment*" (July 1994 Maine Revised Statutes Title 38, Article 4-A).

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Table 6.3
Summary of water quality issues for Upper Narrows Pond

Impairment parameter, concentration range in Upper Narrows Pond	Pollutant, concentration range in Upper Narrows Pond	Source of pollutant	Maine State Water Quality Standard for nutrients*	Target goals for controlling pollutant in Upper Narrows Pond
Dissolved oxygen, 2–5 ppm in hypolimnion zone	Total phosphorus, 5–17 ppb in epilimnion zone	Non-point sources	Great Ponds Class A waters shall have a stable or decreasing trophic state (based on appropriate measures) subject only to natural fluctuations, and be free of culturally induced algae blooms which impair their potential use and enjoyment.	9 ppb total phosphorus (in-lake); water clarity depth > 2 meters; chlorophyll-*a* (<8.0 ppb)

*July 1994 Maine Revised Statutes Title 38, Article 4-A.

Participants and Stakeholders in the TMDL Development Process

Since 2002, federal, state, county, and local groups have been working together to address this nonpoint source pollution issue. The TMDL development project was funded through a CWA Section 319 grant from EPA and was directed and administered by the Maine Department of Environmental Protection (DEP) under separate contracts with the Cobbossee Watershed District (CWD), the primary stakeholder, and the Maine Association of Conservation Districts (MACD). Other contributors to the TMDL process included Kennebec County Soil and Water Conservation District; Natural Resources Conservation Service (NRCS); the Town of Winthrop; Maine Volunteer Lake Monitoring Program (VLMP); Maine Department of Inland Fisheries and Wildlife; and Friends of the Cobbossee Watershed, a water quality education and outreach organization.

Together, this group worked to identify and quantify the potential sources of phosphorus and identify BMPs for watershed management. The CWD conducted watershed survey work, including a shoreline survey and assessments of nonpoint pollution sources, to help identify total phosphorus reduction techniques that would be applicable and beneficial in the watershed. The CWD also conducted an agricultural survey of individual farmers in the watershed. The group prepared a phosphorus control action plan that also serves as a TMDL report.

Role of the Drinking Water Utility in the TMDL Process

On July 20, 2004, the CWD Project Manager met with the Winthrop Utility District's Board of Trustees to explain the TMDL process, and the scope of services that CWD would be providing in preparation of the TMDL. The Trustees were told there would be a TMDL written for Upper Narrows Pond to set goals for reducing phosphorus levels. In addition, the District was invited to provide input to the draft TMDL report.

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Development of the TMDL

The Upper Narrows Pond TMDL process for total phosphorus was initiated in the summer of 2002. During the spring and summer of 2004, several local education/outreach meetings on the TMDL development process occurred with the Winthrop Utilities District, CWD Board of Trustees, and town officials. The purpose of the TMDL for Upper Narrows Pond was to address the declining trophic status due to excessive phosphorus loading from nonpoint sources. A numeric water quality target of 9 ppb total phosphorus, which is predicted to result in the attainment of water quality standard, was established for the TMDL. The numeric target was selected based on available water quality data corresponding to continued maintenance of non-bloom conditions, as reflected in measures of both Secchi disk transparency (>2.0 meters) and chlorophyll-*a* (<8.0 ppb) levels in non-colored water. Based on both historical records and Maine DEP's analysis of a statewide limnological database for non-colored lakes, the target of 9 ppb total phosphorus is a highly conservative goal because "nuisance algal blooms (plankton growth of algae which causes Secchi disk transparency to be less than 2 meters) are more likely to occur at ≥18 ppb total phosphorus. Therefore, based on state data, a total phosphorus level of 17 ppb would not likely allow algal blooms to occur.

The TMDL development approach included the following steps:

1. Collection of background information by reviewing previous reports, conducting phone interviews and personal interviews, and taking field tours of the watershed.
2. Collection of land use data from analysis of GIS and topographic maps, town property tax maps and tax data, aerial photographs, personal consultation, and field visits.
3. Gathering of roadway data by taking actual road width measurements and consulting GIS and USGS topographic maps.

The load allocation for Upper Narrows Pond is 177 kg total phosphorus per year based on a target goal of 9 ppb in-lake phosphorus levels. The loading capacity was set to protect water quality and uses during critical conditions, which occur during the summer season when environmental conditions (e.g., higher temperatures, increased light intensity, etc.) are most favorable for aquatic plant growth. The loading capacity was expressed as an annual load, as opposed to a daily load, because the lake basin has a relatively low flushing rate (1.50 flushes per year). Analysis revealed that direct external sources of total phosphorus constitute 207 kg per year of loading to the pond.

The wasteload allocation component of the TMDL was set equal to zero due to the nonexistence of point source discharges in the watershed (Maine DEP 2004). Further, according to Maine statute, "There may be no new direct discharge of pollutants into Great Pond Class A waters" [38 MRSA 465-A (1) (c)].

The Upper Narrows Pond TMDL includes an implicit margin of safety through the relatively conservative selection of the numeric water quality target of 9 ppb total phosphorus as well as the selection of relatively conservative phosphorus export loading coefficients for cultural pollution sources (Table 3 in Maine DEP 2004). Further, the difference between the in-lake target of 9 ppb and 17 ppb (i.e., the level over which algal blooms are likely to occur) represents a 47% implicit margin of safety for Upper Narrows Pond. An additional unquantified margin of safety for attainment of state water quality goals is provided by the inherently conservative methods used to estimate future growth (Maine DEP 2004).

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The Upper Narrows Pond TMDL took into account seasonal variations as the allowable annual load was developed to be protective of the most sensitive time of year - during the summer, when conditions most favor the growth of algae and aquatic macrophytes (Maine DEP 2004). Further, the TMDL is protective of all seasons, given the lake's flushing rate of 1.5 flushes/year, and the fact that BMPs (implemented and proposed) have been designed to address TP loading during all seasons.

TMDL Implementation

The total phosphorus reduction needed to restore WQS in Upper Narrows Pond was estimated to be approximately 35 kg annually. This assumes an additional 15 kg contribution to the lake from future watershed development. The Upper Narrows Pond TMDL recommends four action items to address the following sources of pollution: individual action of landowners and shoreline erosion, septic system phosphorus loading, and roadways. The recommendations are as follows:

1. Activate the Narrows Pond Improvement Association to take a proactive role in implementing the TMDL. Participants include shorefront landowners, CWS, WUD, and other concerned citizens.
2. Provide incentives for shorefront landowners to establish and maintain vegetated buffers that catch sediment and other pollution before it reaches the lake or stream.
3. Promote public education about septic system impacts and possible cost-effective solutions. Identify old and poorly functioning septic systems.
4. Continue monitoring watershed roadways.

As a parallel effort to help implement the TMDL and balance source water protection with other watershed activities, an Upper Narrows Pond Source Water Protection Plan was developed in 2007 (Maine Rural Water Association 2007). A local stakeholder group was formed to identify potential contaminant sources and to develop protection measures. Program funding is provided by the U.S. Department of Agriculture Farm Services Agency under the state's Source Water Protection Program. Stakeholder representatives include:

- Winthrop Town Manager
- CWD Executive Director
- Winthrop Utilities District Superintendent
- Winthrop Utilities District Board Member
- Winthrop Code Enforcement Officer
- Maine Rural Water Association Source Water Program Manager

The stakeholders identified seven objectives to meet their goal (Maine Rural Water Association 2007):

1. Create or revise local source water protection laws
2. Increase education and outreach to the watershed and service area communities
3. Increase capacity for emergency response and contingency planning

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4. Implement BMPs for erosion and sedimentation control at the District pump house, the boat launch, and throughout the watershed
5. Manage water levels in the pond to minimize shoreline erosion
6. Minimize the potential for hazardous materials spills
7. Provide DEP with an updated watershed boundary

Benefits of Involving the Drinking Water Utility in the TMDL Process

Involvement in the TMDL process has helped the District keep up-to-date on watershed activities and decision-making about source water quality. The District has found it is more constructive to provide input during the formulation and development of decisions rather than at the tail end of the process. The state benefits from the involvement of drinking water utilities in the TMDL process by achieving consensus from all interested parties as TMDL development progresses. This approach conserves state resources that would otherwise be spent on resolving differences among stakeholders about the conclusions of a TMDL report if it were prepared by one party.

Problems Faced, Conflicts Resolved, and Obstacles Overcome

During the TMDL process, a difference of opinion became apparent regarding what constitutes acceptable pollution levels in Upper Narrows Pond. Many interested stakeholders had difficulty understanding the different water quality requirements for drinking water supplies versus other uses of the pond. Winthrop Utilities District expressed concerns emphasizing the importance of Upper Narrows Pond as the primary drinking water supply for the Towns of Winthrop and Monmouth. The District typically uses stricter water quality goals in order to maintain compliance with drinking water regulations. The slow sand filtration facilities cannot accommodate wide ranges in source water quality so the District strives to maintain or improve source water quality. For example, if source water turbidity exceeds 1 NTU for a long period of time, the filters become clogged and require extensive maintenance. Also, large changes in flows or loading to the filters can cause short circuiting which can affect treatment effectiveness.

The District has invested $2million in the water treatment facility located at Upper Narrows Pond and does not have intakes on any other sources of supply. Therefore, the District believes that it is important to continue to list Upper Narrows Pond as an "at risk water body" to maintain source water quality.

The CWD, on the other hand, has considered requesting that Maine DEP remove Upper Narrows Pond from the list of impaired waters. This issue is still unresolved. One possible solution is to have the TMDL report address water quality needs for the drinking water supply separately from water quality needs for other uses of the pond, such as swimming and fish habitat.

Lessons Learned

The primary lesson that Winthrop Utilities District learned from the TMDL process is that every participant and stakeholder looks at water quality from their own perspective. The acceptable pollution level for fishing or boating is higher than what is needed for a drinking water supply. Drinking water utilities are advised to do their homework in advance of the TMDL process. They should approach the TMDL development process with an understanding of what levels of phosphorus or other contaminants are necessary to achieve in order to protect their supply's drinking water quality.

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PHILADELPHIA WATER DEPARTMENT, PHILADELPHIA, PENNSYLVANIA

Drinking Water Utility Contact

Jason Cruz
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Introduction

This case study for Philadelphia Water Department (PWD) highlights the development of two TMDLs for Wissahickon Creek, for nutrients and siltation. PWD's interest in TMDL development for the Wissahickon Creek is driven by concern for its water supply and because the City of Philadelphia has a permitted discharge into the creek. PWD has intermittent taste and odor episodes due to geosmin and MIB, two compounds produced by algae. PWD is also concerned about high nitrate concentrations. These water quality concerns may be alleviated by reducing nutrient concentrations in the creek.

Background

The PWD provides drinking water to 1.6 million people using water from the Delaware and Schuylkill Rivers. The Delaware River supply provides drinking water to 60% of the City's population and parts of Lower Bucks County. The Schuylkill River source, which has a higher mineral content and is slightly harder than water from the Delaware River, serves 40% of the City's population. Wissahickon Creek and its watershed is a subbasin in the Schuylkill River Watershed.

The Wissahickon Creek, shown in Figure 6-5, and its watershed, illustrated in Figure 6-6, encompass an area of 64 square miles, which includes 15 municipalities in Montgomery County and the City of Philadelphia. Wissahickon Creek begins in Montgomery Township and flows for approximately 23 miles where it enters the Schuylkill River. The watershed includes extensive park and recreational areas. Land use within the watershed includes: urban development, which is estimated to represent about 50% of watershed area (Carrick and Godwin 2006); forest (24%); agriculture (23%); and wetlands (<1%). Urban development is further described by EPA (2003b) as low-intensity residential (39% of watershed area), and a mix of high-density residential and urban (12%).

Problem Definition

The Wissahickon Creek has been negatively impacted by excess nutrient input from municipal wastewater treatment plants and siltation due to storm water runoff and stream bank erosion. "Excessive nutrients foster an unhealthy and expanded growth in primary production which decreases DO levels in the stream when these organisms respire in evening hours or when they are broken down by bacterial agents at the completion of their life-cycle" (EPA 2003). "Excessive sediment loading and siltation are detrimental to the biological community for many reasons. Siltation reduces the habitat complexity through the filling of pools and interstitial spaces between gravel and sand. Excess sediment can clog an organism's gill surfaces, which decreases its respiratory capacity. This pollutant also impacts visual predators by negatively impacting their ability to hunt and feed in a more turbid environment" (EPA 2003).

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Source: Philadelphia Water Department

Figure 6.5 Wissahickon Creek

The creek has experienced nuisance algal growth, eutrophication, and violations of State water quality criteria for dissolved oxygen. The high nutrient levels are the likely cause of nuisance levels of algae observed throughout the watershed and fluctuations in dissolved oxygen levels and pH. Dissolved oxygen sampling in 1999 and 2002 showed repeated violations of state WQS (Myers et al. 2007). Storm water flow rates have become magnified by increased urban development including increased impervious areas, and the presence of culverts, bridges, and dams.

Wissahickon Creek is listed on the State of Pennsylvania's Section 303(d) list of impaired waters based on biological investigations by PA DEP that documented impacts on aquatic life and exceedances of dissolved oxygen criteria (Pennsylvania DEP 2006). The creek's "potable water supply" use designation is listed as impaired due to pathogens from an unknown source. The creek's "aquatic life" use designation is listed as impaired due to organic enrichment and low dissolved oxygen levels. The source of organic enrichment and low dissolved oxygen levels is listed as urban runoff and storm sewers.

Carrick and Godwin (2006) estimated water quality conditions and watershed nutrient loadings using an analysis of periphyton biomass. The study found very high levels of total phosphorus (TP) (average 1.91 mg/L), and total nitrogen (TN) (average 8.97 mg/L) compared to streams in the worldwide database (average TP and TN 0.24 and 1.66 mg/L, respectively). High levels of periphyton biomass (as represented by chlorophyll measurements, average 201.5 mg/m^2) were also found in Wissahickon Creek as compared to the worldwide database (average chlorophyll of 37 mg/m^2). Based on sampling results, the ecosystem appears to be overloaded with nutrients and the periphyton biomass is no longer limited by TN or TP. As a result of this analysis, a target total phosphorus concentration in the range of 0.11 mg/L to 0.31 mg/L was determined to be likely to support acceptable levels of algal periphyton biomass (in the range of 50–100 mg/m^2) and avoid nuisance growth in Wissahickon Creek.

Integrated hydrodynamic and water quality modeling was conducted by Myers et al. (2007) to study the cause of the dissolved oxygen impairment in Wissahickon Creek, and to support the

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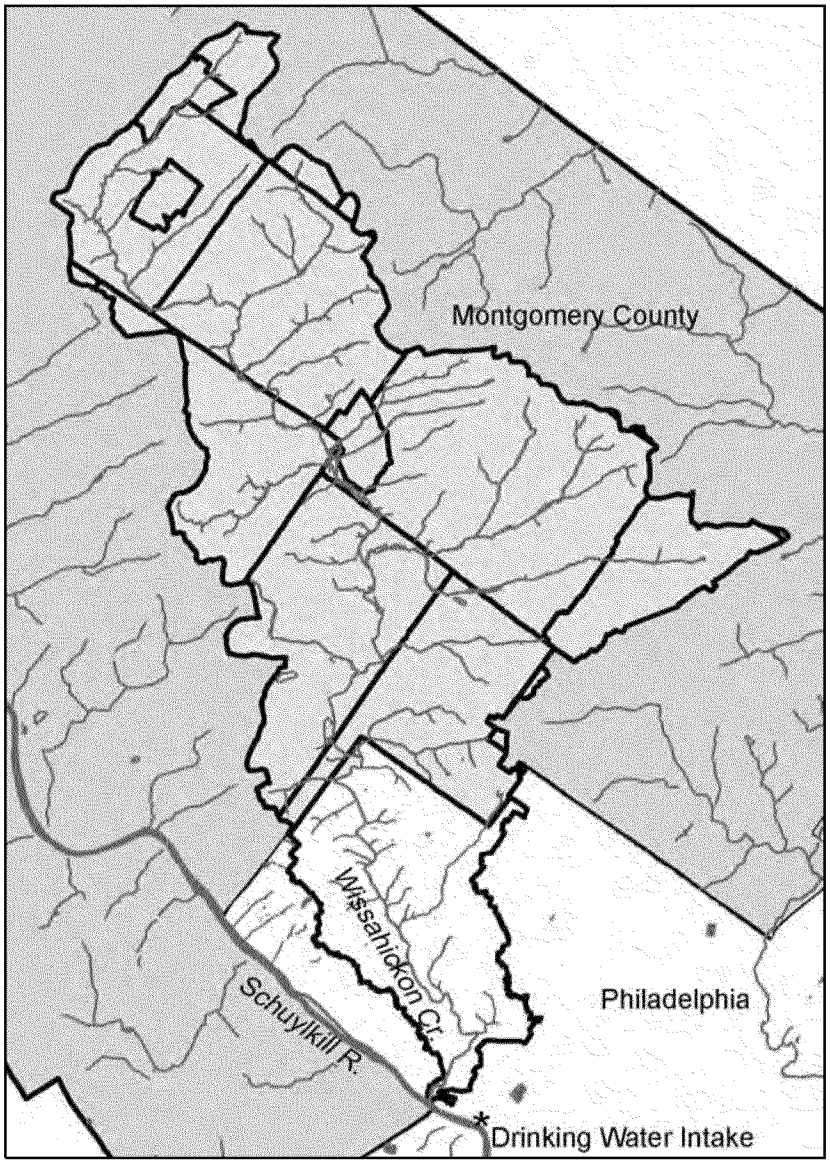

Source: Jason Cruz.

Figure 6.6 Wissahickon Creek Watershed

nutrient TMDL development. Historical data linked high nutrient levels in the creek to large diurnal fluctuations in dissolved oxygen. The modeling study results indicate that periphyton dynamics play an important role in impacting dissolved oxygen conditions in the Wissahickon Creek and its tributaries.

Pennsylvania Code, Title 25, Chapter 93 sets forth WQS for surface waters of the state. Wissahickon Creek is subject to all water quality criteria specific to the trout stocking designated use (dissolved oxygen only) and general statewide uses for aquatic life, water supply, and recreation, as outlined in Table 6.4. Further, water quality criteria for total dissolved solids, nitrite-nitrate, phenolics and fluoride established for the protection of potable water supply shall be met at least 99% of the time at the point of all existing or planned surface potable water supply withdrawals (Pennsylvania Code Title 25 Chapter 96 section 96.3(d). These requirements formed the basis of the nutrient TMDL for Wissahickon Creek.

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Table 6.4
Applicable water quality standards for Pennsylvania

Pollutant	Designated use	Criteria	Period
Dissolved oxygen (mg/L)	Trout stocking	Minimum daily average, 6.0; Minimum, 5.0	February 15 to July 31
	Warm water fishes	Minimum daily average, 6.0; Minimum, 5.0	Remainder of year
Nitrite + Nitrate as Nitrogen (mg/L)	Potable water supply	Maximum, 10.0	Year round
Fecal coliform (# per 100 mL)	Potable water supply	Maximum of 5,000 coliforms per 100 mL as a monthly average value	Year round
Chloride (mg/L)	Potable water supply	Maximum, 250	Year round
Sulfates (mg/L)	Potable water supply	Maximum, 250	Year round
TDS (mg/L)	Potable water supply	Maximum, 750; Monthly average, 500	Year round
TRC (mg/L)	Warm water fishes	4 day average = 0.011; 1-hour average – 0.019	Year round
Ammonia nitrogen	Aquatic life	pH and temperature dependent	Year round

Source: Pennsylvania Code, Title 25, Environmental Protection, Chapter 93.

Participants and Stakeholders in the TMDL Development Process

The TMDL process involved several participants and stakeholders including the PWD, the PA DEP, the National Institute for Environmental Renewal (NIER, now defunct), EPA, Wissahickon Valley Watershed Association (WVWA), Fairmount Park Commission (FPC), and Tetra Tech under contract with EPA. NIER collected watershed data, water quality data and conducted TMDL modeling. PA DEP conducted biological investigations that identified observed impacts on aquatic life and exceedances of dissolved oxygen criteria in Wissahickon Creek and its tributaries. PA DEP has also developed and is implementing Pennsylvania's Comprehensive Stormwater Management Policy statewide.

Role of the Drinking Water Utility in the TMDL Process

PWD has a vested interest in the TMDL process for Wissahickon Creek because of the significant contribution of Wissahickon Creek water to the water supply intake on the Schuylkill River. At times, Wissahickon Creek water represents 30% of the total water at the intake location. PWD was primarily interested in the nutrient TMDL due to concerns with nitrate levels, and tastes and odors due to MIB and geosmin from algal growth in the water supply. At the same time the TMDL was being developed, PWD was conducting a source water assessment for the Schuykill River source. The source water assessment included evaluations of land use, an acid mine drainage issue, and wastewater treatment facilities in the watershed.

To provide assurances that the nutrient TMDL for Wissahickon Creek does not impact the water supply designated use of the Schuylkill River, EPA (2003) conducted analyses to ensure compliance with water quality criteria, in particular the nitrate/nitrite standard, at the Queen Lane water intake. In addition to the nitrate/nitrite issue at the drinking water intake, PWD communi - cated concerns to EPA through the public comment period over the following issues:

- Whether wasteload allocations would be fully protective of the stream's designated use, specifically whether these allocations would jeopardize the Department's efforts

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to improve water quality within the City of Philadelphia, as well as the downstream trout fishery and aesthetic resources within Wissahickon Creek Valley Park.

- Hydrologic inputs in the water quality model and specifically how the 7Q10 flow was estimated in light of the contribution from wastewater discharges. Also, PWD questioned whether modeled conditions would be protective of downstream water quality in the event of cessation of groundwater pumping from Coorson's quarry.

In subsequent revisions to the nutrient TMDL, PWD provided additional comments expressing concern over parameterization of periphyton (attached algae) within the water quality model, and the fact that the calibrated model underestimated the severity of diurnal fluctuations in DO. PWD also made DEP and EPA aware of a severe taste and odor episode centered in the Wissahickon Creek watershed during spring 2006.

The Wissahickon Watershed Partnership was re-initiated by the Philadelphia Water Department in November of 2005 with the task of creating an Integrated Watershed Management Plan for this area.

Development of the TMDL

In October 2003, EPA finalized the Wissahickon Creek TMDLs for nutrients and siltation (EPA 2003). To address the nutrient impairment, TMDLs were established for ammonia nitrogen, nitrate-nitrite nitrogen, orthophosphate and carbonaceous biochemical oxygen demand. For siltation impaired stream segments, EPA established TMDLs based on target load endpoints estimated from a reference unimpaired watershed. TMDLs were determined using the most stringent available dissolved oxygen criteria necessary to provide aquatic life protection, including trout stocking for the period February 15 to July 31, and warm water fish habitat (remainder of the year).

Separate methodologies were used to develop the nutrient and siltation TMDLs. To determine the nutrient TMDL for Wissahickon Creek, a low-flow steady-state model was used to simulate conditions that are most likely to occur during critical low flow periods. The model focused on point sources as the major source of nutrients for the Wissahickon Creek watershed. "To achieve water quality endpoints in the stream segments, multiple scenarios were modeled to account for varying discharge concentrations and conditions" (EPA 2003).

Results of field measurements and data analysis show that most siltation events affecting Wissahickon Creek occur during wet weather events when the highest rates of surface water runoff and streambank erosion occur. "Because all of the Wissahickon Creek Watershed is considered an urbanized area subject to coverage by MS4 stormwater permits, all sources of siltation to Wissahickon Creek and tributaries are considered by EPA as point sources (EPA 2003). To assess the relative loads of sediment from different land uses within the watershed, EPA used unit area loading rates specific to each land use (EPA 2003).

A "reference watershed approach" was used to develop the siltation TMDL. A TMDL was established for each impaired stream section in the watershed. The impaired watershed was matched with a reference watershed. A watershed model was used to evaluate sediment loads from different sources. "…the model was applied to both the impaired and the reference watershed, and results were compared with available monitoring data in the impaired watershed. The sediment loads calculated for the reference watershed were used as endpoints for the impaired watersheds. TMDLs were then developed for the impaired watersheds using those endpoints as the measure of adequate water quality and protection of aquatic life uses." (EPA 2003) To meet these water

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Table 6.5
Wasteload allocations for nutrient TMDL (February 15-July 31/remainder of year)

Point source discharger	Flow (cfs)	$CBOD_5$ (mg/L)	NH_3-N (mg/L)	NO_3+NO_2-N (mg/L)	Orthophosphate (mg/L)
Upper Dublin Township*	1.7	12.77/15.0	2.25/2.5	36.71/32.85	1.45/2.3
Abington Township*	6.05	7.5/10.0	0.72/2.0	30.27	1.85/4.63
Valley Green Corporate Center	0.013	10.04	1.97	18.78	3.13
Sayers, David and Marie	0.0008	9.99	2.24	4.98	0.52
Murray SRSTP	0.0008	9.90	0.52	0.99	0.52
Harris, Albert & Cynthia	0.0006	10.04	2.98	8.00	0.53
Borough of North Wales*	1.29	3.0/5.90	0.5/1.37	15.16/21.22	1.41/2.4
Upper Gwynedd Township*	8.82	5.0/8.5	0.74/1.62	20.08/19.05	1.82/3.22
Bruce Entwisle	0.001	9.92	2.97	1.0	0.49
Merck and Company	0.03/0.1	5.01/1.26	0.10/0.02	0.2/0.86	0.27/2.28
Ambler Borough Water Department*	0.027	5.3	0.11	0.21	0.28
PA Historical & Museum Commission	0.002	24.98	20.0	30.13	0.52
David Fishbone	0.001	9.99	2.97	5.94	0.37
Ambler Boro	10.1	10.0	1.5	30.52	4.68

Source: EPA 2003.
*Wastewater treatment facilities.

quality endpoints, the point source dischargers need to make reductions in the nutrient loading to the watershed.

Wasteload allocations for the nutrient TMDL, summarized in Table 6.5, were established for point source dischargers including several wastewater treatment facilities located in the watershed that have NPDES permits. Effluent water quality from the dischargers was modeled assuming wastewater effluent dissolved oxygen concentrations of 7.0 mg/L. Wasteload allocation parameters include CBOD, ammonia nitrogen, nitrate, nitrite and orthophosphate. In order to meet these wasteload allocations, the TMDL recommends that five wastewater treatment facilities (indicated with an asterisk in Table 6.5) have their NPDES permits modified when next reissued to reduce the amount of pollutants discharged. The recommended reductions in pollutants include orthophosphate concentration by 37–70%; $CBOD_5$ by 15–70%; and ammonia concentration by 15–80%. Load allocations for the nutrient TMDL, summarized in Table 6.6, are based on water quality sampling conducted by PA DEP in the summer of 2002. It was determined that no load reductions are needed for nonpoint sources (background levels) of nutrients.

Wasteload allocations for the siltation TMDL were assigned to each of five MS4 sources based on sediment loading from land uses and stream bank erosion within the municipal boundaries. Of the 13 NPDES permitted dischargers permitted to discharge specific amounts of sediment (measured as total suspended solids) in the watershed, none required reductions to their NPDES permit limits. Load allocations for the siltation TMDL were determined by dividing the Wissahickon Creek watershed into five sub-watershed to match the size of the reference watershed (EPA 2003). Load allocations were assigned to the upstream sub-watersheds where the sediment load originates from sources outside the watershed.

WQS for dissolved oxygen vary seasonally because of more stringent dissolved oxygen requirements for trout stocking during the period February 15 through July 31. Seasonal dissolved

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Table 6.6
Load allocations for nutrient TMDL (February 15-July 31/remainder of year)

Stream segment	Flow (cfs)	$CBOD_5$ (mg/L)	NH_3-N (mg/L)	NO_3+NO_2-N (mg/L)	Orthophosphate (mg/L)
Background, various segments	0.11–0.3	1.19–1.20	0.03–0.04	0.1–1.0	0.02–0.1
Trewellyn Creek, various segments	0.3	0.9	0.03	0.10	0.01
Pine Run	0.18–1.87	1.2–10.83/ 1.2–12.74	0.04–1.92/ 0.04–2.14	1.0–33.33/ 1.0–29.85	0.10–1.29/ 0.1–2.05
Coorson's Quarry	12.5	1.84	0.02	2.00	0.03
Wissahickon Creek, various segments	10.19–41.61	2.84–6.02/ 4.3–6.97	0.36–0.87/ 0.74–1.42	18.16–24.27/ 18.01–24.18	1.61–3.1/ 2.5–3.71
Sandy Run	8.0	6.49/8.32	0.78/1.68	30.38/29.65	1.63/3.82
Lorraine Run	12.51	1.72	0.02	2.0	0.02

Source: EPA 2003.

oxygen criteria were used in developing separate nutrient TMDLs for the trout stocking period and the remainder of the year designated for warm water fishery needs.

Higher nutrient concentrations are typically present in Wissahickon Creek during the summer low-flow period because less water is available to dilute point discharges into the creek. Also, increased biological activity in the creek occurs during warmer, low-flow conditions.

Seasonal variations considered in the siltation model include daily time steps for weather data and water balance calculations, and monthly variation of daylight hours and growing season parameters.

TMDL Implementation

Load reductions proposed by nutrient and siltation TMDLs require specific watershed management measures to ensure successful implementation. To provide additional base flow for low-flow periods, the TMDL recommends BMPs that encourage infiltration through either stormwater retention or stream buffer zones. BMPs to increase base flow will improve the assimilative capacity of the creek for point source discharges. EPA also recommends that additional tree canopy be provided along the stream banks to increase shading and potentially reduce biological activity in the creek that is contributing to reduced dissolved oxygen levels in violation of WQS (EPA 2003).

The nutrient TMDLs and wasteload allocations for five municipal wastewater treatment facilities are based on the assumption that the facilities' NPDES permits will be revised (at next renewal) to require an effluent dissolved oxygen level of 7.0 mg/L as a daily minimum. To provide flexibility in implementing the NPDES permit renewals, EPA (2003) developed alternate scenarios with equally protective TMDLs, wasteload allocations and effluent dissolved oxygen levels.

In order to achieve the water quality goals of the siltation TMDL, EPA (2003) notes that substantial reductions in the volume of water delivered to the creek must be achieved in addition to reductions in sediment load.

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Benefits of Involving the Drinking Water Utility in the TMDL Process

PWD was in an interesting position during the development of the Wissahickon Creek TMDLs, as both a regulated entity (siltation) and a downstream water supplier affected by the wasteload allocations to dischargers upstream (for both nutrient and siltation TMDLs). PWD was able to provide valuable water quality data from years of studying the Wissahickon Creek both independently and in partnership with other agencies.

The TMDL stakeholder process allowed PWD to express its concerns about how TMDLs might affect conditions at drinking water supply intakes, as well as concerns about the City of Philadelphia's goals for water quality and aesthetics in Wissahickon Creek. Furthermore, PWD's efforts to research and understand the role of attached algae in regulating dissolved oxygen conditions allowed the drinking water utility to inform the regulators and their contractors about possible deficiencies in the water quality modeling used to support development of the nutrient TMDL.

Problems Faced, Conflicts Resolved, and Obstacles Overcome

During the public comment period for the draft TMDL report (issued June 2003), PA DEP stated that the TMDL did not address "nuisance algae" (reference public comments). In January 2005, PA DEP requested that EPA reconsider the 2003 TMDL for nutrients. Specifically, PA DEP wanted EPA to address "nuisance algae" using endpoints of 100 mg chlorophyll *a*/m^2 periphyton and 0.24 mg/L total phosphorus (Hall and Hall 2007). In 2005, EPA and PA DEP recalibrated the original model using more restrictive phosphorus limits. The revised TMDL is expected to include year round total phosphorus limits of 0.24 mg/L or less.

Myers et al. (2007) found that it is not feasible to control the periphyton biomass in Wissahickon Creek by reducing the nutrient load from point sources since under critical conditions for dissolved oxygen impairment (summer low flow periods), the required reduction of phosphorus is unreasonably high.

Myers et al. (2007) questioned the model input values and model validation procedures used for the Wissahickon Creek TMDL model that will be used by regulatory agencies to set discharge permit limits to meet in-stream standards for minimum daily dissolved oxygen concentration. In particular, Myers et al. (2007) express concerns that the model over-estimated the daily minimum dissolved oxygen concentrations at sampling locations located downstream of municipal wastewater treatment discharges. If the model is used as currently validated, model results may lead to selection of discharge limits on oxygen-demanding substances that will be too high to meet dissolved oxygen standards.

Lessons Learned

From the experience with the Wissahickon Creek TMDLs, PWD learned the importance of participating in the TMDL stakeholder process as early as possible, especially where drinking water supplies are located downstream of regulated point source discharges. The importance of water quality sampling data, especially long-term, continuous water quality data, cannot be overstated.

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AQUA PENNSYLVANIA, BRYN MAWR, PENNSYLVANIA

Drinking Water Utility Contact

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Introduction

This case study provides an example of a drinking water utility involved in gathering data that were used by the State during the development of the TMDL for Green Lane Reservoir. The reservoir has a history of nuisance algae blooms. Sedimentation has also filled in some of the upper portions of the reservoir, but has not appreciably affected the storage capacity of the 4.5-billion-gallon reservoir. A nutrients TMDL was developed for Green Lane Reservoir to address the organic enrichment.

Background

Green Lane Reservoir is an 814-acre reservoir located in Montgomery County, in south-eastern Pennsylvania. Aqua America owns the reservoir, which discharges an average 165 million gallons per day into the Perkiomen Creek and supplies water to approximately 140,000 customers. Figure 6.7 provides a photo of the reservoir from its dam.

Green Lane Reservoir is the focal point of Green Lane Reservoir Park. The 2,338 acre park is used for fishing, boating, swimming, hiking, and horseback riding. Green Lane Reservoir Park and adjacent Upper Perkiomen Valley Park receive nearly one million visitors a year. The park is owned and operated by the Montgomery County Department of Parks. Much of the land comprising the park was acquired from Aqua in 1983 in an arrangement that also provided the county with an easement for public use of the water for limited recreational uses (e.g., boating is permitted but gasoline engines are not allowed; swimming is not permitted). Aqua retained ownership of the reservoir and a narrow strip of land around the reservoir plus a few other key parcels of land.

The entire Green Lane Reservoir Watershed encompasses approximately 45,400 acres. Land uses in the watershed are primarily forested (approximately 54%) and crop and hay/pasture (approximately 40%). There are 14 point source discharges in the watershed. The reservoir is fed by three main tributaries: West Branch Perkiomen Creek, Main Branch Perkiomen Creek, and Molasses Creek. Water released from Green Lane Reservoir to the Perkiomen Creek flows through Knight Lake, a small impoundment formerly used for producing ice in the 19th century, and adjacent to another small impoundment, Deep Creek Lake, owned by Montgomery County. It then flows downstream approximately 18 miles where it is withdrawn at a low intake dam just upstream of the confluence with the Schuylkill River, the largest tributary of the Delaware River. The entire stretch of the Perkiomen Creek from Green Lane to Audubon benefits from the augmented flows created by this impoundment and release and withdrawal arrangement. A map of the watershed is provided in Figure 6.8.

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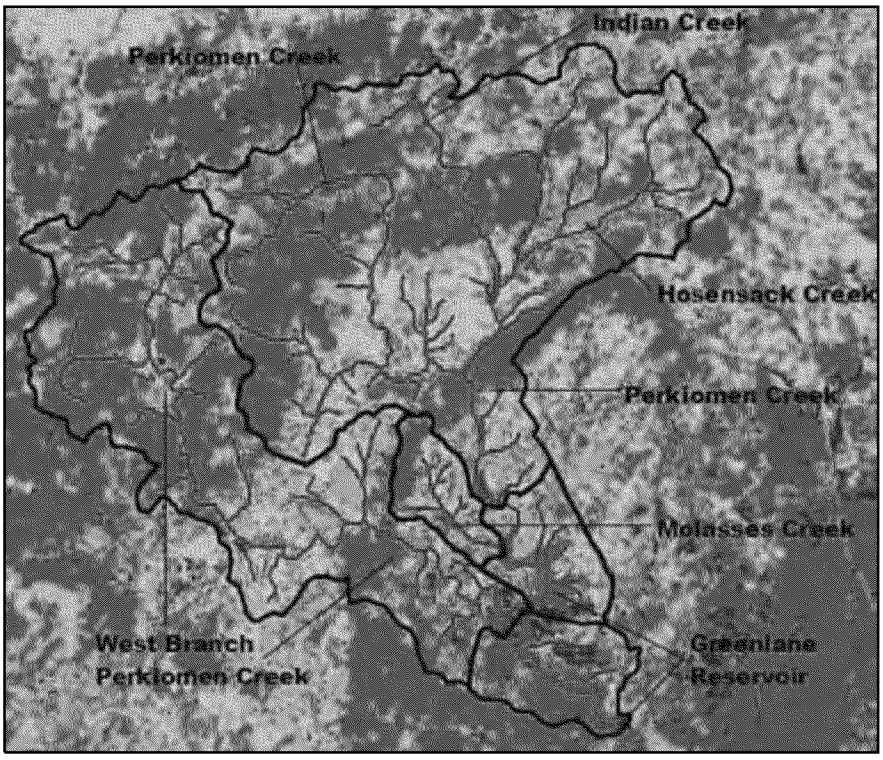
Source: EPA 2003

Figure 6.7 Green Lane Reservoir



Source: EPA 2003

Figure 6.8 Watershed map

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Table 6.7
Summary of water quality issues for Green Lane Reservoir

Impairment parameter	Pollutant concentration range in Green Lane Reservoir	Source of pollutant	Pennsylvania state WQS for nutrients	Target goals for controlling pollutant in Green Lane Reservoir
Organic enrichment, measured as chlorophyll *a*	5.5–76.7 mg/L	Agriculture	General narrative water quality criteria	20 mg/L chlorophyll *a* as a seasonal average

Problem Definition

Green Lane Reservoir has a history of nuisance algae blooms. Sedimentation has also filled in some of the upper portions of the reservoir, but has not appreciably affected the storage capacity of the 4.5-billion-gallon reservoir. Eutrophication and depleted oxygen at depth in the summer limit the quality of the warm water fishery in the reservoir. The algae and eutrophication can be aesthetic considerations for recreational users of the impoundment and the surrounding park, though they have never presented a drinking water quality problem, in part because of the long distance from the point of release to the point of withdrawal. The water quality issue at Green Lane Reservoir is further summarized in Table 6.7.

In 1996, Green Lane Reservoir was added to Pennsylvania's 303(d) list because it was not deemed to be supporting its aquatic life use and was deemed to be impaired by organic enrichment and low dissolved oxygen due to agricultural sources. Pennsylvania's decision to list Green Lane Reservoir on the 303(d) list of impaired water bodies was based to a great extent on the results of an EPA-funded Clean Lakes Study conducted from 1993 through 1995. The Clean Lakes Study was carried out by F.X. Browne, Inc. with assistance from Aqua (at that time, Aqua was named Philadelphia Suburban Water Company). Additional studies performed by PA DEP, USGS, and EPA provided additional water quality data that justified the 303(d) listing.

Phosphorus concentrations measured during these studies indicated that Green Lane Reservoir was hyper-eutrophic (overly productive) and was not supporting its aquatic life use due to excessive organic enrichment of the water. The reservoir serves as a settling basin for runoff from surrounding agricultural land. Algae blooms, siltation, and excessive nutrients have been documented in the tributaries draining into the reservoir.

In 2002, the 303(d) listing was revised for the reservoir. Data collected in the late 1990s and early 2000s established that the reservoir was not actually impaired due to low dissolved oxygen. As a result of this finding, PA DEP prepared a TMDL for Green Lane Reservoir that addressed organic enrichment only and not low dissolved oxygen.

According to Title 25, Chapter 93, Water Quality Standards, Section 93.6 of the Pennsylvania Code, all surface waters in the state shall be protected for the following uses: warm water fishes, potable water supply, industrial water supply, livestock water supply, wildlife water supply, irrigation, boating, fishing, water contact sports and aesthetics. Pennsylvania does not have specific numeric water quality criteria for organic enrichment to support these designated uses. The state does, however, have the following general water quality criteria that can be interpreted to identify an acceptable water quality endpoint:

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1. Water may not contain substances attributable to point or nonpoint source discharges in concentrations or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life; and
2. In addition to other substances listed within or addressed by this chapter, specific substances to be controlled include, but are not limited to, floating materials, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits.

Participants and Stakeholders in the TMDL Development Process

Before the TMDL was developed, a coalition of stakeholders had already begun to work together to implement BMPs in the watershed. Chief among these was the Upper Perkiomen chapter of Trout Unlimited. The Pennsylvania Fish and Boat Commission, county agricultural extension agents, the county conservation district, and Aqua all also played active roles in this effort. Together these groups, and eventually others, installed BMPs along more than 20,000 feet of streambanks on seven farms upstream of Green Lane Reservoir.

These groups, however, were not the drivers in the TMDL process. PA DEP was the lead agency, prodded by litigation by environmental groups. Aqua provided data and commented on the process. A number of government agencies, potentially affected parties, and environmental groups also participated in the TMDL process. The Montgomery County Health Department, the Montgomery County Planning Commission, and the Montgomery County Conservation District and the Montgomery County Parks were all involved to some extent in the TMDL process, as were local municipal officials from Upper Hanover Township and East Greenville, Red Hill and Pennsburg boroughs.

Wastewater dischargers, particularly the Upper Montgomery Joint Authority, and wastewater authorities in Bally and Washington Townships, participated in public hearings and commented on the TMDL. The wastewater dischargers generally pointed out their small proportional contribution to the phosphorus loading. Agricultural interests also participated and commented, questioning the share of loading attributed to them, and the feasibility of measures to reduce loadings from their activities and properties.

An ad hoc environmental group, the Upper Perkiomen Watershed Coalition, also commented and participated. This group had been formed by the Delaware Riverkeeper a few years prior to the TMDL. The Delaware Riverkeeper also participated. Both organizations promoted and implemented BMP projects on the watershed. Both groups were generally critical of wastewater dischargers, developers, and municipal governments. Finally, the Perkiomen Watershed Conservancy also participated in the process. PWC is an established organization with headquarters far downstream on the watershed, but some 30 years of dedicated work to encouraging land preservation and improving land and water resources on the Perkiomen watershed.

Role of the Drinking Water Utility in the TMDL Process

Prior to the TMDL, an environmental group sued a particular industrial discharger for self-reported discharge violations. None of the violations involved either phosphorus or sediment, and the particular discharger was not considered by Aqua to be particularly problematic. The lawsuit was settled, and the Delaware Riverkeeper was awarded approximately $100,000 to conduct a study of the watershed. In undertaking the study, the Riverkeeper opened with a public relations campaign that denigrated water quality in the reservoir. The Riverkeeper hired a consultant with

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whom Aqua had disagreements about scope and methodology of the study. The consultant somewhat arbitrarily chose a watershed area that included tributaries that discharged below Green Lane Reservoir. Subsequent events suggest that this may have been motivated by opposition to a proposed wastewater plant on one of the tributaries, and a controversial initiative to have one of the other tributaries upgraded to Exceptional Value status. The latter ultimately ended in a compromise upgrade to a less restrictive High Quality status. Neither tributary had any relevance to water quality in Green Lane Reservoir.

It became clear that the study, though initially billed as a "Clean Lakes Study," would not provide the information that was really needed for such a study. The report did, however, document a reduction in phosphorus loading to the reservoir from a prior study that had been done by F.X. Browne, Inc. Despite the shortcomings of this report, Aqua considered this documented reduction in phosphorus to be encouraging.

Aqua subsequently worked with F.X. Browne, Inc. to secure funding, with substantial match from Aqua, for a true Clean Lakes Study funded in part by U.S. EPA's 314 Program. Aqua played an active role in the gathering of information for this study of Green Lane Reservoir water quality. After that, from July 2000 through June 2002 the water company, which is equipped with its own laboratory, analyzed additional samples collected from the reservoir's tributaries for nutrients and total suspended solids. During the summer months, they also analyzed reservoir samples for orthophosphate, chlorophyll a, pH, temperature, conductivity, and secchi disk depth (a measure of water transparency). The data collected were used by PA DEP, along with data from other sources, to establish the target chlorophyll *a* concentration and develop a nutrient budget for the watershed.

Development of the TMDL

The Green Lane Reservoir TMDL (developed in 2003) focused on controlling phosphorus, because phosphorus was determined to be the nutrient limiting algae growth in the reservoir, and the cause of organic enrichment in the reservoir. PA DEP selected chlorophyll *a* as the water quality target for organic enrichment in Green Lane Reservoir. Chlorophyll *a*, a pigment used by algae to convert sunlight into chemical energy, is considered a measure of algal biomass. Chlorophyll *a* was selected as the parameter that would be used as the water quality target primarily because it is an effective measure of algal biomass and algae are a primary source of organic enrichment in Green Lane Reservoir. Data collected as part of an earlier study were used to identify a seasonal average chlorophyll *a* concentration of 20 ug/L as the target for the reservoir. If the reservoir were to achieve an average chlorophyll *a* concentration of 20 ug/L, its trophic state (amount of nutrients in the water) would be reduced to "moderately eutrophic" from its pre-TMDL trophic state of "hyper-eutrophic."

For the TMDL modeling, the Green Lane Reservoir Watershed was segmented into five subwatersheds; three of the subwatersheds represented the three major tributaries to the reservoir, and the other two subwatersheds represented the surrounding area that drains directly into the reservoir. PA DEP used the ArcView Generalized Watershed Loading Function (AVGWLF) model to run a 10-year simulation for existing nutrient loading concentrations to the segmented watershed. Water quality data collected by Aqua and others from 1999 through 2002 were used to run the model.

After the AVGWLF model was used to estimate the point and nonpoint source phosphorus loading to Green Lane Reservoir, PA DEP used the BATHTUB model to simulate the chlorophyll

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Table 6.8
Overview of the TMDL allocations for Green Lane Reservoir (lbs/month)

Watershed	Load allocation	Wasteload allocation	Margin of safety	TMDL
Molasses Creek	10.62	0	0.56	11.18
Main Branch Perkiomen	161.39	29.7	10.11	201.2
West Branch Perkiomen	85.81	95.8	9.61	191.22
Direct drainage area (urban)	7.31	250.2	13.62	271.13
Direct drainage area	6.9	4.2	0.59	11.7
Green Lane Reservoir	272.03	379.9	34.5	686.4

Source: EPA 2003.

concentration in the reservoir. Various phosphorus loading scenarios and management alternatives were used as inputs to the BATHTUB model to determine watershed loading rates which would be consistent with the water quality target of 20 ug/L chlorophyll *a*.

Table 6.8 identifies the load and wasteload allocations, total allowable loads, and margin of safety for the phosphorus TMDL for Green Lane Reservoir for each of the five sub-watersheds and the total load to Green Lane Reservoir. In order to achieve the TMDL, nonpoint source loading of phosphorus will need to be reduced by 44.5 percent across the watershed. As part of this effort, all 14 point sources in the watershed must achieve effluent limitations of 0.5 mg/L total phosphorus.

A margin of safety was added to account for uncertainty with the data and the model's computational methodology. PA DEP reserved five percent of the total phosphorus TMDL value as the margin of safety. Since the phosphorus TMDL is 686.4 pounds/month, the margin of safety was computed as 34.3 pounds/month. Further, the AVGWLF model was run over a ten-year period to consider seasonal environmental variations. The model considers seasonal variations in temperature and precipitation, as well as hours of daylight for each month, and changes in land use practices (e.g., whether manure is applied to the land).

Existing NPDES permits for two point source discharges directly to the Green Lane Reservoir already had 0.5 mg/L phosphorus discharge limits prior to the TMDL. However, other wastewater dischargers upstream had less stringent, or no, phosphorus limits. Nevertheless, the largest portion of the projected phosphorus locating was from nonpoint sources, and the burden of reducing phosphorus loading in the watershed will have to rest on nonpoint sources. Measuring actual nonpoint contributions to phosphorus loadings, and then measuring the effectiveness of BMPs is a daunting task. Furthermore, funds are limited for implementation of BMPs. Some farmers and property owners have already implemented improvements.

TMDL Implementation

PA DEP identified BMPs that would help reduce the amount of sediments and nutrients reaching Green Lane Reservoir. These BMPs include stream bank fencing, riparian buffer strips, strip cropping, contour plowing, conservation crop rotation, and protection of heavy use areas. PA DEP has also recommended that a comprehensive watershed restoration plan be prepared identifying those BMPs that should be installed at particular watershed locations. A single-point contact person has been established in the agency's Southeast Regional Office to serve as the Watershed Manager, who is charged with supporting local efforts for developing and implementing a Green Lane Reservoir watershed restoration plan.

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The Montgomery County Conservation District also now has a staff person designated as a watershed specialist who has been very active in promoting BMPs and in establishing forested riparian corridors in Montgomery County. The Montgomery County Parks Department has devoted considerable resources to improvement and maintenance of equestrian trails throughout Green Lane Park to reduce impacts from erosion. Land around the reservoir that was formerly in agriculture has been enrolled in the Conservation Reserve Program through the local Farm Services Agency.

Benefits of Involving the Drinking Water Utility in the TMDL Process

The drinking water utility had an active watershed protection program long before the development of the TMDL. The drinking water utility continues to perform annual Trophic State Index sampling and seasonal temperature and dissolved oxygen profiling of the reservoir, promotes establishment of forested buffers along the tributaries, and works with a variety of stakeholders in the watershed to reduce nonpoint source pollution. These efforts began and continue independent of the TMDL, and have received little impetus or support from the TMDL process. The drinking water utility's representatives, therefore, are skeptical that the TMDL process was an effective mechanism for addressing water quality issues in the reservoir, and are discouraged by conflicts that arose between point source dischargers and the agricultural community and other nonpoint source dischargers during TMDL development.

In addition to continued monitoring of the trophic state of Green Lane Reservoir and the levels of phosphorus in the tributaries, Aqua has supported tree planting in the watershed through participation in a program called TreeVitalize. Aqua has pledged $500,000 over four years to this program that has a goal of increasing the tree cover in five southeastern Pennsylvania counties. Aqua has specifically targeted its contributions to riparian corridors on its source water watersheds, including the Perkiomen watershed above Green Lane Reservoir.

Aqua and Montgomery County Parks have revised the management of their lands, reducing mowing on lands around the reservoir.

The land management around the reservoir has had a secondary benefit to the public of improving the habitat for wildlife. The area supported one of the first nesting pair of bald eagles, and this pair of eagles has returned year after year and had fledged young. The upper portion of the reservoir has been informally designated as a bird sanctuary, and supports a wide variety of species. The Green Lane Nature Center is a popular venue for local school groups and the public. The Upper Perkiomen High School, with land adjacent to Green Lane Reservoir Park, has undertaken a series of demonstration projects to implement BMPs for storm water management on their campus.

Problems Faced, Conflicts Resolved, and Obstacles Overcome

Aqua was not consulted on the establishment of the TMDL based on chlorophyll *a* as the target parameter, nor on the selected target level of 20 ug/L. Having seen the seasonal and year-to-year variability of chlorophyll *a* in the reservoir, Aqua was skeptical of the suitability of this particular parameter, or level, as a TMDL target. Aqua sympathized with both farmers and dischargers on the watershed who were afraid that the TMDL would impose unrealistic demands on them.

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Lessons Learned

It is difficult to assess which of the beneficial projects and programs that have occurred in the Perkiomen Watershed after the development of the TMDL might have happened anyway. The TMDL process might have been more productive had more effort been made to recognize, encourage, support and guide voluntary watershed protection efforts already underway. It might have been less adversarial had the regulators and consultants developing the TMDL communicated more openly and sympathetically with potentially affected parties (e.g., farmers and wastewater dischargers).

As was Winthrop Utilities' experience, Aqua found that participants in the TMDL process had perspectives and goals that differed widely from each other and from Aqua's perspective and goals. To prevent their interests from being inaccurately represented or ignored, water utilities may need to develop and clearly articulate well-defined water quality goals when standards are being set and the TMDL is being developed. Active participation by the water utility can help avoid alternative endpoints from being pursued in the name of drinking water protection. However, active participation in no way assures that the interests of water suppliers will be reasonably reflected in the final product.

The TMDL is useful in that it has provided a target to aim for. Whether the target is achievable, or even really measurable, remains to be seen. The TMDL has provided a justification for stringent phosphorus limits on upstream discharges. These were resisted initially, but in the end have not proven to be excessively burdensome on dischargers. Prior to the TMDL, the limits had not been consistently applied to dischargers upstream.

The TMDL has provided a way to prioritize limited funding for nonpoint BMPs in the region, targeting funds to projects on the watershed above the reservoir. Measuring the actual impact of these projects on water quality in the reservoir remains a challenge.

CITY OF WILMINGTON WATER DEPARTMENT, DELAWARE

Drinking Water Utility Contact

Matthew Miller, Water Quality Manager
City of Wilmington Department of Public Works

Introduction

This case study for the City of Wilmington provides an example of a municipality that became involved in the development of a TMDL for sediment and bacteria in the Christina River Basin to improve the quality of its water supply, as well as to participate in the decision-making process regarding the permitting and management of CSOs and MS4s in its jurisdiction. One major challenge to the development of this TMDL was that the watershed contains land in three states (Pennsylvania, Maryland, and Delaware) and numerous counties. Issues that arose as a result of this included having different water quality criteria in different states, defining and meeting water quality criteria at state boundaries, and orchestrating a large and varied interstate group of stakeholders.

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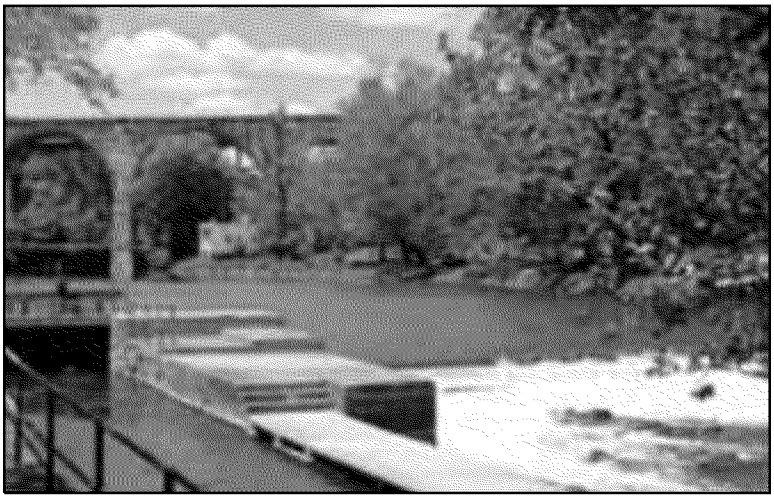

Figure 6.9 Wilmington's city dam raceway on the Brandywine Creek

Background

The City of Wilmington's Water Department serves a population of 140,000 people covering a service area of forty square miles. Normal demand is approximately 25 MGD, and peak demand can reach 35 MGD. The City has been using the Brandywine Creek as its primary source of drinking water since 1827. The City draws water from two intakes on the creek. Water is diverted at intake #1 at City Dam, 4,800 feet upstream from the Brandywine Pumping Station. The diverted water flows down a raceway alongside the river to the Brandywine Pumping Station and Filtration Plant (Figure 6.9). Untreated water can then be pumped from the Brandywine Pumping Station to the Porter Filtration Plant. In addition, raw water can be diverted from the Brandywine Creek at a second intake at Compton Wills Pumping Station and sent for treatment to the Porter Filtration Plant. The intake capacity for the drinking water utility is 44 MGD and the treatment capacity is 56 MGD. Approximately 3.3 MGD of additional water can be provided by a series of interconnections with other drinking water utilities (Artesian Water Company and United Water Delaware). The City of Wilmington has a raw water holding reservoir (the Edgar Hoopes Reservoir) with a capacity of two billion gallons, which can provide additional water during droughts, heavy rains, and emergencies.

Both treatment plants for the City of Wilmington provide comparable conventional treatment: pre-chlorination, flocculation, sedimentation, filtration, post-chlorination, and fluoridation. Water is also pre-treated with activated carbon to remove taste and odor compounds.

The Brandywine Creek Watershed drains approximately 319 mi^2 of land in two states, Delaware and Pennsylvania. In addition to the challenge of the watershed being an interstate basin, three counties also sit in the basin. Table 6.9 characterizes the Brandywine Creek Watershed upstream of the City of Wilmington's water intakes. The Brandywine Creek is one of four major tributary creeks in the Christina River Basin, which contains land in Pennsylvania, Delaware, and Maryland. A map of the Christina River Basin is provided in Figure 6.10. The four creeks converge in the City of Wilmington as the Christina River and drain to the tidal Delaware River.

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Table 6.9
Characteristics of the Brandywine Watershed

Source water	Brandywine Creek
Watershed Area	Delaware - 27 mi^2 (8% of basin) Pennsylvania - 292 mi^2 (92% of basin) Total - 319 mi^2
Counties in Watershed	Chester County, PA Delaware County, PA New Castle County, DE
Land Use	Urban/Suburban - 74 mi^2 (23% of basin) Agriculture - 127 mi^2 (37% of basin) Wooded/Open Space - 118 mi^2 (40% of basin)

Source: Adapted from Source Water Assessment of the City of Wilmington, Delaware Public Water Supply Intake Located on the Brandywine Creek May 2002 University of Delaware

Problem Definition

Based on water quality and biological studies carried out by the Pennsylvania Department of Environmental Protection (PA DEP), Delaware Department of Natural Resources and Environmental Control (DNREC), and Maryland Department of Environment, many streams in the Christina River Basin have been listed on the states' Section 303(d) lists of impaired waters for failure to meet their designated uses of habitat for aquatic life, municipal and industrial water supplies, and recreation

Under low flow conditions, the Christina River Basin is impaired by excessive nutrient loads and low dissolved oxygen Under higher flows, the Basin is impaired by excessive sediment and bacteria loads In 1997, Delaware and Pennsylvania came to agreement with EPA to establish low flow and high flow TMDLs in the basin The low flow TMDL, which focuses primarily on point sources of pollution, was issued by EPA in October 2002 and addresses nutrients and dissolved oxygen The high flow TMDL, which focuses primarily on stormwater and nonpoint sources of pollution, was issued EPA in 2006 and addresses bacteria and sediment The TMDL that will be discussed in this case study is the high flow TMDL addressing sediment and bacteria

The bacteria TMDL addresses water body impairments in both Pennsylvania and Delaware, while the sediment TMDL addresses impairments in just Pennsylvania No streams in the Maryland area of the basin were listed for bacteria impairment; similarly, no streams were listed for sediment impairment in either the Delaware or Maryland portions of the basin

Since the Christina River Basin is an interstate basin, both Pennsylvania and Delaware are responsible for meeting downstream Delaware's WQS Pennsylvania and Delaware, however, use different bacterial indicators for their WQS - Pennsylvania uses fecal coliform bacteria as an indicator of bacteria contamination and Delaware uses enterococcus bacteria Further, in Pennsylvania, the waters of the Christina River Basin are designated for contact recreation *, and potable water supply uses In Delaware, the Brandywine Creek is designated for public and industrial water supply, primary and secondary contact recreation, and fish, aquatic and wildlife Delaware does

* Contact recreation in Pennsylvania is classified as swimming season and non-swimming season, with the water quality criteria for bacteria are more stringent during the swimming season (May 1 through September 30)

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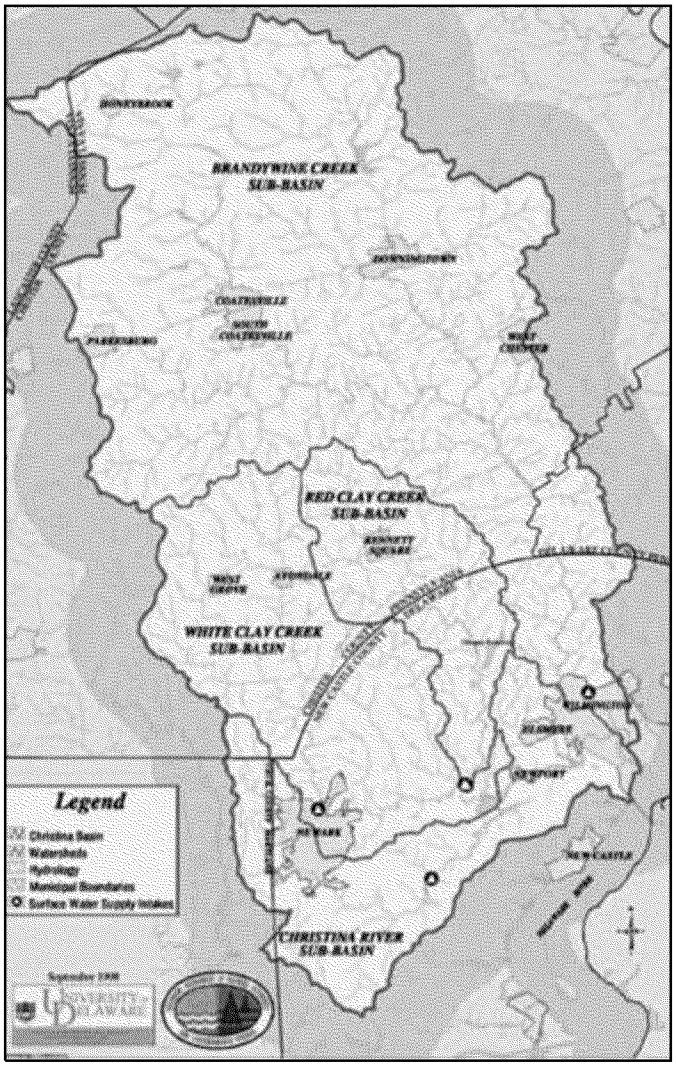

Source: Source Water Assessment of the City of Wilmington, Delaware Public Water Supply Intake Located on the Brandywine Creek. May 2002. University of Delaware.

Figure 6.10 Christina River Watershed

not distinguish between swimming and non-swimming seasons for its water quality criteria. The applicable bacteria WQS for the Pennsylvania and Delaware reaches of the Brandywine Creek are provided in Table 6-10.

Pennsylvania does not have numeric water quality criteria for sediment. Pennsylvania has a narrative standard that addresses turbidity (PA Code, Title 25, Chapter 96.3(b)):

> "In addition to other substances listed within or addressed by this chapter, specific substances to be controlled include, but are not limited to, floating materials, oil, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits."

EPA used the Reference Watershed Approach to establish water quality objectives for the Christina River Basin for reducing sediment loads sufficient enough to attain designated uses in the basin. The Reference Watershed Approach involves the comparison of two watersheds with similar topographical, geological, and land use/cover distributions. One of the watersheds is currently

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Table 6.10
Summary of bacteria WQS for Brandywine Creek

Pollutant	Designated use	Criteria		Period
Pennsylvania				
Fecal Coliform Bacteria	Water Contact Recreation (statewide)	Maximum geometric mean of 200 cfu/100 mL, based on a minimum of 5 consecutive samples each sample collected on different days during a 30-day period	No more than 10% of the total samples taken during a 30-day period may exceed 400 cfu/100 mL	May 1 to September 30 (swimming season)
		Maximum geometric mean of 2,000 cfu/ 100 mL, based on a minimum of 5 consecutive samples each sample collected on different days during a 30-day period		October 1 – April 30
	Potable Water Supply (statewide)	Maximum of 5,000 cfu/100 mL as a monthly average value, no more than this number in more than 20 samples collected during a month, nor more than 20,000 cfu/100 mL in more than 5% of the samples		Year round
Delaware*				
Enterococcus Bacteria	Primary Contact Recreation Fresh Waters	Single-Sample Value: 185 cfu/100 mL	Geometric Mean: 100 cfu/100 mL	Year round
	Secondary Contact Recreation Fresh Waters	Single-Sample Value: 925 cfu/100 mL	Geometric Mean: 500 cfu/100 mL	Year round

*Delaware WQS contain criteria for bacteria for primary and secondary contact waters.

attaining its designated uses, and the other is the watershed for which water quality objectives are being developed (in this case the sub-basins of the Christina River Basin). The goal is to use information from the reference watershed to develop model loading rates of pollutants in the impaired stream segments of the Christina River Basin.

Participants and Stakeholders in the TMDL Development Process

Since 1994, local agencies in Delaware and Pennsylvania have coordinated the activities of the overall watershed strategy on behalf of the Christina Basin Clean Water Partnership. The Chester County Water Resources Authority and Chester County Conservation District serve as local watershed coordinators for the Pennsylvania portion of the basin. The University of Delaware, Institute for Public Administration, Water Resources Agency serves as a local coordinator for the Delaware portion of the Basin. Several nonprofit organizations also provide stewardship of the Christina River Basin.

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Role of the Drinking Water Utility in the TMDL Process

The City of Wilmington became engaged in the TMDL development process for several reasons. First, reductions in sediment loads in the Brandywine Creek will alleviate some of the burden on the City to manage its source water intakes and raw water storage for high turbidities, as well as alleviate some of the burden placed on the City's treatment plants to remove substantial amounts of sediments during its treatment process in order to meet effluent turbidity standards for drinking water. Secondly, the City is responsible for several CSOs and a small separate storm sewer system in the basin. Loads assigned in the TMDLs to these pollutant sources will guide future permitting of the sewers and dictate related pollutant load reductions that would be required to meet the standards in those permits.

Development of the TMDL

The modeling framework for the Christina River Basin TMDLs consisted of three major components: 1) a watershed loading model; 2) a CSO model developed by the City of Wilmington; and 3) a hydrodynamic model. The Hydrologic Simulation Program—Fortran (HSPF) is a EPA supported model that simulates watershed hydrology and water quality for both conventional and toxic organic pollutants. Using historical water quality and flow data, among other data, four separate HSPF models (one for each of the four major tributary creeks in the Christina River Basin) were developed to simulate watershed runoff and sediment and bacteria loading in the basin. Detailed descriptions of the HSPF models developed for the Christina River Basin can be found in Senior and Koerkle (2003a, 2003b, 2003c, and 2003d).

The Wilmington area has combined sewer systems. Usually all of the wastewater is transported by these combined sewers to a sewage treatment plant where it is treated and discharged at a NPDES-permitted facility. During periods of wet weather, however, the combined storm water and wastewater volume can exceed the capacity of the sewer system or treatment plant, and the combined sewers overflow and discharge excess wastewater directly to nearby water bodies. These CSOs discharge for short periods of time at random intervals due to their association with wet weather events. There are 40 CSO outfalls in the vicinity of the City of Wilmington. The City of Wilmington developed a model (XP-SWMM) to simulate stormwater flows and CSO events in the city's sewer collection system. Using hourly rainfall measured at New Castle County Airport and Porter Reservoir, XP-SWMM was used to calculate hourly flow rates at each of the city's 40CSO outfalls. Bacteria loads from these CSOs were determined for the TMDL using flow rates calculated by the XP-SWMM model and event mean concentrations measured during two storm events in 2003 (EPA, 2006).

A number of critical data sets were needed to assess the relative bacteria and sediment loads from different land uses; some of these data sets are described below:

- Land use estimates were developed from an aggregate of two land use data layers (one from 1995 and the other used by USGS to develop the HSPF model).
- A GIS database of septic system data for New Castle County, DE was used to extrapolate the estimated number of septic systems in the basin for the periods 1990, 1995, and 2005. Estimates of the bacteria loads from septic systems were based on factors

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such as population served, number of properly and improperly functioning septic systems, average daily discharge per person, and septic effluent fecal coliform and enterococcus concentrations. These assumptions were made based on the review of a variety of broad-based and localized studies.

- Livestock inventories of Chester County and New Castle County from the previous three agricultural census periods were used to estimate the extent of bacterial loading from farming operations (e.g., grazing animals, confined animal operations, and manure application). Monthly fecal coliform bacteria and enterococcus accumulation rates were derived and used in the watershed loading model to categorize the variability of loading over the months of the year.
- Wild animal population densities for different land use categories were estimated from literature values. Monthly adjustment factors were used to account for seasonal variations in wild animal populations. In addition, EPA estimated that approximately 82,593 dogs and 115,415 cats are kept as domestic pets within the Christina River Basin. Their bacteria load was incorporated into the HSPF watershed model runoff values from urban and residential areas.

The model was used to estimate sediment loads from each of the contributing land uses, as well as a total sediment load from streambed erosion, for each of the sub-basins in the watershed. The methodology used for identifying candidate reference watersheds and final selection of reference watersheds for the TMDL target sediment loads is outlined in Appendix K of the model report (EPA, 2005a). The TMDL sediment endpoints (as unit area loads) for each of the reference watersheds were used as targets for loading reductions in the impaired watersheds.

TMDL allocations for enterococci bacteria in Pennsylvania were determined at the Pennsylvania-Delaware state line for Brandywine Creek, White Clay Creek, Red Clay Creek, and Burroughs Run and for Maryland at the Maryland-Delaware state line for the East and West Branches of the Christina River.

The sediment and bacteria TMDLs for the Christina River Basin includes a five percent margin of safety. During development of the TMDLs and allocations for fecal coliform bacteria, the five percent margin of safety was applied by comparing the model in-stream fecal coliform bacteria concentrations to 190 cfu/100mL and 1900 cfu/100mL instead of the water criteria of 200 cfu/100mL and 2000 cfu/100mL. In Delaware, TMDL allocations for enterococci were also determined for each modeled sub-basin using a five percent margin of safety. The model run results were compared to a 30-day geometric mean of 95 cfu/100mL rather than the state's 30-day geometric mean criterion of 100 cfu/100mL.

Model results for fecal coliform and enterococci bacteria showed that the bacteria concentrations tend to be higher during warm weather months. The bacteria concentrations appear to be correlated with cattle grazing behavior and storm events. The model results suggest that the highest bacteria concentration in terms of 30-day geometric mean may occur in warm weather following a storm event preceded by a long dry-weather period. Since critical conditions for bacteria, or any pollutant washed off the land surface by rainfall runoff, cannot be defined with a fixed flow rate, a long-term continuous simulation was used to determine when the bacteria concentrations are highest. Models were run for a four-year period (October 1, 1994 through October 1, 1998) that characterized extreme low flows during the summers of 1995 and 1997, as well as high-flow events during storms. This simulation period covered the range of typical critical hydrological conditions expected in the Christina River Basin.

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Annual TMDL sediment load allocations were calculated using daily model simulation output (i.e., summed to get yearly values). The continuous simulation model used for determining sediment loads and allocations considered seasonal variation through a number of mechanisms. Daily time steps were used for weather data and water balance calculations. As with the loading calculations for bacteria, the HSPF model utilized data for the four-year period of October 1, 1994 through October 1, 1998 and covered the range of typical critical hydrological conditions expected in the Christina River Basin.

TMDL Implementation

The bacteria and sediment TMDLs were finalized in September 2006, so they have not been in effect for very long. A major factor for meeting the TMDLs in the Christina River Basin is the extent to which the City of Wilmington and neighboring governments will address issues related to loading from CSOs and MS4s under wet weather conditions. EPA believes that implementation of BMPs throughout the basin can result in significant reductions in bacteria and sediment loads in the affected areas and achieve the loading reduction goals established in the TMDLs. Substantial reductions can be made through the planning of riparian buffer zones, contour strips, cover crops, or stormwater retention techniques (EPA, 2006). Further, EPA recommended that reductions in in-stream loads from bank erosion be made using two approaches: 1) Create and implement stream restoration plans to stabilize stream banks and provide better transport of high storm flows associated with urban areas, and 2) Implementing urban BMPs that reduce peak storm flow through retention or increased infiltration (EPA 2006).

State and local policies have been developed to help ensure implementation of BMPs. PA DEP has developed a Proposed Comprehensive Stormwater Management Policy encouraging implementation of BMPs for stormwater control. This policy seeks to integrate watershed management plans with permitting programs and urges that TMDL targets be referred to when setting goals for future watershed management plans. Such watershed management plans should be consistent with Stormwater Management Plans developed by counties and implemented by municipalities on a watershed basis, as required by the Pennsylvania Stormwater Management Act (Act 167) (EPA 2006). To date, the City of Wilmington has implemented CSO controls that include:

- Upgrading the Wilmington Wastewater Treatment plant from 90 mgd to 134 mgd
- Improving the capacity and modifying pump controls at one of its pump stations
- Developing plans to reduce discharges from three CSOs
- Installing a netting system and raise the regulating weir at one CSO

The City has also prepared a Long Term CSO Plan (LTCP) to control 85% of the CSO volume by 2010. The LTCP recommends the following nonstructural and structural improvements:

- Nonstructural Improvements
  - Inspect and repair tide gates city wide
  - Assess performance of floatables control
  - Initiate GIS mapping of sewers
- Structural Improvements
  - Partial separation of combined sewers
  - Expand pumping capacity
  - Utilize a “real-time control” system to maximize the storage and efficiency of the CSS

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The Christina Basin Clean Water Partnership has developed a Watershed Restoration Action Strategy (WRAS) for the Delaware portion of the basin. The mission of the Christina Basin Clean Water Partnership is to "conduct a cooperative, interstate effort to restore the water quality of the streams and tributaries in the Brandywine, Red Clay and White Clay Creeks, and Christina River watersheds of Delaware, Maryland, and Pennsylvania to fishable, swimmable, and potable status by 2015" (Kauffman et al., 2003). In its WRAS, the Partnership identifies goals for achieving the sediment and bacteria TMDLs.

The Christina River Basin also benefits from the stewardship of many active watershed groups in addition to various local and government organizations. These include the Brandywine Conservancy, Brandywine Valley Association, Red Clay Valley Association, Delaware Nature Society, White Clay Watershed Association, Stroud White Clay Creek Laboratory, and Christina Conservancy, and Wilmington River-City Steering Committee. In addition, the Chester County Water Resources Authority and Chester County Conservation District in Pennsylvania, and the University of Delaware, Water Resources Authority, are very engaged in the coordination of watershed protection and remediation efforts. Local county conservation districts in Pennsylvania and Delaware are installing BMPs to reduce nonpoint source loadings, in keeping with the stated goals of the sediment and bacteria TMDLs. Most of these groups are actively involved in the Christina Basin Clean Water Partnership mentioned above.

Since the sediment and bacteria TMDLs were finalized late in 2006, there has not been enough time to see significant results from TMDL implementation. Most striking with this case study is the extent to which stakeholders in the watershed are engaged and coordinated in their efforts to improve water quality and reduce pollutant loading, regardless of the interstate nature of the watershed. As with other case studies described in this chapter, efforts were being made to improve water quality in the Christina River Basin before the TMDLs were developed, and continue after the TMDLs have been finalized. Stakeholder organizations do, however, seem to be using the TMDLs as guidance for setting water quality goals and focusing their efforts.

None of the NPDES permitted dischargers in either Pennsylvania or Delaware that discharge to the Brandywine Creek or its tributaries is required to reduce their present NPDES permit limits of 200 cfu/100mL for fecal coliform bacteria or 100 cfu/100mL for enterococcus bacteria as a result of the bacteria TMDL.

The City of Wilmington's CSOs are NPDES permitted discharges but currently have no permit limits. Future permits will contain permit limits and require reductions in loads discharged to the Brandywine Creek and other water bodies in the Christina River Basin. In addition, EPA's stormwater permitting regulations require municipalities to obtain permit coverage for all storm water discharges from MS4. The MS4s within the Christina River Watershed have received allocations expressed as WLAs in the TMDLs, which will be enforceable through the NPDES permitting process.

In Pennsylvania, TMDL allocation results indicate that reductions in bacteria loading from nonpoint sources to streams in the Brandywine Creek subbasins of approximately 93 percent are necessary to protect the WQS for enterococci bacteria at the PA-DE state line. Sediment load reductions in Pennsylvania required to achieve the TMDL are also substantial. Table 6-11 compares current and TMDL annual sediment allocations, and the percent load reductions necessary in order to achieve the TMDL allocations. All of the townships listed in the table are located in Pennsylvania.

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Table 6.11
Sediment load allocations for towns in Brandywine Creek Watershed

Township	Baseline (ton/yr)	TMDL (ton/yr)	Percent reduction
Birmingham TWP	311	130	58%
Coatesville City	231	80	66%
East Bradford TWP	1185	467	61%
East Fallowfield TWP	803	426	47%
East Marlborough TWP	367	139	62%
Highland TWP	385	239	38%
Honey Brook Boro	21	13	36%
Honey Brook TWP	814	559	31%
Modena Boro	28	12	55%
Newlin TWP	144	60	59%
Parkesburg Boro	52	32	38%
Pennsbury TWP	114	43	62%
Pocopson TWP	821	321	61%
Sadsbury TWP	290	172	41%
Thornbury TWP	82	34	58%
Valley TWP	485	165	66%
Wallace TWP	22	17	20%
West Bradford TWP	283	122	57%
West Caln TWP	68	43	37%
West Goshen TWP	461	181	61%

Source: EPA 2006

Benefits of Involving the Drinking Water Utility in the TMDL Process

In part due to its involvement in the TMDL development process for the Christina River Basin, the City of Wilmington has been engaged in an effort to collect information that improves understanding of pollutant loads from CSOs under its jurisdiction. Following the establishment of the Christina River Basin bacteria and sediment TMDLs, the City of Wilmington and DNREC completed a storm monitoring program that collected nutrient and bacteria data from four storm events to establish characteristic concentrations for the CSO discharges in the City of Wilmington. Two storm events were completed prior to drafting the original TMDL in April 2005. After April 2005, monitoring data from two additional storm events were available (EPA 2006). As a result of the additional information collected, the 2005 TMDL was revised to incorporate the additional data from the four storm events and establish updated event mean concentrations for the Wilmington CSO discharges.

The City of Wilmington has also helped public education and outreach efforts by the Christina River Basin Partnership by including water bill and brochure inserts. Since 2002 the City has implemented a storm drain marking program to encourage the proper disposal of materials that would otherwise reach the watershed. Finally, the City holds an annual Earth Day Festival which is focused on protecting water quality.

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Problems Faced, Conflicts Resolved, and Obstacles Overcome

Different water quality concerns under low flow and high flow conditions were ultimately addressed by developing two TMDLs: one for nutrients and dissolved oxygen under low flow conditions, which dealt primarily with NPDES permitted discharges; and one for bacteria and sediment under high flow conditions, which addressed in more detail nonpoint source loading, CSO, and MS4s.

The states of Pennsylvania and Delaware have different water quality criteria for designated uses (Maryland's contribution was negligible in this regard). Pennsylvania uses fecal coliform bacteria WQS when identifying standards for different designated uses, and Delaware uses enterococcus bacteria. In addition, Pennsylvania's standards for contact recreation, which provide the most stringent bacterial standards, differ depending on whether it is swimming season or not. Delaware does not draw a seasonal distinction with its contact recreation bacterial standards. Regardless of the difference, Pennsylvania is responsible for meeting Delaware's standards at the Pennsylvania-Delaware border.

The coordination and production of TMDLs for the Christina River Basin was difficult and drawn out. At one time, the states asked the Delaware River Basin Commission, an interstate agency, to take the lead with the data collection and organizational effort. EPA was under pressure to complete the TMDLs as a result of settlement conditions of two civil action lawsuits regarding EPA's oversight of the TMDL programs in Pennsylvania and Delaware.

Lessons Learned

As an older urban municipality, the City of Wilmington was involved in the TMDL process because it was a stakeholder in more than one way. First, it draws water from the Brandywine Creek in the Christina River Basin, and is therefore concerned about conserving and improving the water quality of the creek. Secondly, the City is responsible for the management of CSOs and MS4s in its jurisdiction. It is important to the City that pollutant loads assigned to those discharges are accurate and achievable.

The City learned that TMDL allocations can be modified if better water quality data are collected and presented to EPA and the states. By conducting a more detailed study of storm events, the City was able to gather more accurate pollutant loading information that resulted in the revision of the high flow bacteria and sediment TMDL.

SANTA CLARA VALLEY WATER DISTRICT, SAN JOSE, CALIFORNIA

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Table 6.12
Santa Clara Valley Water District water supply characteristics

Source of supply	Watershed drainage area	Designated use of water body	Reservoir storage volume (acre-feet)	Reservoir surface area (acres)	Year of service
Guadalupe Reservoir	5.9 mi^2 (Guadalupe Creek)	Recharge*, stream enhancement	3,415	74	1935
Almaden Reservoir	12 mi^2 (Alamitos Creek)	Water supply, recharge, stream enhancement	1,586	57	1935
Calero Reservoir	6.9 mi^2 (Calero Creek)	Water supply, recharge, stream enhancement	9,934	349	1935

* Provides storage for downstream groundwater recharge ponds and percolation.

Introduction

This case study for Santa Clara Valley Water District focuses on the mercury TMDL developed for the Guadalupe River Watershed. The Guadalupe River is surrounded by dense urban development, and passes through the heart of the City of San Jose, California. The river receives nonpoint source inputs from surface erosion within the upper watershed, and from urban drainage within the lower valley. The river is used for recharge of public water supply aquifers, as well as supports an important anadromous fishery. Mercury concentrations in resident fish exceed applicable criteria for human consumption and may be detrimental to some wildlife; there is no evidence that the anadromous fishery has been adversely affected by mercury (loss of spawning and rearing habitat is the main threat to these fish).

Background

The Santa Clara Valley Water District is a wholesale supplier of drinking water for 2.8 million customers in the Silicon Valley area of northern California. The District operates ten reservoirs that serve as raw water for water supply, replenish underground aquifers, or provide protection from flooding by storing excess runoff. The majority of the District's water supply comes from the South Bay Aqueduct, Del Valle Reservoir, and San Luis Reservoir, which all draw water from the Sacramento/San Joaquin Delta Watershed. The District also utilizes several local sources of supply including Anderson, Coyote, Calero, and Almaden Reservoirs. The District provides treated water from three water treatment plants to seven water retailers in Santa Clara County.

Background information on the three water supply reservoirs highlighted in this case study—Almaden, Calero, and Guadalupe—is summarized in Table 6.12. The Guadalupe River and its watershed support many beneficial uses, such as drinking water supply, sport fishing, and habitat for wildlife and endangered species. The Guadalupe River Watershed drainage covers 170 square miles (Figures 6.11 and 6.12). As shown in Figure 6.12, tributaries of the Guadalupe River include Guadalupe Creek, Los Gatos Creek, Ross Creek, Alamitos Creek, and Canoas Creek. Major California cities located within the watershed include San Jose, Los Gatos, Monte Sereno, Campbell, and Santa Clara. The Guadalupe reservoir is one of the six original systems approved

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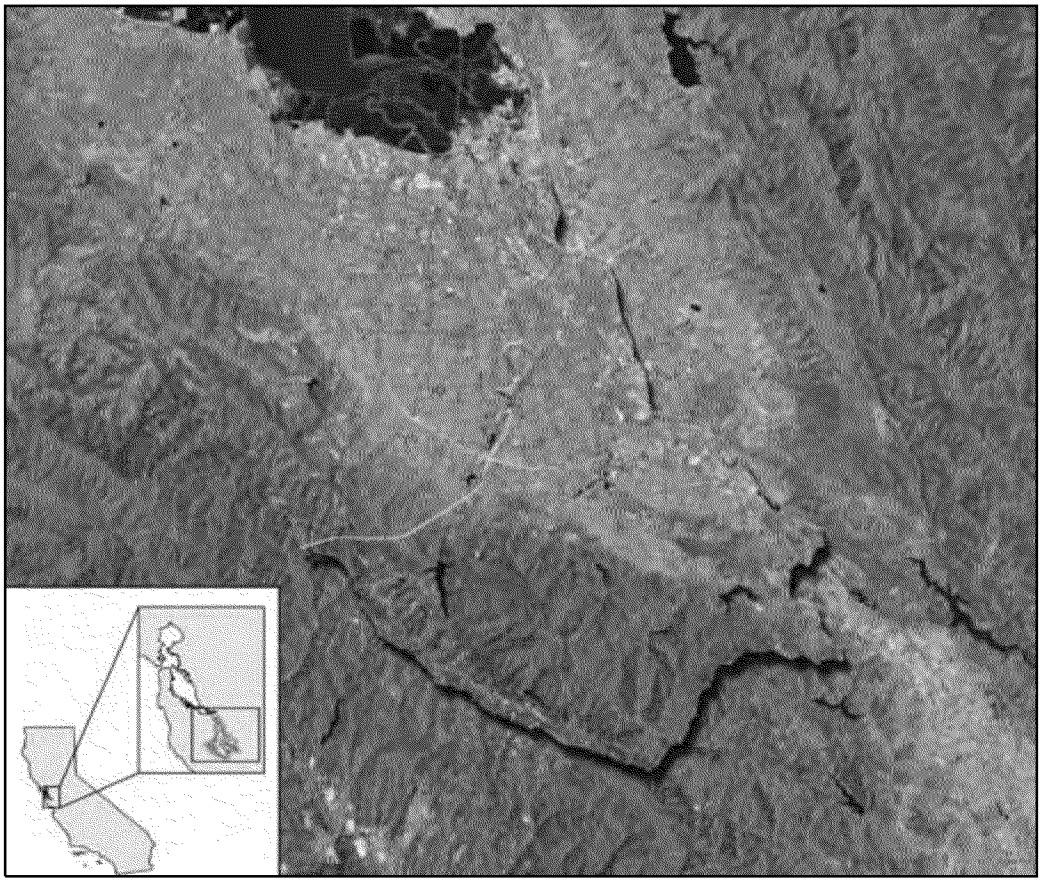

Source: Tetra Tech 2005c (Figure ES-1 Final Conceptual Model Report)

Figure 6.11 Location of Guadalupe River Watershed

for construction by voters in 1934 (Figure 6.13). The dam is located on the Guadalupe River adjacent to Hicks Road. The reservoir can store 3,415 acre-feet of water. The surface area of the reservoir is 74 acres.

Almaden Reservoir is one of the six original reservoirs in the county (Figure 6.14). It was completed in 1935. The reservoir can store 1,586 acre-feet of water; its surface area is 57 acres. "Almaden" in Spanish means "mineral" or "mine." In 1845, Andres Castillero discovered a quicksilver (mercury) deposit in the area now known as the Almaden Hills. At one time, the New Almaden Mine was the largest mercury-producing mine in the Americas. The dam and reservoir are located in these same hills.

Calero Reservoir is also one of the six original reservoirs approved for construction by voters in May 1934 (Figure 6.15). The reservoir is located on Calero Creek, east of Almaden Quicksilver County Park. The reservoir can store 9,934 acre-feet of water; its surface area is 349 acres. "Calera" is the Spanish word for limekiln or limestone quarry. In 1935, the Santa Clara Valley Water Conservation District obtained land for the proposed Calero Reservoir from the Newman brothers. They had operated a ranch since they purchased the land in 1905 from the Bailey family, who owned 873 acres in what was then known as Calero Valley.

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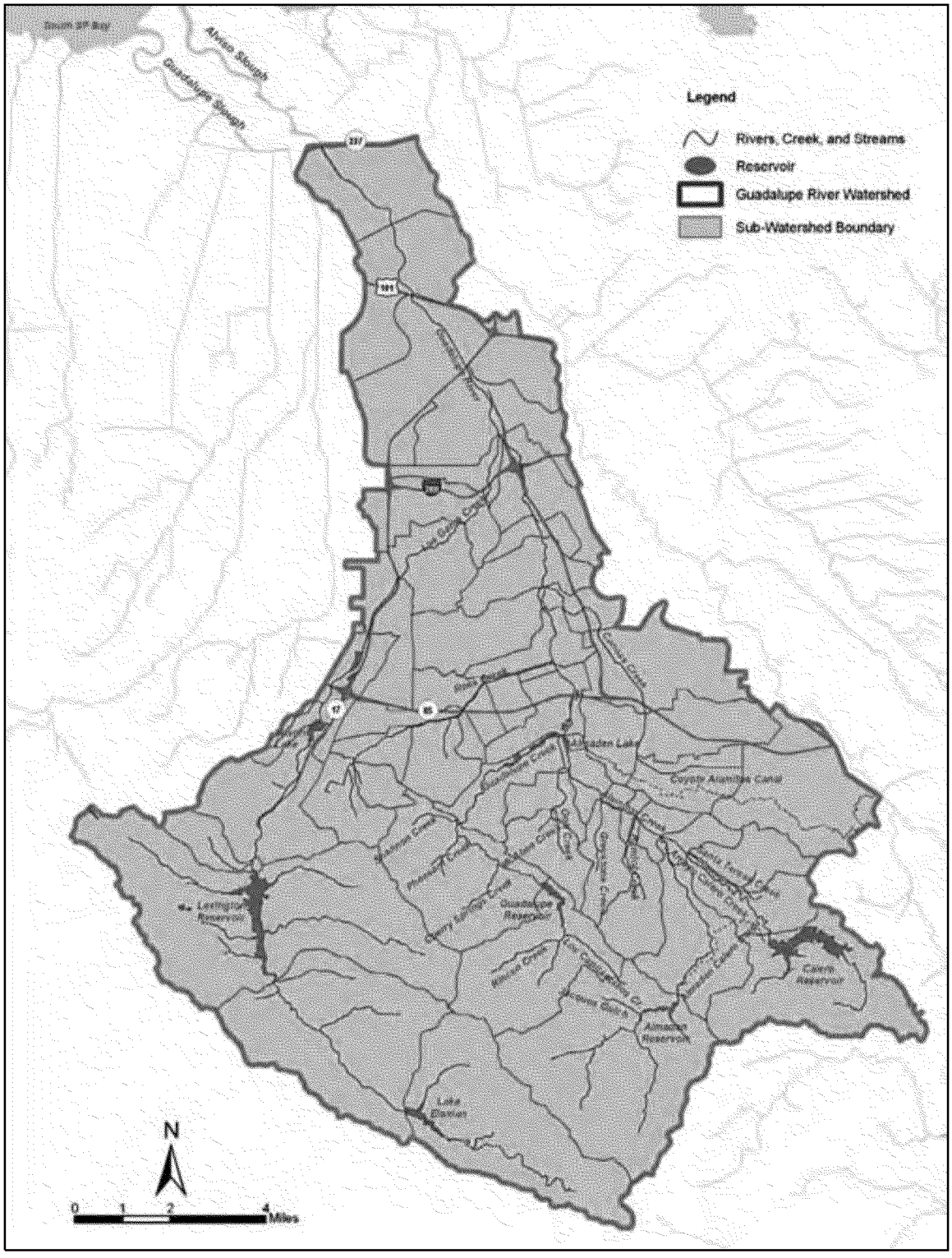

Source: Tetra Tech 2005c) (Figure 2-2 Final Conceptual Model Report)

Figure 6.12 Guadalupe River Watershed map

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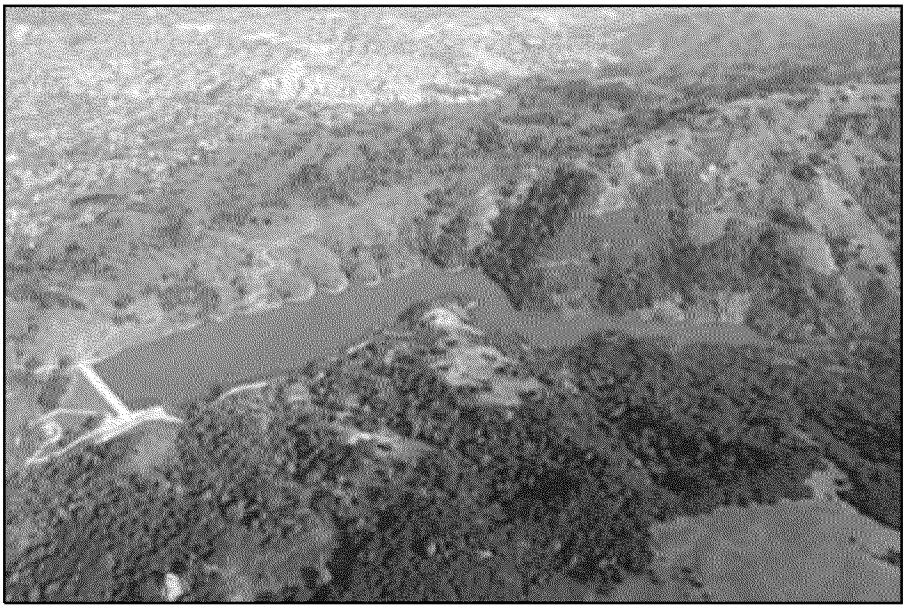

Figure 6.13 Guadalupe Reservoir

Figure 6.14 Almaden Reservoir

Problem Definition

The following waters within the Guadalupe River Watershed are listed as impaired (on the 303(d) list) by mercury: Almaden Reservoir, Alamitos Creek, Calero Reservoir, Guadalupe Reservoir, Guadalupe Creek, and the Guadalupe River Other water bodies in and downstream of the historic New Almaden Mining District are also considered impaired due to the presence of mining wastes but have not yet formally been listed—these water bodies were, however, addressed by the Guadalupe River Watershed TMDL

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Figure 6.15 Calero Reservoir

Of the many beneficial uses recognized by the State (which range from municipal water supply to recreation and groundwater recharge), only human and wildlife consumption of fish are impaired by mercury. For this reason,mercury in fish is the focus of the Guadalupe River Watershed TMDL. Mercury concentrations in fish tissue that exceed the EPA human health mercury fish criterion (0.3 mg/kg) have been measured at numerous creeks and reservoirs in the watershed.

Prior to the development of the TMDL, several studies compared mercury levels in fish from reservoirs and lakes downstream of the New Almaden Mining District to those from elsewhere in the San Francisco Bay Area. Although largemouth bass from many of the Bay region's water bodies have elevated mercury concentrations (in the range of 0.8–1.4 parts per million, ppm), the concentrations are markedly higher in Guadalupe and Almaden Reservoirs and in Almaden Lake (2.1–5.8 ppm). In reservoirs inhabited by fish considered safe for human consumption, such as nearby Lexington Reservoir and Alameda County's Lake Chabot, levels are closer to 0.6 ppm.

Comparisons were also made between the Guadalupe River Watershed and another stretch of the Central Coast Range mined for mercury—the Cache Creek Watershed about 80 miles upstream of the Bay. Cache Creek is one of the largest contributors of mercury to the Sacramento River System. Comparing 40-cm-long largemouth bass (a size large enough to be consumed by humans) from both watersheds, the Guadalupe Reservoir's bass contained more than 10 times (6.1 ppm) the amount of methylmercury in their bodies as Cache Creek's Clear Lake bass (0.6 ppm). Such data show that the Guadalupe Watershed is a larger producer and bioaccumulator of methylmercury than Cache Creek and other Bay Area Watersheds, and therefosre should be of concern to the State and to Bay Area residents, and particularly to local fishermen.

Former mercury mines located in the upper Guadalupe River Watershed have contributed mercury to downstream surface waters and San Francisco Bay. Miners placed most of the roasted waste, called calcines, in or near creeks so winter flows would sweep the waste material downstream—a mining practice common at the time. The New Almaden Mining District in the Guadalupe Creek and Alamitos Creek subwatershed was the largest producer of mercury in North America. Mercury in the mining district is primarily present as the mineral cinnabar. Mercury in water and sediment can be present in dissolved or particulate forms. Under appropriate conditions,

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Table 6.13
Target levels of mercury in the Guadalupe River Watershed

Protection of wildlife	Protection of wildlife	Protection of human health
TL3 Fish* 50 – 150 mm	TL3 Fish* 150 – 350 mm	Typical size and species of fish consumed
0.05 ppm methylmercury, wet weight	0.10 ppm methylmercury, wet weight	0.3 ppm methylmercury, wet weight

Source: RWQCB 2003.
* TL3 refers to the two sizes of smaller fish considered to be at the third trophic level (TL3) in the aquatic food web.

bacteria can convert inorganic mercury to the organic form, methylmercury, in a process called "methylation." This process is known to occur in the oxygen-depleted depths of impoundments in the Guadalupe River Watershed.

Other sources of mercury to the watershed include atmospheric deposition from global and local sources, urban stormwater runoff, soil erosion from areas not known to contain mines, Central Valley Project imported water inputs to Calero Reservoir, and seepage from contaminated sites and landfills.

Consumption of fish containing mercury is the principal route of human exposure to this metal. Methylmercury, the organic form of mercury, is a much greater concern than other chemical forms of the metal due to its greater toxicity and ability to bioaccumulate. In humans, mercury is a neurotoxin, affecting the brain and spinal cord, and interfering with nerve function. The main human health concern is for the fetus and young children. Pregnant women and nursing mothers can pass mercury to their fetuses and infants through the placenta and breast milk. In children, particularly those under age six, mercury can decrease brain size, delay physical development, impair mental abilities, cause abnormal muscle tone, and result in coordination problems. Substantial mercury exposure is also associated with birth defects and infant mortality. Adults exposed to mercury may experience abnormal sensations in their hands and feet, tiredness, or blurred vision. Higher levels of mercury exposure can impair hearing and speech. The young, and reproductive problems, are also of concern for wildlife consuming mercury-laden fish.

Elevated mercury concentrations in fish tissue may also pose a threat to wildlife, such as birds, amphibians, and mammals. In and around the Guadalupe River, wildlife sensitive to mercury include ducks, kingfishers, herons, terns, osprey, mink, and otter; among them the least tern is the only listed rare and endangered species.

The EPA limits mercury concentrations in fish tissue to 0.3 mg/kg for human health concerns. To demonstrate attainment of WQS, TMDLs must specify numeric targets that reflect measurable conditions. For mercury, these targets are typically represented as the amount of mercury (solid, suspended, liquid, or airborne) allowed in a certain amount of water, fish tissue, or sediment. For the Guadalupe River Watershed TMDL, the Regional Water Quality Control Board proposed three targets for methylmercury in fish to protect human health and wildlife (RWQCB 2008), as shown in Table 6.13.

The fish targets for wildlife are more stringent than the human health targets and therefore provide additional protection of human health (strong controls on smaller fish at the base of the food chain will reduce accumulation in the larger fish that humans consume). Achieving these targets will protect the Guadalupe River Watershed's wildlife and recreational (fishing) beneficial

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uses, help reduce bioaccumulation of mercury in fish, and attain all applicable numeric water quality objectives.

In 1987, California's Office of Environmental Health Hazard Assessment (OEHHA) issued a fish consumption advisory for mercury contamination in the Guadalupe region's reservoirs and lakes. During the same year, the state ordered a Superfund cleanup of the New Almaden mines property, which the County had purchased in 1975 to create the 4,000-acre Almaden Quicksilver County Park. The County began cleanup in 1990, and worked to bury, cover, and re-vegetate waste piles, and to control erosion and runoff at five sites that posed the greatest threat to people visiting the park. Although progress was made in the effort to clean up New Almaden's mercury legacy, a great deal more remained to be done both within and downstream of the New Almaden Mining District because the cleanup requirements did not address mercury in fish.

Participants and Stakeholders in the TMDL Development Process

Collection of the data to support the development of the Guadalupe River Watershed mercury TMDL was conducted collaboratively, with involvement from the Regional Water Quality Control Board, the Santa Clara Valley Water District, and the Santa Clara Basin Watershed Management Initiative (WMI). WMI created the Guadalupe Mercury Work Group and Stakeholder Group for the primary purpose of public and stakeholder participation in the TMDL data collection process. The Work Group and a Technical Review Committee of scientific subject experts formed and funded by the District reviewed the draft data reports.

The collaborative included: USEPA contractors; Santa Clara Valley Water District (District); Santa Clara Basin Watershed Management Initiative (WMI); California Regional Water Quality Control Board, San Francisco Bay Region (Regional Board); and USEPA. The District and its contractors conducted the majority of the data collection and analysis, including wet and dry season water and sediment sampling, visual surveys, fish sampling, laboratory analyses of samples, data reporting, and conceptual modeling. USEPA conducted reservoir fish sampling and laboratory analysis. USGS also contributed to the TMDL; with funding from the District, they conducted phytoplankton and zooplankton sampling in the watershed.

Role of the Drinking Water Utility in the TMDL Process

The Santa Clara Valley Water District and the California Regional Water Quality Control Board, San Francisco Bay Region (Regional Board) mutually adopted a Memorandum of Understanding (MOU) for cooperatively developing the TMDL for the Guadalupe River Watershed (RWQCB, 2003). The MOU formally established a mutual commitment by both parties to work with stakeholders. The specific roles and responsibilities of the District and Regional Board were described by the Guadalupe Mercury TMDL Work Group (WMI, 2000).

The District contributed to the development of the Watershed Mercury TMDL by working collaboratively with the Regional Board and its project manager, using the WMI to fully ensure public and stakeholder participation. Specifically the District provided funding for the data collection and technical reports, encouraged and assisted WMI in providing support services to ensure adequate and effective public and stakeholder participation; served as co-chair of the Work Group (with the Regional Board) and as a member of the Stakeholder Group; formed and funded a Technical Review Committee (TRC), approved by the Regional Board, who provided independent, expert scientific review of key deliverables during the project.

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Development of the TMDL

A comprehensive data collection effort was conducted to develop a conceptual model of mercury contamination, fate and transport in the watershed, including estimates of wet and dry weather loads. The data collection effort had wide spatial coverage. Sampling and chemical analyses were conducted at 24 different locations, using a consistent set of sampling and analytical methods. Wet weather sampling was conducted to assess the magnitude of mercury loading in the Guadalupe River Watershed during wet seasons. Dry weather sampling was conducted to identify methyl mercury production sites and conditions associated with its production, and to measure mercury concentrations in fish tissue throughout the watershed. An additional purpose of the data collection effort was to evaluate the relative bioavailability of solid phase mercury as a potential means of prioritizing sediment removal and erosion control of mine wastes.

The information from the data collection effort was used to support the development of a conceptual model of mercury in the watershed, as well as the development of a "quantitative linkage" of sources to numeric targets as required by the TMDL. Reconnaissance-level visual field surveys were also conducted to identify and map possible areas of eroding mine wastes and wetlands with the potential for enhanced mercury methylation. Three types of information was gathered: Wetland vegetation; sediment erosion and accumulation; and mercury mine waste.

Four central points emerged from the technical studies and regulatory work undertaken in developing the TMDL (RWQCB, 2008):

1. The largest source of mercury contamination in the watershed is mining waste, which can be reduced by routine stream maintenance methods of erosion control and sediment removal.
2. Most of the production of methylmercury, the chemical form of mercury most harmful to fish, and to the humans and wildlife that eat them, occurs in summer in the oxygen-depleted depths in the watershed's impoundments.
3. There is a tentative linkage between the amount of contamination in the fine sediments at the bottom of the impoundments and the amount of methylmercury present in the tissues of the fish living in them. This linkage provided the basis of the allocation of loads to the New Almaden Mining District in the TMDL. (Subsequent data collection has shown that productivity and the ecological status of the fishery are more important factors controlling the concentration of mercury in fish).
4. Curbing the production of methylmercury in the watershed—primarily by innovative changes in reservoir management currently under development by engineers at the Santa Clara Valley Water District will be a necessary component of an implementation plan to reduce bioaccumulation in fish and protect human health and wildlife.

Four sources of mercury were identified in the Guadalupe River Watershed: mining wastes, urban runoff, naturally occurring mercury in the soil, and atmospheric deposition. Based on measurements of total mercury transported downstream during the 2003–2004 wet season, mining waste was identified as the largest source. Whatever the source, once mercury enters the water column, most of it is bound to particles. Not all four sources, however, contribute to every water body within the watershed. Lexington Reservoir, for example, does not receive mining wastes or urban runoff. As a result, Lexington Reservoir was selected as the "reference reservoir" indicative of natural background conditions.

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Table 6.14
Guadalupe River Watershed TMDL allocations

Source of mercury	Allocation
Hypolimnion of Guadalupe, Almaden, and Calero reservoirs and Almaden Lake	(concentration-based) 1.5 ng/l (parts per trillion) dry/wet seasonal maximum of methylmercury
Erodible soil fines transported from the portion of the New Almaden Mining District that drains to Guadalupe, Almaden, and Calero reservoirs and Almaden Lake;	0.1 ppm total mercury (annual median, dry weight)
Sediments suspended from Guadalupe, Alamitos, and Calero creeks and the Guadalupe River	0.2 ppm mercury (annual median, dry weight)
Urban runoff	0.2 ppm mercury (annual median, dry weight)
Nonurban Stormwater runoff discharges	0.1 ppm total mercury (annual median, dry weight)
Atmospheric deposition	0.02 mg mercury per square meter of water surface (per year)

Mercury loads are not only influenced by their primary source of origin and physical form (solid, suspended, liquid, or airborne), but also by seasonal changes and the resulting changes in water chemistry from thermal stratification (layering) within reservoirs. The TMDL studies indicated that the wet season is largely a time of transport for the inorganic particulate mercury, whereas the more problematic methylation largely occurs in the dry season. As explained above, this is because during the dry season, oxygen levels in the water become very low (anoxic) down in the hypolimnion (i.e., deeper waters) of impoundments and in the upper few centimeters of bottom sediment—conditions that enhance methylation.

Once produced in the depths of the watershed's reservoirs, and/or discharged downstream, the methylmercury may find its way into resident fish. TMDL studies found that mercury concentrations in fish samples collected in 2004 were greatest in Guadalupe and Almaden reservoirs located immediately downstream of the mining district. In contrast, adult largemouth bass in nearby Lexington Reservoir remained safe for human consumption.

The Guadalupe River Watershed TMDL consists of concentration- and mass-based allocations, and were carefully established to protect against the adverse effects of mercury that occur through long-term bioaccumulation. The allocations are based on the goals of a) eliminating inputs of mercury caused by human activities, particularly mining and urban runoff, and b) minimizing the transformation of mercury to methylmercury caused by human activities, particularly the construction and operation of impoundments. The allocations are listed in Table 6.14.

TMDL Implementation

The TMDL represents a major step forward in the state's efforts to address public concerns about mercury contamination in their fish and waterways, and to implement the broader 2004 San Francisco Bay Mercury TMDL. Implementation of the TMDL and measures to reduce methylmercury production and bioaccumulation requires innovative approaches—currently underway for the first time ever in the world by engineers at the Santa Clara Valley Water District—to adapt reservoir management and treatment controls for methylation. These efforts may have management and

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operational implications, as well as provide indirect benefits, such as the enhancement of source drinking water quality. Other implementation actions will entail erosion control in areas where mining waste is present, as well as removal of contaminated sediments from stream beds, banks, and floodplains, and storm drains. During implementation, monitoring will be carried out to document progress made in cleaning up and managing mercury within the Guadalupe River Watershed.

Benefits of Involving the Drinking Water Utility in the TMDL Process

Three major benefits were identified: (1) prioritization of implementation actions to achieve measurable improvements; (2) identification of early actions that may be implemented while the TMDL process is ongoing; and, (3) reducing costs. TMDLs may be developed based on existing information, no matter how limited, and this was the intent of the Regional Board following the 1998 listing of the Guadalupe River Watershed as impaired due to mercury in fish tissue. The dearth of data that existed at that time would likely have resulted in a TMDL that would include measures that would compel the Regional Board to require the District (and others) to implement mercury control measures without regard to their efficiency and efficacy. By taking the lead (and controlling the funds) in collection of data to support a sound science-based TMDL, the District achieved its goal of ensuring that implementation actions would be prioritized toward those that would achieve the greatest benefits of reducing mercury loads and improving mercury concentrations in fish. This approach also allowed the District to identify, plan, and implement effective control measures and initiate applied studies in advance of the lengthy TMDL development and approval process. Taking these early actions placed the District in a much stronger negotiating position once the TMDL was presented to the public for review and comment. As a result, TMDL implementation actions will primarily be incorporated into existing programs and projects as supplemental features; this is a much more cost-effective approach than having to implement stand-alone activities. The proactive approach is less costly than reacting to regulatory requirements and resisting them after the draft documents are out for review. It is more efficient to actively participate and, develop science based knowledge to help guide the development of the documents.

Problems Faced, Conflicts Resolved, and Obstacles Overcome

The three most significant challenges encountered were: (1) Perception of participation; (2) Paradigm shift of the regulatory agency; and, (3) access to private property.

1. The most difficult problem encountered was associated with the perspectives of other participants (and potential "Responsible Parties") in the stakeholder process who did not share the District's goal to identify and prioritize actions to address mercury contamination in the watershed. Instead of accepting the idea that there is a problem and helping to understand it, some merely observed the process while others continued to deny that a problem existed. While these attitudes were not changed, the results from conducting sound science-based data collection prevailed in at least demonstrating the existence of a problem and identification of potential remedies.
2. Another problem that arose concerned the need for a Paradigm shift of the Regional Board to relax its command and control approach to regulation in order to work collaboratively with the stakeholders. This Paradigm shift challenge is exemplified by the Regional Board's abandonment of the collaborative process following the data

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collection phase, when the Regional Board spent two years developing the TMDL without involving the stakeholders. This led to inaccuracies, inconsistencies, and conflicts with the schedule, timing, and scope of control measures, studies, and monitoring requirements that appeared in the TMDL presented for public review. Due to the early involvement and funding of sound science, the District's comments carry greater weight in "negotiation" with the Regional Board regarding these issues, and maintaining open lines of communication is the favored approach to resolution.

3. One significant obstacle encountered was obtaining access to private property to conduct the visual survey, but permission for right of entry was received from about 40% of the creekside property owners. In order to achieve this level of positive response, the survey had to be limited to visual observations only. Permission would not have been as successful if collection of soil and water samples were included. However, an indirect benefit was that the request for entry provided a means for informing and educating the public about the TMDL, and has since led to the formation by the residents of a nonprofit organization which is eligible to apply for state and federal funding to conduct mercury control projects on their property.

Lessons learned

Once the TMDL process has been initiated, trying to fight it or defeat it is a waste of resources. The collaborative approach tends to ensure that participants become informed and educated at the same pace, and conducting comprehensive and sound-science based data collection is essential to development of a TMDL that has the best chance of achieving the end goal of restoring water quality. Active participation results in the generation of ideas and creative approaches to incorporate control measures into existing projects and programs, which is the most cost-effective approach as opposed to the more costly approach of being reactive to requirements based on little or no science.

CASE STUDY LESSONS LEARNED

- Drinking water utility representatives can influence whether their source water body is listed on the state's 303(d) list.
- It's more likely that your drinking water utility's source water quality goals will be used for TMDL development if you actively participate in the setting of water quality goals at the beginning of the TMDL process.
- Involvement in the TMDL process helps drinking water utilities keep up-to-date on watershed activities and decision-making about source water quality. It is also generally more constructive to provide input during the formulation and development of TMDL decisions rather than at the tail end of the process.
- It is important to participate in the TMDL stakeholder process as early as possible, especially where drinking water supplies are located downstream of regulated point source discharges. The importance of water quality sampling data, especially long-term, continuous water quality data, cannot be overstated.
- Older urban municipalities may be especially motivated to get involved in the TMDL process because they are often stakeholders in more than one way. They may be engaged in the watershed because of their water supplies, as managers of CSOs and

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MS4s, as well as other permitted discharges. It is important that TMDLs developed for such a watershed be sufficiently protective of the source water quality of the water supply. It is also important, however, that pollutant loads assigned to permitted discharges are accurate and achievable.

- The state benefits from the involvement of drinking water utilities in the TMDL process by achieving consensus from all interested parties as TMDL development progresses. This approach conserves state resources that would otherwise be spent on resolving differences among stakeholders about the conclusions of a TMDL report if it were prepared by one party.
- Every stakeholder looks at water quality from their own perspective. For example, the acceptable pollution level for fishing or boating may be higher than what is needed for a drinking water supply (as was the case in the Winthrop Utilities case study). Drinking water utilities should approach the TMDL development process with an understanding of what levels of contaminants are necessary to achieve in order to protect their supply's drinking water quality.
- The more data available to populate models used during TMDL development, the more accurately the TMDL will reflect conditions in the watershed. It is usually in the best interest of the drinking water utility to gather additional data that fills gaps, or to provide additional data the drinking water utility has already collected.
- Different water quality concerns under low flow and high flow conditions have been addressed by developing two TMDLs: one for water quality parameters under low flow conditions, which in the related case study (Wilmington, DE) dealt primarily with NPDES permitted discharges; and one for water quality parameters under high flow conditions, which for Wilmington's watershed addressed in more detail nonpoint source loading, CSO, and MS4s.
- TMDL allocations can be modified if better water quality data are collected and presented to EPA and the states. By conducting a more detailed study of storm events, the City of Wilmington was able to gather more accurate pollutant loading information that resulted in the revision of the high flow bacteria and sediment TMDL.
- It is often difficult to assess which of the beneficial projects and programs that have occurred in a watershed after the development of the TMDL might have happened anyway. Care should be taken by all stakeholders that projects or programs not be derailed or delayed on account of an adversarial atmosphere that may develop during TMDL preparation.
- A TMDL provides a measurable target to aim for. Whether the target is achievable, however, remains to be seen for most of the case studies. The TMDL can provide justification for more stringent limits on upstream discharges.
- TMDLs provide a way to prioritize limited funding for nonpoint BMPs in a watershed.

ADDITIONAL EXAMPLES OF TMDLs DEVELOPED FOR POLLUTANTS IMPACTING DRINKING WATER SUPPLIES

The following are additional examples of TMDLs developed for pollutants causing impairments to drinking water supplies.

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Atrazine TMDL for Aquilla Reservoir, Texas (2002)

The Aquilla Reservoir is located in the 255 square-mile Brazos River Watershed within Hill County and Johnson County, Texas. The Aquilla Reservoir dam was constructed by the U.S. Army Corps of Engineers in 1983. The reservoir is used by the Aquilla Water Supply as a drinking water source, supplying over 18,000 people with water. The majority of the reservoir's watershed (approximate 81%) is comprised of row crops, pasture, hay, and grassland. Atrazine has been widely used in the Aquilla Reservoir Watershed since 1958 for the control of broadleaf weeds (mainly henbit, pigweed, ryegrass, sunflowers, and cockleburs) in corn and grain sorghum. Atrazine is an inexpensive, effective herbicide that blocks photosynthesis. No alternative herbicide is as economically viable for these weeds.

The Aquilla Reservoir has the following uses: public water supply, fish consumption, contact recreation, and aquatic life. As established by the Texas Natural Resource Conservation Commission (TNRCC), atrazine in treated drinking water has an MCL of 3 mg/L. Compliance with the MCL in surface water bodies is based on a running annual average from quarterly sampling using EPA certified laboratories and methods for drinking water. In 1997 and 1998, tests of treated drinking water by the Aquilla Water Supply District found the herbicide atrazine in the Aquilla Reservoir at levels in excess of state drinking WQS; samples had an annual running average (second quarter of 1997 through the first quarter of 1998) of 0.4 mg/L. The Aquilla Reservoir was assessed as not supporting its designated use as a public drinking water supply.

In 1998, the Aquilla Reservoir was listed on the Texas CWA Section 303(d) List of Impaired Waters for failure to support the public water supply use. Shortly after the 303(d) listing, TNRCC assigned the reservoir a high priority for TMDL development. Meanwhile, the Aquilla Water Supply District began additional treatment to remove atrazine from the finished water.

The TMDL developed for the Aquilla Reservoir involved a significant amount of stakeholder involvement through a twenty-four member Watershed Steering Committee. Members of the Steering Committee included the Aquilla Water Supply District, state and federal agencies, and members of the general public and agricultural community. An agricultural subcommittee was also formed to encourage awareness of BMPs. A Surface Water Protection Committee formed from various government agencies and private interest groups served as the advisory group for the TMDL.

The endpoint selected for the TMDL was an atrazine concentration of 3 mg/L, which is equivalent to the drinking water MCL. It was determined that all atrazine loading in the watershed originated from nonpoint sources associated with human activities (i.e., weed control in row crops). There were no point source discharges, nor were there natural background sources of atrazine. The fate and transport of atrazine are difficult to quantify and model. However, an understanding of atrazine's properties aided in establishing a link between the chemical's sources and the receiving water, Aquilla Reservoir. The maximum allowable load (i.e., the TMDL) for atrazine (141 lbs/yr) was developed using a simple mass balance calculation. A resulting load reduction of approximately 25 percent would be necessary to achieve the TMDL and meet the 3 mg/L water quality standard. Compliance with the TMDL endpoint is assessed against the running annual two-year average based on monthly sampling of water from the reservoir.

The responsibility for reducing atrazine fell primarily to agricultural producers in the watershed. Agricultural producers responded effectively to the TMDL and implemented BMPs with the assistance of state and federal agencies. Between 1998 and 2003, atrazine concentrations in the reservoir were reduced by approximately 60 percent to levels lower than that required for treated drinking water. Although there have been a few measurements that exceed the allowable amount

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in the reservoir, no atrazine concentrations higher than the allowable amount have been detected at the drinking water treatment plant since April 1998. Atrazine concentrations in the reservoir have been reduced to safe levels and the goal of the TMDL has been met.

According to the Texas Commission on Environmental Quality (2005), a key factor in the success of this TMDL was the coordination of activities and interested parties through the Texas Watershed Protection Committee (formed to address threats to several lakes from atrazine contamination), as well as the voluntary cooperation of agricultural producers in the watershed. The successful paradigm developed for the Aquilla Reservoir Watershed has been used in several watersheds across the state to reduce threats to drinking water sources from atrazine and other chemicals.

Atrazine TMDL for Vandalia City Reservoir, Missouri (2006)

The Vandalia City Reservoir is located in Pike County, Missouri, between Vandalia and Curryville, Iowa. The reservoir was created by damming a tributary of South Spencer Creek and serves as a drinking water source for the town of Vandalia in Audrain County and surrounding dwellings. The Vandalia City Reservoir watershed encompasses 3,655 acres. The majority of the watershed (about 53%) is agricultural, and most of the farmland is used for crops such as soybeans, corn, wheat, and grain sorghum. Pasture and hay land comprise the next largest portion of the watershed (21%), where hogs and beef cattle are the main livestock. Similar to the Aquilla Reservoir watershed, atrazine is the most heavily used herbicide in corn and grain sorghum production in the Vandalia City Reservoir Watershed (and all over Missouri), as it provides selective broadleaf control and grass suppression at a lower cost than many other herbicides.

In Missouri, drinking water supply use is defined as follows: "Maintenance of a raw water supply which will yield potable water after treatment by public water treatment facilities" (Missouri Code of State Regulations, 2007). Missouri's criterion for atrazine in drinking water supplies is 3 µg/L in surface waters used for drinking water; this is the same criterion applied to finished drinking water. Compliance with the drinking water standard is measured as a running annual average and the surface water standard (for raw water) is based on a 70-year mean.

There were 308 records of data collected for atrazine at the reservoir from October 10, 1996 to December 19, 2005. These data represent raw water samples collected from the point where water is drawn from the reservoir for treatment. Data values from 1997, taken before the implementation of BMPs, were much higher than the subsequent years on record. The annual average atrazine concentration reached a maximum of 10.5 µg/L in 1997, greatly exceeding the 3 µg/L water quality criterion for drinking water supplies. Missouri listed the Vandalia City Reservoir as impaired on its 2002 303(d) list for drinking water use due to exceedence of Missouri's atrazine criterion for drinking water supplies.

Missouri's drinking water criteria for substances that are rendered nontoxic by transformation processes in the surface water body apply at water supply withdrawal points (i.e., the point where water is drawn out of a water body) prior to being transported to a drinking water processing plant. Regardless of what the levels of the pollutant are elsewhere in the lake, the levels found at the withdrawal point are what is important when drinking water is the designated use. As a result, the TMDL target for the Vandalia City Reservoir was set to be equal to an atrazine concentration of 3 µg/L at the withdrawal point. This is a raw water quality standard that should not be confused with the MCL in drinking water rules (although they share the same numerical value in this case).

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The TMDL for the Vandalia City Reservoir was developed based on data analysis of the overall average concentration using monitoring data and lake volume. The resulting loading capacity (1.8 lbs/yr) was set at the maximum long-term average mass within the reservoir that results in compliance with the water quality criterion. This long-term average mass was determined by converting the cumulative running average concentration since 1999 into mass terms using the reservoir volume. As additional data are collected (post TMDL), those data are to be added to the original data set used to develop the TMDL in order to determine the long-term cumulative average mass and assess for compliance with this TMDL. There were no point source discharges of atrazine within the Vandalia City Reservoir watershed so the only sources of atrazine in the lake are linked to nonpoint sources. Overland runoff, rainfall containing low levels of dust falling directly onto the lake, and drainage tile discharge were identified as the likely mechanisms transporting atrazine to the reservoir.

In 1997, the City of Vandalia worked with both the University of Missouri Outreach & Extension Office and the Natural Resources Conservation Service (NRCS) to create the Vandalia Watershed Management Committee. The committee sprang from an initial meeting held by the city to inform the producers in the watershed about the problem and what the city was doing to try to address it. Committee members included representatives from the city (including elected officials), residents, landowners and producers within the reservoir watershed, Pike and Audrain County Soil and Water Conservation District (SWCD) members, and extension staff from the University of Missouri. The committee developed an atrazine reduction plan that included recommendations that farmers change some of their management practices. The plan also contained a number of specific goals, including maintaining atrazine levels below MCL limits to ensure acceptable water treatment costs.

In 1997, the Environmental Quality Incentive Program (EQIP) became available to producers in the watershed through NRCS. Through the program, farmers were able to receive an incentive payment for using less than a pound per acre of atrazine or for using an alternative herbicide. According to the Pike County SWCD, ten contracts started in spring of 2000 and two more started in 2001. In the spring of 2004, EPA and the registrants of pesticide products containing atrazine signed into effect a Memorandum of Agreement (MOA). The goal of the MOA was to reduce loading of atrazine to levels below a drinking water criteria on which EPA and the technical registrants agreed. If drinking water standards are not met, the use of atrazine may be excluded within the applicable watersheds. The MOA resulted in cooperation between atrazine producers and the Missouri Corn Growers Association and other entities to work with producers in exploring employment of BMPs to protect water quality in the Vandalia City Reservoir.

The implementation of the atrazine reduction plan, EQIP contracts, and subsequent adoption of BMPs resulted in a dramatic reduction of atrazine levels in raw water from 1997 to 1999. The yearly running average of atrazine in the reservoir has been equal to or below the 3 µg/L water quality criterion since 2000.

Algae TMDL for McDaniel Lake, Missouri (2004)

McDaniel Lake was constructed in 1929 by impounding the Little Sac River. In 1990, the dam was raised to increase storage capacity. McDaniel Lake serves as a source of drinking water for the City of Springfield, Missouri. Land use in the watershed is predominately agricultural, both cropland and pasture. The land bordering McDaniel Lake is mostly wooded and nearly 100 percent

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of it is owned by City Utilities of Springfield. The McDaniel Lake Watershed has been subject to increasing development for the last several years.

Since before 1982, the City Utilities of Springfield had been receiving customer complaints regarding the taste and odor of drinking water from McDaniel Lake. Initial problems in McDaniel Lake were linked to cyanobacteria (blue-green algae) metabolites, primarily geosmin and 2-methylisoborneal (MIB). Taste and odor events were officially recorded in McDaniel Lake in 1991, 1997–2000, and 2002. Formations of *Raphidiopsis*, *Lyngbia*, and occasional *Oscillatoria* blooms (types of cyanobacteria) have been linked to the contamination issues in McDaniel Lake. Increased production of cyanobacteria is related primarily to high levels of phosphorus and nitrogen, abundant sunlight, and warm water temperatures.

For years, the City Utilities of Springfield tried numerous management approaches to control the taste and odor problem, including: reducing the amount of phosphorus, nitrogen, and sediment reaching the reservoir through installation of BMPs along erodible tributary banks in the watershed; destratification of the layers in the lake to keep it from getting too warm; evaluating chemical treatment by targeting problematic species of algae; and removing nutrients trapped in the nutrient-rich hypoliminion, or bottom thermal layer of water, during July and August. Withdrawal of water from McDaniel Lake for drinking water and the transfer of water from other watersheds (Stockton Lake and the James River) into McDaniel Lake increased the complexity of the situation. These activities alter the water-to-sediment ratio and affect the lake's stratification, the natural thermal layering of lakes due to temperature differences in the water. These activities can also affect nutrient storage and release from bottom sediments, as well as cause fluctuations in mean lake elevation.

McDaniel Lake was listed on the 303(d) list based on exceedence of the following general criteria contained in Missouri's WQS: "Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses; and waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses." The impairment is also based on criteria related to taste- and odor-producing substances.

Although excessive algal growth is the impairment, Missouri does not have specific water quality criteria for algal growth. It was determined that the TMDL endpoint could not be based on treatment of taste and odor compounds alone. The endpoint must be based on the specific substances causing the production of the taste and odor compounds in the lake. After careful evaluation of several options, significant review of literature, and consultation with limnology experts, the EPA, Missouri Department of Natural Resources (MDNR), and City Utilities of Springfield decided to set the TMDL targets based on research conducted by Downing et al. (2001). Downing's research showed that suspended chlorophyll *a* concentration predicts the risk of cyanobacteria dominance better than nutrient ratios, phytoplankton biomass, or concentrations of nitrogen and phosphorus. Further, the risk of cyanobacteria dominance exponentially increases in temperate lakes when chlorophyll *a* exceeds 10 μg/L. Therefore, in an effort to control biomass at levels that reduce the risk of cyanobacteria proliferation that results in taste and odor problems in McDaniel Lake, the total phosphorus loading would be allocated so that chlorophyll *a* concentrations near the dam do not exceed 10 μg/L.

Due to the complexity of natural processes within McDaniel Lake and the lack of sufficient data to model them, for the purposes of the TMDL, McDaniel Lake was modeled as a "black box" and a simple approach based on a statistical interpretation of the data was taken to develop the TMDL. Statewide lake data were included in the analysis in order to increase the reliability and

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applicability of the model. A linear regression equation was developed to describe the relationship between in-lake concentrations of chlorophyll *a* and total phosphorus. The TMDL target value of 10 µg/L chlorophyll *a* was used in the linear regression equation to determine the target total phosphorus concentration. Once the target total phosphorus concentration was determined, a total phosphorus loading target for McDaniel Lake could be calculated. In order to achieve a chlorophyll *a* target concentration of 10 µg/L at McDaniel Lake's dam, it was determined that total phosphorus loading to the lake would have to be reduced by 40 percent.

The major causes of excessive algal growth in McDaniel Lake were identified as increased nutrient loading from agricultural sources, urban stormwater runoff of nutrients and pollutants from lawns, and septic tanks. Implementation approaches recommended in the TMDL included the creation of a wetland at the head of McDaniel Lake and the use of aquatic plants to take up extra nutrients, as well as reduction of nutrients leaching into the lake from malfunctioning on-site septic systems. At the time of TMDL development, it was anticipated that the Watershed Committee of the Ozarks would receive a 319 grant from the state that would be used to construct an on-site wastewater training center. The center would provide a place to train on-site system installers, inspectors, and maintenance personnel. The grant would also allow the committee to hire a nonpoint source educator who would develop training materials and methods for the center.

Manganese TMDLs for Target Watersheds: Farina Lake, Old Kinmundy Lake, New Kinmundy Lake, and Kinmundy Borrow Pit, Illinois (2005)

Four lakes in the East Fork Kaskaskia Watershed (Farina Lake, Old Kinmundy Lake, New Kinmundy Lake, and Kinmundy Borrow Pit) serve as public water supplies. The 82,254-acre East Fork Kaskaskia Watershed is largely agricultural, with extensive soybean and corn production. The drainage areas of each of the four water supply lakes are relatively small and, in some cases, not much larger than the lakes themselves.

The public water supply designated use, as stated in Title 35 of the Illinois Administrative Code, is established to protect waters withdrawn for treatment and distribution as a potable supply or for food processing. The standard for total manganese in untreated public water supplies is 150 µg/L. The four lakes were sampled through the State's Ambient Lake Monitoring Program on a five-year cycle. During summer stratification, many lakes develop anoxia in their hypolimnia (bottom waters). Under these anoxic conditions, manganese undergoes a chemical reduction and becomes dissolved in the hypolimnetic water of lakes. Data revealed significant instances of noncompliance with the public water supply total manganese standard of 150 µg/L. Measurements of manganese in the four lakes exceeded the water quality standard as a result of thermal stratification and the development of reducing conditions in the hypolimnia in the lakes. Because the epilimnion (the water layer overlaying the thermocline, which is the area where the warmer and colder waters meet) and hypolimnion do not substantially mix during thermal stratification, manganese-rich bottom waters are overlaid by a manganese-poor epilimnion. The lakes were listed by the State of Illinois as impaired due to manganese and assigned a high priority for TMDL development.

Sources of manganese in the lakes include seasonal reduction of manganese in lake sediment during summer anoxia, and (for Farina Lake) pumping of water containing manganese from the Loy Pit and from the East Fork Kaskaskia River. Additional nonpoint sources of manganese originate from the lake's watershed in the form of eroded soils. After being transported to the lake, particulate manganese settles. The particulates eventually become dissolved and enter the water column and cause levels to spike in the hypolimnetic waters. Infiltration of shallow groundwater

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to the lakes may also be a source of manganese; however, no data on groundwater infiltration rates or manganese concentrations in shallow groundwater were available at the time of TMDL development.

Farina Lake is specifically managed to maintain the lake as full as possible. The Village of Farina pumps water from the East Fork Kaskaskia River to supplement the supply provided by Farina Lake. This pumping is not metered, but occurs principally during moderate flow periods (i.e., generally not summer, as the stream may be dry). Data for the East Fork Kaskaskia River show a long-term average total manganese concentration of 526 µg/L. The Village also pumps from the Loy Pit to supplement their water supply. This pumping is also not metered, and no data on manganese concentrations in Loy Pit water were available. According to Village of Farina water operators, an estimated 50 percent of the lake's supply is pumped from the Loy Pit and about 50 percent from the East Fork Kaskaskia River.

The TMDL for the four lakes was developed based on the 150 µg /L public water supply standard for manganese and the assimilative volume of the lakes. The assimilative volumes were calculated as the sum of lake volume and inflows during the period of time that the lakes are not stratified. During summer stratification, the assimilative volume was taken as the volume of the hypolimnion and inflows. Thermal stratification is a seasonal phenomenon, and the assimilative lake volume varies during the course of a year. For the purposes of the TMDL, the summer stratification period was considered a critical condition.

Iron TMDL in Lake Okeechobee, Florida (2005)

Lake Okeechobee is a 700 square-mile shallow (average depth about 9 feet) eutrophic lake. The lake's designated use is "potable water." The lake is a multi-purpose reservoir that provides drinking water to five communities around the lake. The lake also serves as a source of water for irrigation of agricultural lands, recharge of aquifers, fresh water for the Everglades, habitat for fish and waterfowl, flood control, recreation and navigation. Lake Okeechobee's watershed encompasses about 2,900 square miles. Land use within the watershed is dominated by agriculture (62%), with major agricultural uses including pasture, sugarcane, rangeland, unimproved pasture, and citrus groves.

South Florida Water Management District (SFWMD) collected data for iron in Lake Okeechobee from 1996–2002 at 50 water quality sampling stations. Out of 620 data points, 45percent exceeded the drinking water iron criterion of 0.3 mg/L. The average iron concentration was 0.574 mg/L, which also exceeded the 0.3 mg/L drinking water criterion. Water quality data in the south Florida ground water and surface water indicate that iron is commonly found at concentrations that exceed the drinking water criterion. However, significant human-related activities surrounding Lake Okeechobee made it difficult to conclude that the elevated iron levels in the lake were a result of natural conditions. As a result, Florida's 1998 Section 303(d) list identified three portions of Lake Okeechobee as being impaired for iron.

Lake Okeechobee is designated a Class I water. Florida Class I water bodies are designated as potable water supplies. Florida's Class I water quality criterion for iron is 0.3 mg/L and represents a secondary MCL (SMCL) that applies to public water systems. EPA established SMCLs for 15 contaminants as guidelines to assist public water systems in managing their drinking water for aesthetic considerations. The guidelines address contaminants such as iron, manganese, hardness, taste, color, and odor. SMCLs are not enforced as requirements, as they are not considered to present a risk to human health. However, it is believed that the presence of these contaminants

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in drinking water at levels above the secondary standards may cause the water to appear cloudy or colored, or to taste or smell bad. This may cause people to stop using water from their public water system even though the water is actually safe to drink. Noticeable effects for iron above the SMCL may include rusty color, sediment, metallic taste, and reddish or orange staining.

Florida applies their Class I water quality criteria to raw water rather than the treated drinking water or at the tap for purposes of complying with the CWA. At the time of TMDL development, the public drinking water providers that use Lake Okeechobee as a drinking water source were not using additional treatment technology to remove iron, since existing filtration processes already in place were sufficient.

Statistical analysis indicated that iron in Lake Okeechobee was very strongly associated with turbidity and natural processes within the lake, which led to the conclusion that controlling turbidity would control iron. Based on this relationship, an iron concentration of 0.3 mg/L corresponded to turbidity of about 10.5 NTU. Calculations indicated that when lake turbidity is less than 10.5 NTU, there is a 90 percent probability that iron will meet the water quality standard in raw lake water.

Because of the largely variable contributions from nonpoint sources and difficulty linking the load to flow or time, the iron TMDL for Lake Okeechobee was expressed as a percent reduction. Iron data for the entire lake were used for the TMDL calculation. Evaluation of the data indicated that concentrations of iron across the lake reflected similar ranges. Therefore, the same percent reduction was applied to all three impaired sections of the lake. The reduction was calculated as 51 percent. The allowable 51 percent reduction in concentration of loads to the lake would result in an in-lake concentration that would achieve the 0.3 mg/L water quality criterion for iron.

Iron in the Biscayne Aquifer, which lies beneath Lake Okeechobee and its watershed, commonly exceeds the 0.3 mg/L drinking water criterion. In addition, ground water movement is such that the iron-rich ground water moves toward the lake. Iron is dissolved from practically all soils and rocks. Surface waters in southeast Florida generally have less than 0.1 mg/L iron but groundwater may contain from nearly none to 3 or 4 mg/L or iron. It was, therefore, determined that the prevalence of iron in Lake Okeechobee was attributed primarily to non-anthropogenic sources. Iron occurs naturally in the environment and is attributed to ground water, watershed soils, or particulate matter in the lake, as opposed to atmospheric sources or anthropogenic point or nonpoint sources. While anthropogenic activities in the watershed, such as agricultural activities, may be contributing some iron the lake, it was not possible to determine whether potential anthropogenic sources were significantly raising iron levels above those natural levels otherwise observed.

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CHAPTER 7
TOOLS FOR DRINKING WATER UTILITIES

This chapter contains tools for utilities to use as they navigate through the TMDL process. These tools are intended to inform readers about how the TMDL process works, provide definitions of terminology used, and help with decision-making. The following tools are included in this chapter:

- Glossary of key terms and definitions
- Step-by-step description of the TMDL process and how utilities can get involved
- Flow chart to help utilities get started with the TMDL process
- Sample letter for utilities to use to request involvement in the TMDL process
- Useful TMDL web sites

KEY TERMS AND DEFINITIONS

303(d) List - Required by Section 303(d) of the CWA, a list of a state's water bodies that do not meet or are not expected to meet applicable WQS with technology-based controls alone.

305(b) Report - Required by Section 305(b) of the CWA, a report that describes the quality of a state's surface waters and an analysis of the extent to which all waters provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water.

Acute Health Effect - An immediate (i.e., within hours or days) effect that may result from exposure to certain drinking water contaminants (e.g., pathogens).

Allocations - That portion of a receiving water's loading capacity attributed to one of its existing or future pollution sources (nonpoint or point) or to natural background sources. A wasteload allocation [WLA] is that portion of the loading capacity allocated to an existing or future point source, and a load allocation [LA] is that portion allocated to an existing or future nonpoint source or to natural background levels. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading.

Ambient monitoring - Monitoring program with fixed station networks and intensive surveys and producing chemical, physical, and biological analyses. Ambient monitoring deals with conditions in the aquatic environment--streams, lakes, bays, estuaries, and oceans. By contrast, effluent (discharge) monitoring involves sampling and analysis of wastewater.

Antidegradation - A policy designed to prevent deterioration of existing levels of good water quality.

Aquifer - A natural underground layer, often of sand or gravel, which contains water.

Assimilative capacity - The amount of contaminant load that can be discharged to a specific water body without exceeding WQS or criteria. Assimilative capacity is used to define the ability of a water body to naturally absorb and use a discharged substance without impairing water quality or harming aquatic life.

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Background levels - Levels representing the chemical, physical, and biological conditions that would result from natural geomorphological processes such as weathering or dissolution.

Best Available Technology -The water treatment(s) that EPA certifies to be the most effective for removing a contaminant.

Best management practices (BMPs) - Methods, measures, or practices determined to be reasonable and cost-effective means for a landowner to meet certain, generally nonpoint source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.

Bioaccumulation - The accumulation of contaminants in the tissues of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, pore water, or dredged material. Such processes can result in levels of pollutants in tissues of aquatic organisms far higher than in the surrounding water.

Chronic Health Effect - The possible result of exposure over many years to a drinking water contaminant at levels above its MCL.

Clean Water Act (CWA) - The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The CWA contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the TMDL program.

Critical condition - The critical condition can be thought of as the "worst case" scenario of environmental conditions in the water body in which the loading expressed in the TMDL for the pollutant of concern will continue to meet WQS. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence.

Coliform - A group of related bacteria whose presence in drinking water may indicate contamination by disease-causing microorganisms.

Community Water System - A water system which supplies drinking water to 25 or more of the same people year-round in their residences.

Cryptosporidium - A microorganism commonly found in lakes and rivers which is highly resistant to disinfection. *Cryptosporidium* has caused several large outbreaks of gastrointestinal illness, with symptoms that include diarrhea, nausea, and/or stomach cramps. People with severely weakened immune systems (that is, severely immuno-compromised) are likely to have more severe and more persistent symptoms than healthy individuals.

Designated uses - Uses that society, through state and federal governments, determines should be attained in the water body. Examples include warm water aquatic ecosystems, public water supply, and recreational fishing.

Disinfectant - A chemical (commonly chlorine, chloramine, or ozone) or physical process (e.g., ultraviolet light) that kills microorganisms such as bacteria, viruses, and protozoa.

Distribution System - A network of pipes leading from a treatment plant to customers' plumbing systems.

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Drainage basin - A part of a land area enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as a watershed, river basin, or hydrologic unit.

Eutrophication - The aging process by which lakes are fertilized with nutrients. Natural eutrophication will very gradually change the character of a lake. Cultural eutrophication is the accelerated aging of a lake as a result of human activities.

Exemption - State or EPA permission for a water system not to meet a certain drinking water standard. An exemption allows a system additional time to obtain financial assistance or make improvements in order to come into compliance with the standard. The system must prove that: (1) there are compelling reasons (including economic factors) why it cannot meet a MCL or Treatment Technique; (2) it was in operation on the effective date of the requirement, and (3) the exemption will not create an unreasonable risk to public health. The state must set a schedule under which the water system will comply with the standard for which it received an exemption.

Finished Water - Water that has been treated and is ready to be delivered to customers.

Geographic Information System (GIS) - A system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth.

Geometric mean - The geometric mean of 'n' fecal coliform samples is the nth root of their product. For example, the geometric mean of 5 values is the 5th root of the product of the 5 values.

***Giardia lamblia* -** A microorganism frequently found in rivers and lakes, which, if not treated properly, may cause diarrhea, fatigue, and cramps after ingestion.

Ground Water - The water that systems pump and treat from aquifers (natural reservoirs below the earth's surface).

Impaired water body - A water body (e.g., stream reach or lake) that does not meet WQS or designated uses for one or more pollutant(s).

Inorganic Contaminants - Mineral-based compounds such as metals, nitrates, and asbestos. These contaminants are naturally-occurring in some water, but can also get into water through farming, chemical manufacturing, and other human activities. EPA has set legal limits on 15 inorganic contaminants.

Load - The quantity that is or can be carried at one time, as compared to a concentration. A pollutant load is the quantity of a pollutant that a water body is carrying measured at a point in time.

Load allocation (LA) - The portion of a receiving waters loading capacity attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished (40 CFR 130.2(g)).

Loading capacity (LC) - The greatest amount of loading a water can receive without violating WQS.

Margin of safety (MOS) - A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body

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(CWA section 303(d)(1)(C)). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by EPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a TMDL = LC = WLA + LA + MOS).

Maximum Contaminant Level (MCL) - The highest level of a contaminant that EPA allows in drinking water. MCLs ensure that drinking water does not pose either a short-term or long-term health risk. EPA sets MCLs at levels that are economically and technologically feasible. Some states set MCLs which are more strict than EPA's.

Maximum Contaminant Level Goal (MCLG) - The level of a contaminant at which there would be no risk to human health. This goal is not always economically or technologically feasible, and the goal is not legally enforceable.

Microorganisms - Tiny living organisms that can be seen only with the aid of a microscope. Some microorganisms can cause acute health problems when consumed in drinking water. Also known as microbes.

Narrative criteria - Nonquantitative guidelines that describe a desired water quality goal or goals.

National Pollutant Discharge Elimination System (NPDES) - The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318, and 405 of the CWA. Facilities subjected to NPDES permitting regulations include operations such as municipal wastewater treatment plants and industrial waste treatment facilities.

Nonpoint Source (NPS) - Pollution that , unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and man-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. Loadings of pollutants from NPS enter water bodies via sheet flow, rather than through a pipe, ditch or other conveyance.

Non-Transient, Non-Community Water System - A water system which supplies water to 25 or more of the same people at least six months per year in places other than their residences. Some examples are schools, factories, office buildings, and hospitals which have their own water systems.

Numeric targets - A measurable value determined for the pollutant of concern, which, if achieved, is expected to result in the attainment of WQS in the listed water body.

Organic Contaminants - Carbon-based chemicals, such as solvents and pesticides, which can get into water through runoff from cropland or discharge from factories. EPA has set legal limits on 56 organic contaminants.

Pathogen - A disease-causing organism.

Point source - Discrete conveyances, such as pipes or man made ditches that discharge pollutants into waters of the United States. This includes not only discharges from municipal wastewater treatment plants and industrial facilities, but also collected storm drainage from larger urban areas, certain animal feedlots and fish farms, some types of ships, tank trucks, offshore oil platforms, and collected runoff from many construction sites.

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Public Water System (PWS) - Any water system which provides water to at least 25 people for at least 60 days annually. There are more than 170,000 PWSs providing water from wells, rivers and other sources to about 250 million Americans. The others drink water from private wells. There are differing standards for PWSs of different sizes and types.

Radionuclides - Any man-made or natural element that emits radiation and that may cause cancer after many years of exposure through drinking water.

Raw Water - Water in its natural state, prior to any treatment for drinking.

Reach - A section of a river or stream that generally extends from one tributary to another, or sometimes from a tributary to a dam or other feature. A reach is typically less than 20 miles in length. Water quality assessments of use support are made on individual river reaches using monitoring data for that reach, and other supporting data and information.

Safe Drinking Water Act (SDWA) - Congress passed the 1974 Safe Drinking Water Act (SDWA), P.L. 93-523, to protect public drinking water supplies from harmful contaminants. The Act, as amended, is administered through regulatory programs that establish standards and treatment requirements for drinking water, control underground injection of wastes that might contaminate water supplies, and protect groundwater.

Sanitary Survey - An on-site review of the water sources, facilities, equipment, operation, and maintenance of a public water systems for the purpose of evaluating the adequacy of the facilities for producing and distributing safe drinking water.

Secondary Drinking Water Standards - Non-enforceable federal guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor, or color) of drinking water.

Source Water - Water in its natural state, prior to any treatment for drinking.

Total Maximum Daily Load (TMDL) - A calculation of the maximum amount of a pollutant that a water body can receive and still meet WQS, and an allocation of that amount to the pollutant's sources.

Transient, Non-Community Water System - A water system which provides water in a place such as a gas station or campground where people do not remain for long periods of time. These systems do not have to test or treat their water for contaminants which pose long-term health risks because fewer than 25 people drink the water over a long period. They still must test their water for microbes and several chemicals.

Turbidity - Measures particles in the water, such as sediment and algae. Related to the depth sunlight can penetrate into the water. Higher turbidities reduce the penetration of sunlight in the water and can affect species of aquatic life that survive in the water body.

Wasteload allocation (WLA) - The portion of a receiving waters' loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).

Water quality criteria - levels of individual pollutants or water quality characteristics, or descriptions of conditions of a water body that, if met, will generally protect the designated use of the water. Numeric criteria are scientifically derived ambient concentrations developed by EPA or

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states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal.

Water quality standards (WQS) - Law or regulation that consists of the beneficial designated use or uses of a water body, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and antidegradation provisions.

Watershed - A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Variance - State or EPA permission not to meet a certain drinking water standard. The water system must prove that: (1) it cannot meet a MCL, even while using the best available treatment method, because of the characteristics of the raw water, and (2) the variance will not create an unreasonable risk to public health. The State or EPA must review, and allow public comment on, a variance every three years. States can also grant variances to water systems that serve small populations and which prove that they are unable to afford the required treatment, an alternative water source, or otherwise comply with the standard.

Wellhead Protection Area - The area surrounding a drinking water well or well field which is protected to prevent contamination of the well(s).

DRINKING WATER UTILITY INVOLVEMENT IN THE TMDL PROCESS

Clean Water Act and TMDL Framework

Although the TMDL development process has numerous intermediate steps and various levels of complexity, the following schematic provides a simplified illustration of key steps in the "TMDL process" within the framework of the CWA. Following the diagram, each step of the process is briefly discussed and opportunities for drinking water utility involvement are identified.

It is important to note that this process applies primarily to situations where a TMDL has not yet been developed for your source water. However, as shown in the illustration below, the process does not have an absolute end. The process is cyclical in that once the TMDL is completed and implementation is underway, compliance with standards is continuously assessed through monitoring. If a TMDL is already in place for your source water, visit your state TMDL Web site or contact your state TMDL coordinator to obtain a copy of the TMDL report. Determine what pollutants are included and how the loads are allocated. Talk with your state about the best way to obtain periodic updates about progress towards implementing the TMDL and attaining WQS.

Opportunities for Drinking Water Utility Involvement in the TMDL Process

Establish Water Quality Standards

The CWA requires states to adopt WQS that protect public health or welfare. This is accomplished by first *designating the uses* of the water body and then by *setting criteria* necessary to protect those uses. In addition to establishing water quality goals for a specific water body, WQS also serve as the regulatory basis for establishing water quality-based controls and strategies. Proper designation of your surface water source is one of many important factors to protecting its quality. Contact your state's WQS coordinator to confirm that your surface water source has been

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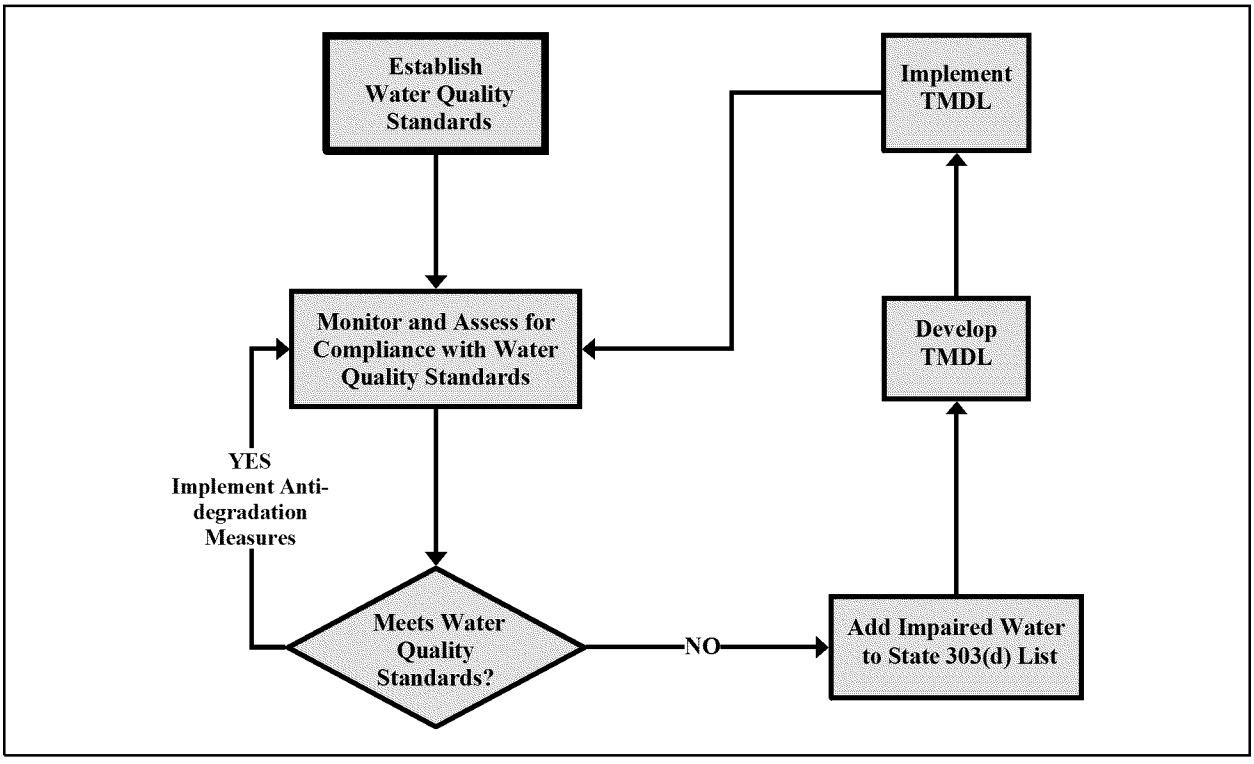

designated as a drinking water supply and find out what other designated uses have been identified for your source water. Obtain a copy of your state's WQS, including the administrative rules on how the standards are applied, and determine what WQS have been established for your source of drinking water supply.

The CWA requires states to review and revise their WQS every three years as part of the *triennial review* process. At a minimum, states must hold hearings; however, most states have more involved processes that include stakeholders. The triennial review is an appropriate time to advocate for improved use designations or new or revised water quality criteria. Find out when your state will begin the process of conducting its next triennial review. Inquire about which specific standards will be revised during the next review and find out when and how you can have input. If your state is ignoring the triennial review, you can begin urging them for action, giving particular attention to standards you think need to be revised. Also, find out when your state completed its last triennial review, and what revisions or additions they made during that last review, and request a copy of EPA's response to the state's triennial review, which may indicate areas needing revision during the next review.

Monitor and Assess for Compliance With WQS

Contact your state's ambient monitoring program coordinator to find out when in the past your source of drinking water has been monitored. If it has been previously monitored, request a copy of the data and the assessment results summary (if one was prepared). Ask the state to discuss the results with you and any potential implications of the assessment for your source water. For example, are any of the water body's designated uses impaired or threatened? If so, by which pollutants and sources? Also, examine the list of specific parameters that were collected. Are there any missing parameters that would be useful to monitor in the future to better assess whether the

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water body is meeting its drinking water use designation? Also, do the specific collection sites sufficiently capture water quality conditions near your drinking water intake? If not, perhaps you can suggest the addition of a collection site closer to your intake. Finally, find out when your source water is next schedule for additional monitoring and how you can be kept updated on the status of the monitoring and, eventually, the assessment results.

Responsibility for monitoring the quality of surface waters usually falls to the state. Limited resources, however, often prevent states from comprehensively characterizing the conditions of all their surface waters. If your drinking water utility collects surface water monitoring data (prior to treatment), consider sharing these data and information with your state's water quality program. If you don't currently collect surface water monitoring data, determine the feasibility of implementing a monitoring program for your water body. Keep in mind, however, that designing a good monitoring program requires careful planning. Key considerations include:

- Monitoring goals – Why do you want to collect data or information?
- Indicators – What parameters do you want to collect?
- Methods – What are the best methods for collecting the data you need to answer your questions and assess your water quality? You will want to develop or obtain standard operating procedures to ensure that data are collected in the same manner each time.
- Sites – Where should you collect water quality? Collecting data close to your intake is important; however, depending on the size of your source water, you may also want to establish additional sites to help with identifying potential sources.
- Frequency – How often do you need to collect data? What time of the year should you collect samples? What time of the day should you collection samples?

Many state agencies are often hesitant to accept monitoring data not collected by their own agency. Therefore, prior to designing your water quality monitoring program, contact your state to discuss your plans. There may be measures you can take to assure the quality of your results (e.g., develop a Quality Assurance Project Plan or QAPP), which will enable the state to use your data. Also, your state can provide useful guidance and assistance during the planning and implementation of your monitoring program. Finally, you may be able to coordinate your monitoring efforts with the state's efforts and avoid unnecessary duplication of efforts or to ensure consistent parameters are being collected; better coordinating your efforts can result in a larger, more informative data set.

Meets Water Quality Standards?

As discussed earlier in this report, the CWA requires each state to submit two surface water quality documents to the EPA every two years. Section 305(b) of the CWA requires the submittal of a report (commonly called the *305(b) Report)* that describes the quality of a state's surface waters and an analysis of the extent to which all such waters provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water. The second document is the *303(d) List*, whose name is based on the section ("303(d)") of the CWA that requires this list. In their 303(d) List, states identify all water bodies that are not meeting WQS and, therefore, are impaired by one more pollutants. Most water bodies on the 303(d) list will have a TMDL established. There are, however, other options for "delisting" a water body from the 303(d) list absent a TMDL. For example, restoration efforts may already be

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underway and if the water body comes into compliance with WQS before its scheduled date for TMDL development, the state may decide that a TMDL is no longer needed. As another example, if another control plan is in place to restore the water body, and that control plan is deemed sufficient (by EPA) to bring the water body into compliance with WQS in a reasonable timeframe, then a TMDL may not be needed.

The monitoring data and information collected by the states (and partner agencies) serves as the basis for the development of the 305(b) report and 303(d) list* and, ultimately, the determination of whether or not a water body is meeting its standards. Unfortunately, budgetary restraints allow states to monitor only a small percentage of their waters consistently enough to adequately assess water quality status and detect problems. As mentioned in the previous section, many states are hesitant to considering monitoring data not collected by their own agency staff during the 305(b) assessment and 303(d) listing process. However, if you have data that you have collected for your source water, contact your state 305(b) and 303(d) coordinator(s) to share your data and discuss the quality of your data for use in their assessment. If your data cannot be used in the state's assessment, find out what measures you can take (e.g., develop a QAPP) to assure the quality of your data for the next assessment.

States are required to provide an opportunity for public input to both the 305(b) Report and the 303(d) List. Prior to submitting their 305(b) Report and 303(d) List to EPA for review and approval, the state releases drafts of both documents for a 30-day public review and comment period. Participating in the public review process for both the 305(b) Report and 303(d) List is a great way to stay informed about and contribute input to the impairment status of your source water (assuming it is included in the assessment). The 305(b) Report and 303(d) List are typically posted on the state agency's Web site; however, to ensure you don't miss an opportunity to review the drafts, contact your state 305(b) and 303(d) coordinator(s) to inquire about the expected release date and to confirm that the draft documents will be made available via the state's Web site. Some states maintain mailing lists to notify interested individuals about the availability of the draft documents. If your state maintains such a distribution list, request that you be added to the list.

When reviewing the draft 305(b) report, determine whether your source of drinking water supply has been assessed. If your source water currently meets WQS, make sure that the standards are protective enough to ensure continued designated use as a drinking water source. Federal antidegradation policies have been developed to protect existing designated uses of waters and waters with exceptional water quality levels. Talk to your state about antidegradation policies related to your source water and ask what is being done to make sure that appropriate controls are in place to ensure continued beneficial use of your source water. Most on-the-ground antidegradation programs (e.g., BMPs) are carried out by stakeholders at the local level. Identify and coordinate with local stakeholders to determine what controls have been put in place to protect your source water and what additional ones may be necessary to protect against new or future threats. Also, work with your state's staff to ensure that new potential sources of pollution (e.g., new permitted facilities) or new activities in your watershed (e.g., mining, farming, tree harvesting, etc.) will not degrade water quality.

* Many states now submit these two documents as a single consolidated report.

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Add Impaired Water to State 303(d) List

In addition to reviewing your state's draft 305(b) Report, be sure to also review your state's draft 303(d) List. If monitoring and assessment reveal that your drinking water source is not meeting one or more of its standards, or is considered "threatened," then that water body is considered "impaired" and should be placed on the state's 303(d) List; if it isn't on the list, bring this to the attention of your state 303(d) coordinator. Once a water body is placed on this list, the state must develop a TMDL or alternate strategy for attaining WQS. If your source water is on the draft 303(d) List put out for public comment, inquire about the schedule for TMDL development for your source water. If you believe a TMDL should be developed sooner, provide the state with a formal comment letter stating just this, along with an explanation of why you believe your source water should be given a higher priority for TMDL development. If you are satisfied with the state's current schedule for TMDL development for your source water, this is still a good opportunity to identify yourself to your state TMDL coordinator and express your interest in being involved in the development of the TMDL and the role you would like to play (e.g., active stakeholder at the table providing input on decisions or a reviewer of the draft TMDL once released for public comment). Ask the state TMDL coordinator if they have a mailing list for your water body. If they do, request to be added to it so that you can receive updates on plans to develop the TMDL. If they don't have a mailing list, ask the state to set up a way to keep you updated.

Is a Third-Party TMDL right for you?
There is a growing number of "third party TMDLs," which refer to a TMDL in which an organization or group other than the state or EPA take the lead on conducting the TMDL analysis and developing the TMDL documentation. In 2007, the Water Environment Federation (WEF) released the Third-Party TMDL Development Tool Kit, which provides a guide for those interested in taking the lead on TMDL development, including consideration factors to help you decide whether the third-party approach is the right one for your situation. Regardless of who develops the TMDL (e.g., watershed group, county, utility, etc.), ultimately, the state will need to adopt the TMDL and submit it for approval to EPA. Therefore, it is to the third party's benefit to involve the state and/or EPA in the development of the TMDL and obtain as much of their guidance and input as possible.

Keep in mind that not all water bodies on the 303(d) List will have a TMDL established. If this is the case for your source water, talk to your state's water quality program staff to determine what steps are being taken to bring the water quality back into compliance. You may be able to assist in that effort.

Develop TMDL

Once a water body is placed on the 303(d) list of impaired waters, a TMDL (or alternative pollution control plan) must be established for that water body. Technically, a TMDL is a calculation (of the maximum amount of a pollutant that a water body can receive before becoming impaired). However, the term "TMDL" is often used to identify the (documented) plan to reduce pollutant loading and attain WQS. The TMDL calculation is the sum of the allowable pollutant loads from all contributing point and nonpoint sources, taking into account natural background sources, seasonal variations, and a margin of safety. Though not yet required, many TMDLs also include a pollutant load allowance for future growth.

Although the states and EPA often take the lead on the development of the TMDL, numerous stakeholders often play a key role in its development. The state and EPA recognize the

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importance of involving stakeholders early in the process, as the implementation of TMDLs (i.e., the cleanup process) is ultimately driven by the local watershed stakeholders, especially when nonpoint sources need to be addressed in order to meet WQS. As a drinking water utility, you should try to become involved at some level in the development of TMDLs for your source water(s). The level of involvement and the role a drinking water utility can play in a TMDL will vary by TMDL. It's best to talk directly with your state TMDL coordinator and/or EPA about the role you can play in the development of the TMDL.

Even if you don't participate in the actual development of the TMDL, at a minimum, you should plan to review and comment on the draft TMDL report once your state issues it for public comment. The following are suggested items you should look for and/or comment on (in a letter to the state) when reviewing the TMDL report:

- Does the TMDL take into account all of the existing uses for your source water?
- Does the TMDL account for all sources of pollutant(s)? Examples of sources to verify include point sources such as municipal and industrial wastewater treatment plants, CSOs, and MS4s (i.e., urban stormwater runoff). Nonpoint sources include runoff from agricultural, urban, forestry, and other land uses, atmospheric deposition (i.e., air pollution that deposits on to the water).
- Does the TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between pollution allocations and water quality?
- Does the TMDL take in account seasonal variations, such as temperature? Seasonal factors such as temperature can affect pollution concentrations and should be taken into account when calculating TMDLs.
- Has an implementation plan been developed for the TMDL or will one be developed in the near future? Although not required by federal law,* TMDLs with implementation plans have a greater chance for success in restoring water quality.
- Has a post-TMDL monitoring plan been developed to assess and track the effectiveness of implementation activities? See the next section for more on TMDL implementation.

If a TMDL is already in place for your source water, and you did not have a chance to provide comments on it during the public review process, visit your state TMDL Web site or contact your state TMDL coordinator to obtain a copy of the TMDL report. Determine what pollutants are included and how the loads are allocated. Talk with your state about the best way to obtain periodic updates about progress towards implementing the TMDL and attaining WQS. Even though the official public comment period has closed, you can still contact your state to talk about any of the items indicated above.

Implement TMDL

Under the CWA, wasteload allocations established for point sources (e.g., industrial and wastewater treatment plants, CSOs, concentrated animal feeding operations (CAFOs), and MS4) are required to be implemented through the NPDES program. For nonpoint sources, however, the federal government has no authority to require nonpoint source polluters to reduce their pollutant

* In some states (e.g., Virginia), state regulations require the implementation of TMDLs.

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loads; however, many of the polluters are stepping up to the plate and voluntarily implementing BMPs (e.g., riparian buffers, changes in farming practices, etc.) to reduce nonpoint source loading.

Although not required by federal law, it is becoming increasingly common for states to develop implementation plans in conjunction with TMDLs or following the development of the TMDL. Implementation plans identify and describe needed actions (both required and voluntary) to achieve the TMDL goals. TMDL implementation plans typically include a monitoring plan (to assess the effectiveness of the TMDL) and milestones for incremental improvements and, ultimately, full attainment with WQS. TMDL implementation plans sometimes include provisions for when a TMDL should be revised (i.e., if significant improvements in water quality have not been made in a reasonable timeframe).

Similar to the role a drinking water utility may play in the development of a TMDL, a drinking water utility's role in the implementation of the TMDL can vary significantly. You may want to participate in the conceptualization of the TMDL implementation plan. You may have an active role in the actual implementation of the TMDL. For example, you can reach out to local stakeholders to educate them about BMPs and the importance of reducing pollutant loading to the source water; or you can participate in the post-TMDL monitoring. In some cases, you may decide it is in your best interest to purchase surrounding land to further protect your source of drinking water.

Even if you don't assist with the development of the implementation plan or assist in carrying out elements of the implementation plan, at a minimum, you should request a copy of the TMDL implementation plan (if one exists). The following are suggested items to look for when reviewing the TMDL implementation plan or, in the absence of an implementation plan, to ask your state TMDL coordinator:

- List of permits that need to be changed as a result of the TMDL. Contact your state NPDES permitting program to inquire about new facilities that may be seeking NPDES permits in your watershed
- List of BMPs necessary to address the nonpoint sources
- Description of how BMPs will be implemented and by whom
- Monitoring plan to assess the effectiveness of BMPs (and other actions taken to implement the TMDL) and provide the necessary information for revising the TMDL in the future, if needed
- Milestones to track implementation of management measures and progress towards achieving WQS
- Discussion of estimated timeframe for attainment with WQS and plans for actions that will be taken if standards are not attained in the expected timeframe

After the TMDL Has Been Implemented

As shown in the illustration at the start of this section, it is important to realize that the TMDL development (and implementation) process does not have an absolute end. The process is cyclical in that once the TMDL is completed and implementation is underway, compliance with WQS is continuously assessed through monitoring. If, after a reasonable amount of time, incremental progress towards meeting WQS has not been made, the implementation measures or the TMDL itself may need to be revised.

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Example of Drinking Water Utility Involvement in the TMDL Process: Contra Costa Water District

Introduction

With source water intakes located in the Sacramento and San Joaquin River Delta, the Contra Costa Water District (CCWD) needs to stay current on existing and potential impairment issues for the rivers. This case study illustrates ways in which CCWD has already engaged in the TMDL process and outlines additional ways in which CCWD can continue to be involved in the TMDL process for the Sacramento and San Joaquin Rivers. The steps for getting involved in the TMDL process that are described earlier in this chapter are applied in this case study. The authors have worked with CCWD to develop some guidance as to how and when CCWD should consider getting involved.

Background

The CCWD water supply draws primarily from surface water sources. CCWD's three source water intakes are located in the Sacramento and San Joaquin River Delta, just upstream of the San Francisco Bay; the combined watersheds of these two rivers extend through most of the Central Valley of California. CCWD currently supplies water to an estimated 550,000 people in central and eastern Contra Costa County. CCWD supplies treated drinking water directly to its retail customers and also supplies wholesale untreated source water to various water retailers within its service area. CCWD depends entirely on diversions from the Delta for its water supply.

In 2007, CCWD updated its watershed sanitary survey and submitted it to the California Department of Public Health. Sanitary surveys of surface water systems are required under the Interim Enhanced Surface Water Treatment Rule (IESWTR) and the Total Coliform Rule. The goal of the watershed portion of the sanitary survey is to protect water quality for current and future supplies. Given the size of the source watersheds, there are a vast number of potential sources of contamination to the watersheds including: discharge from municipal and industrial wastewater treatment plants; wastewater collection and septic tank systems; runoff from urban areas, highways, agricultural land, mines, and logging sites; concentrated animal feeding operations (CAFOs); insecticide/herbicide use; grazing and wild animals; solid and hazardous waste disposal sites; recreation; unauthorized activities; traffic accidents/spills; groundwater influencing surface water; seawater intrusion; geologic hazards; and fires.

As part of its sanitary survey, CCWD identified the following specific potential sources of contamination that could pose a risk to the quality of its source water:

- Seawater intrusion, including the possibility of a Delta levee failure
- Wastewater from houseboats and agricultural runoff near the Rock Slough intake
- Agricultural and domestic treated wastewater discharges from RD 800 outfall and elevated copper levels from Discovery Bay WWTP near the Old River intake
- Urban runoff contributions to the Contra Costa Canal
- Potential release of toxic substances during an accident or natural disaster at landfills, hazardous waste sites, and industries within the study area

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In addition to the local sources listed above, CCWD is also affected by contaminants discharged into surface waters throughout the Sacramento and San Joaquin River watersheds, including those contained in agricultural, wastewater, and urban non-point sources.

CCWD has made numerous investments to minimize risks from these potential sources of contamination, including: identifying alternative locations for source water intakes in the Delta, conducting regular monitoring, and implementing the measures in the Stormwater Remediation Study. Further, activities undertaken by other agencies help improve and protect source water quality, such as the Contra Costa County Clean Water Program (CCCWP) stormwater management program. A key recommendation from the survey is to seek new opportunities for continuing improvements to water quality through point and nonpoint source load reductions in the Sacramento and San Joaquin River Watersheds.

TMDL Involvement

In 2004, CCWD submitted a comment letter on the San Joaquin River Salt and Boron TMDL. A copy of this letter is provided in Appendix C. In the letter, CCWD expressed its support of efforts to develop a TMDL to address the consistent exceedances of salinity standards in the lower San Joaquin River. Further, CCWD used the letter as an opportunity to provide the state with its knowledge about impairments in the river. This letter serves as a useful example for other drinking water utilities.

Many of the TMDLs developed (and to be developed) are located far upstream from CCWD's source water intakes. However, there is always concern about pollutant transport downstream. Therefore, CCWD should continue to monitor progress in implementing the existing TMDLs and with efforts to develop the remaining TMDLs. The following are key questions and suggestions that CCWD should keep in mind:

- Water quality standards
  - What WQS (designated uses and water quality criteria) apply to the segments in which their source water intakes are located, as well as critical segments upstream of the intakes?
  - Are the segments accurately designated as a drinking water supply?
  - Are the WQS protective enough for the drinking water sources?
  - Where in the triennial review process is California and which specific standards will be revised during the next review?
  - What revisions or additions were made during the last triennial review? CCWD should request a copy of EPA's response to the state's last triennial review.
- Monitoring
  - If CCWD currently monitors source water quality in the Sacramento and San Joaquin Rivers, CCWD should share those data with the state 305(b) and 303(d) coordinators as they may be able to use those data as part of their assessment.
  - Does the state conduct ambient monitoring of the Sacramento and San Joaquin Rivers in the vicinity of CCWD's source water intakes? If so, CCWD should request a copy of those data and the assessment summary.
  - Are there any critical parameters that should be monitored in the rivers that are not currently monitored? If so, what are they, and who should be responsible for monitoring them?

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- Compliance with WQS
  - CCWD should review the draft 305(b) reports and 303(d) lists when they are released for public comment every two years, as well as submit a comment letter if needed (e.g., perhaps CCWD is aware of an impairment not included on the list). CCWD should keep track of the status of prior year 303(d) listings (i.e., was a TMDL established and approved by EPA?), as well as watch for new listings. As an example, 303(d) listings for the Sacramento and San Joaquin Rivers were extracted from the most current (2006) 303(d) list and summarized in Table 7.1.
  - Given the large size of the watersheds and the vast number of potential contaminants of concern, CCWD may want to track 303(d) impairment information in a spatial format using GIS. For example, it could develop a map that shows the location of the source water intakes, the watershed boundaries for their source water, and all of the 303(d) listed segments. This information and map could be updated every two years when the 303(d) list is updated. Some of this information may have already been gathered and mapped by the state or its contractors during the development of Source Water Assessments for CCWD's intakes.
- TMDL Development
  - For those water bodies that already have completed TMDLs, CCWD should check in with the state periodically on progress being made implementing the TMDLs.
  - For those water bodies still scheduled for TMDL development, CCWD should contact the state periodically about the status of their development. The State and Regional Boards maintain an electronic subscription mailing list service to provide periodic updates on specific topics of interest. CCWD should decide what role it would like to play in any future TMDL development. If the TMDL is for an impairment that is significantly further upstream of their intakes, then maybe CCWD will only need to review the draft TMDL when it is issued for public comment. If, however, the TMDL is for a segment closer to one of its intakes, CCWD may want to play a more active role in the development of the TMDL.

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FLOW CHART TO HELP UTILITIES GET STARTED WITH THE TMDL PROCESS

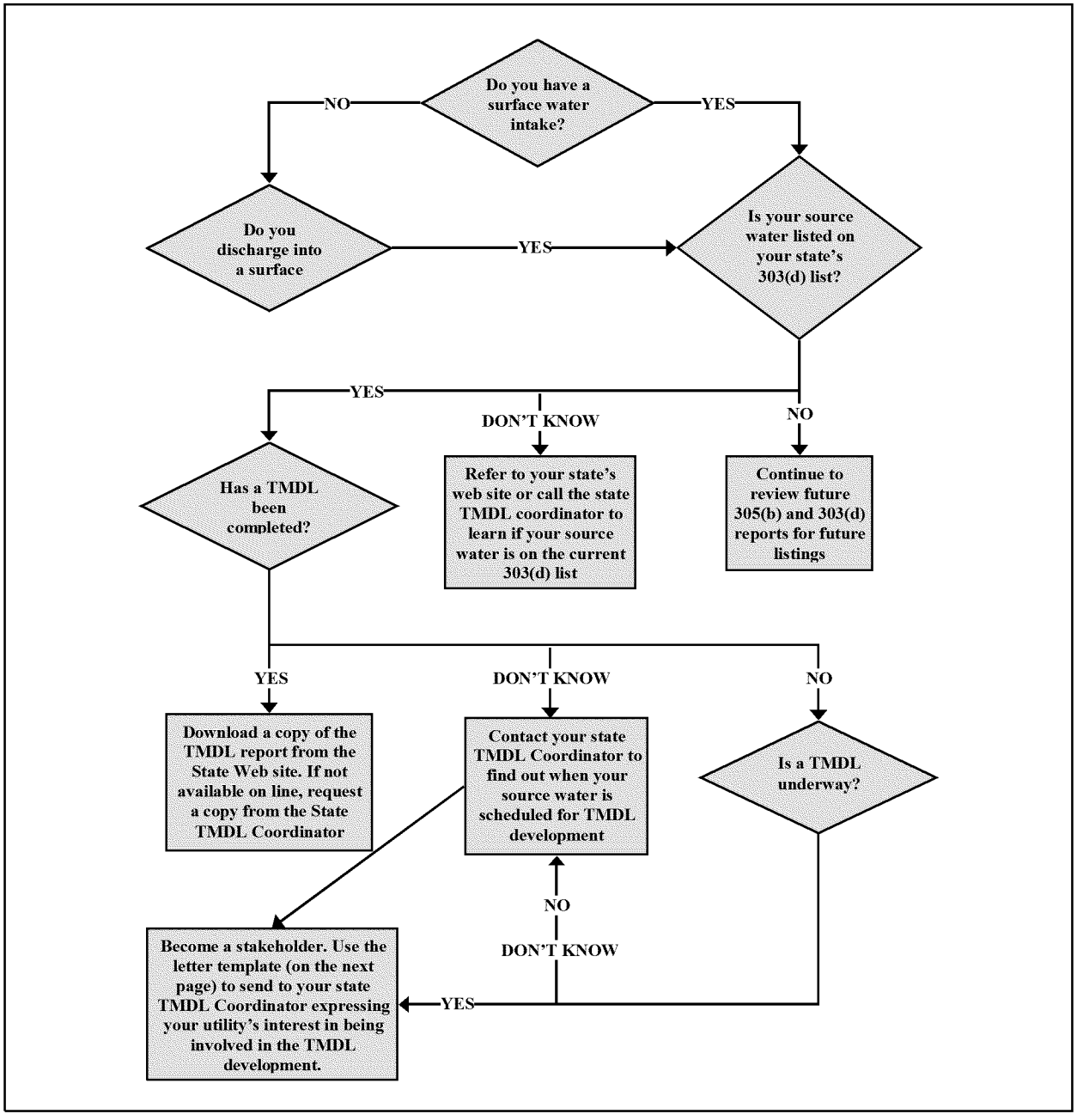

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Table 7.1
303(d) listing status for the Sacramento and San Joaquin rivers

Water body	Pollutant	Proposed TMDL completion	TMDL status
Sacramento River (Keswick Dam to Cottonwood Creek)	Cadmium	2002	EPA Approved TMDL
Sacramento River (Keswick Dam to Cottonwood Creek)	Copper	2002	EPA Approved TMDL
Sacramento River (Keswick Dam to Cottonwood Creek)	Zinc	2002	EPA Approved TMDL
Sacramento River (Knights Landing to the Delta)	Diazinon	2003	EPA Approved TMDL
Sacramento River (Knights Landing to the Delta)	Mercury	2010	
Sacramento River (Keswick Dam to Cottonwood Creek)	Unknown Toxicity	2019	
Sacramento River (Cottonwood Creek to Red Bluff)	Unknown Toxicity	2019	
Sacramento River (Red Bluff to Knights Landing)	Unknown Toxicity	2019	
Sacramento River (Red Bluff to Knights Landing)	Mercury	2019	
Sacramento River (Knights Landing to the Delta)	Unknown Toxicity	2019	
San Joaquin River (Mud Slough to Merced River)	Selenium	1996	
San Joaquin River (Merced River to Tuolumne River)	Selenium	2002	EPA Approved TMDL
San Joaquin River (Tuolumne River to Stanislaus River)	Selenium	2002	EPA Approved TMDL
San Joaquin River (Stanislaus River to Delta Boundary)	Selenium	2002	EPA Approved TMDL
San Joaquin River (Mendota Pool to Bear Creek)	Boron	2006	
San Joaquin River (Mendota Pool to Bear Creek)	Electrical Conductivity	2006	
San Joaquin River (Bear Creek to Mud Slough)	Boron	2006	
San Joaquin River (Bear Creek to Mud Slough)	Electrical Conductivity	2006	
San Joaquin River (Mud Slough to Merced River)	Boron	2006	
San Joaquin River (Mud Slough to Merced River)	Electrical Conductivity	2006	
San Joaquin River (Mendota Pool to Bear Creek)	Chlorpyrifos	2007	EPA Approved TMDL
San Joaquin River (Mendota Pool to Bear Creek)	Diazinon	2007	EPA Approved TMDL
San Joaquin River (Bear Creek to Mud Slough)	Chlorpyrifos	2007	EPA Approved TMDL
San Joaquin River (Bear Creek to Mud Slough)	Diazinon	2007	EPA Approved TMDL
San Joaquin River (Mud Slough to Merced River)	Chlorpyrifos	2007	EPA Approved TMDL
San Joaquin River (Mud Slough to Merced River)	Diazinon	2007	EPA Approved TMDL
San Joaquin River (Merced River to Tuolumne River)	Boron	2007	EPA Approved TMDL
San Joaquin River (Merced River to Tuolumne River)	Electrical Conductivity	2007	EPA Approved TMDL
San Joaquin River (Merced River to Tuolumne River)	Chlorpyrifos	2007	EPA Approved TMDL
San Joaquin River (Merced River to Tuolumne River)	Diazinon	2007	EPA Approved TMDL
San Joaquin River (Tuolumne River to Stanislaus River)	Boron	2007	EPA Approved TMDL

(continued)

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Table 7.1 (Continued)

Water body	Pollutant	Proposed TMDL completion	TMDL status
San Joaquin River (Tuolumne River to Stanislaus River)	Electrical Conductivity	2007	EPA Approved TMDL
San Joaquin River (Tuolumne River to Stanislaus River)	Chlorpyrifos	2007	EPA Approved TMDL
San Joaquin River (Tuolumne River to Stanislaus River)	Diazinon	2007	EPA Approved TMDL
San Joaquin River (Stanislaus River to Delta Boundary)	Boron	2007	EPA Approved TMDL
San Joaquin River (Stanislaus River to Delta Boundary)	Electrical Conductivity	2007	EPA Approved TMDL
San Joaquin River (Stanislaus River to Delta Boundary)	Chlorpyrifos	2007	EPA Approved TMDL
San Joaquin River (Stanislaus River to Delta Boundary)	Diazinon	2007	EPA Approved TMDL
San Joaquin River (Mendota Pool to Bear Creek)	DDT	2011	
San Joaquin River (Mendota Pool to Bear Creek)	Group A Pesticides	2011	
San Joaquin River (Bear Creek to Mud Slough)	DDT	2011	
San Joaquin River (Bear Creek to Mud Slough)	Group A Pesticides	2011	
San Joaquin River (Mud Slough to Merced River)	DDT	2011	
San Joaquin River (Mud Slough to Merced River)	Group A Pesticides	2011	
San Joaquin River (Merced River to Tuolumne River)	DDT	2011	
San Joaquin River (Merced River to Tuolumne River)	Group A Pesticides	2011	
San Joaquin River (Tuolumne River to Stanislaus River)	DDT	2011	
San Joaquin River (Tuolumne River to Stanislaus River)	Group A Pesticides	2011	
San Joaquin River (Stanislaus River to Delta Boundary)	DDT	2011	
San Joaquin River (Stanislaus River to Delta Boundary)	Group A Pesticides	2011	
San Joaquin River (Mendota Pool to Bear Creek)	Unknown Toxicity	2019	
San Joaquin River (Bear Creek to Mud Slough)	Unknown Toxicity	2019	
San Joaquin River (Mud Slough to Merced River)	Unknown Toxicity	2019	
San Joaquin River (Merced River to Tuolumne River)	Unknown Toxicity	2019	
San Joaquin River (Tuolumne River to Stanislaus River)	Unknown Toxicity	2019	
San Joaquin River (Friant Dam to Mendota Pool)	Exotic Species	2019	
San Joaquin River (Stanislaus River to Delta Boundary)	Unknown Toxicity	2019	
San Joaquin River (Stanislaus River to Delta Boundary)	Toxaphene	2019	
San Joaquin River (Bear Creek to Mud Slough)	Mercury	2020	
San Joaquin River (Mud Slough to Merced River)	Mercury	2020	
San Joaquin River (Merced River to Tuolumne River)	Mercury	2020	
San Joaquin River (Tuolumne River to Stanislaus River)	Mercury	2020	
San Joaquin River (Stanislaus River to Delta Boundary)	Mercury	2020	

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SAMPLE LETTER FOR UTILITIES TO USE TO REQUEST INVOLVEMENT IN THE TMDL PROCESS

[If possible, write the letter on your drinking water utility's letterhead.]

Date
TMDL Manager
State Clean Water Act Office
Address

Re: Drinking Water Utility Involvement in TMDL Development for (Name of Watershed)

Dear TMDL Manager (Name),

I am the water quality manager for (Name Drinking Water Utility) I understand that one of our sources of supply, (Name Water Body) is on the state's 303(d) list of impaired water bodies for (list contaminants) I would like to get involved with the TMDL development process to make sure our interests are represented I would like to request that you contact me so that we can discuss this further Please also add me to your distribution list for future communications regarding TMDL development

We have some water quality data and other information that may be helpful to the TMDL's development We are willing to share this information including: (list sources of info such as source water assessment, sanitary survey, water quality monitoring etc)

I look forward to discussing the TMDL development process with you

Sincerely,
(Name)

(Drinking Water Utility)
(Address)

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USEFUL TMDL WEB SITES

EPA Web Sites

EPA Region	Web site
EPA Headquarters	http://www.epa.gov/owow/tmdl/
Region 1	http://www.epa.gov/ne/eco/tmdl/index.html
Region 2	http://www.epa.gov/region02/ (No TMDL-specific Web page)
Region 3	http://www.epa.gov/reg3wapd/tmdl/index.htm
Region 4	http://www.epa.gov/region4/water/tmdl/
Region 5	http://oaspub.epa.gov/waters/region_rept.control?p_region=5
Region 6	http://www.epa.gov/earth1r6/6wq/npdes/tmdl/index.htm
Region 7	http://www.epa.gov/region7/water/tmdl.htm
Region 8	http://www.epa.gov/Region8/water/tmdl/index.html
Region 9	http://www.epa.gov/region09/water/tmdl/index.html
Region 10	http://yosemite.epa.gov/R10/WATERNSF/TMDLs/TMDL+Program

State Web Sites

State	Web site
Alabama	http://www.adem.state.al.us/WaterDivision/WQuality/TMDL/WQTMDLInfo.htm
Alaska	http://www.dec.state.ak.us/water/tmdl/tmdl_index.htm
Arizona	http://www.azdeq.gov/environ/water/assessment/tmdl.html
Arkansas	http://www.adeq.state.ar.us/water/tmdls/
California	http://www.swrcb.ca.gov/tmdl/tmdl.html
Colorado	http://www.cdphe.state.co.us/wq/Assessment/TMDL/tmdlmain.html
Connecticut	http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325604&depNav_GID=1654
Delaware	http://www.dnrec.state.de.us/water2000/Sections/Watershed/TMDL/tmdlinfo.htm
Florida	http://www.dep.state.fl.us/water/tmdl/
Georgia	http://www.gaepd.org/Documents/techguide_wpb.html#tmdl
Hawaii	http://www.state.hi.us/health/environmental/env-planning/wqm/wqm.html
Idaho	http://www.deq.state.id.us/water/data_reports/surface_water/tmdls/overview.cfm
Illinois	http://www.epa.state.il.us/water/tmdl/
Indiana	http://www.in.gov/idem/programs/water/tmdl/index.html
Iowa	http://www.iowadnr.com//water/watershed/tmdl/index.html
Kansas	http://www.kdheks.gov/tmdl/index.htm
Kentucky	http://www.water.ky.gov/sw/tmdl/Total+Maximum+Daily+Load+main+page.htm
Louisiana	http://www.deq.louisiana.gov/portal/tabid/130/Default.aspx
Maine	http://www.maine.gov/dep/blwq/docmonitoring/impairedwaters/index.htm
Maryland	http://textonly.mde.state.md.us/Programs/WaterPrograms/TMDL/home/index.asp
Massachusetts	http://www.mass.gov/dep/water/resources/tmdls.htm
Michigan	http://www.michigan.gov/deq/1%2C1607%2C7-135-3313_3686_3728-12464--%2C00.html
Minnesota	http://www.pca.state.mn.us/water/tmdl/index.html
Mississippi	http://deq.state.ms.us/MDEQ.nsf/page/TWB_Total_Maximum_Daily_Load_Section?OpenDocument
Missouri	http://www.dnr.mo.gov/env/wpp/tmdl/index.html
Montana	http://www.deq.state.mt.us/wqinfo/tmdl/index.asp
Nebraska	http://www.deq.state.ne.us/SurfaceW.nsf/Pages/TMDL
Nevada	http://ndep.nv.gov/bwqp/tmdl.htm

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State	Web site
New Hampshire	http://www.des.state.nh.us/wmb/TMDL/index.html
New Jersey	http://www.state.nj.us/dep/watershedmgt/tmdl.htm
New Mexico	http://www.nmenv.state.nm.us/swqb/tmdlds.html
New York	http://www.dec.ny.gov/chemical/31290.html
North Carolina	http://h2o.enr.state.nc.us/tmdl/
North Dakota	http://waterq.ndsu.nodak.edu/nd1/n_wtrshed.htm
Ohio	http://www.epa.state.oh.us/dsw/tmdl/
Oklahoma	http://www.deq.state.ok.us/WQDnew/tmdl/index.html
Oregon	http://www.deq.state.or.us/wq/tmdls/tmdls.htm
Pennsylvania	http://www.dep.state.pa.us/watermanagement_apps/tmdl/
Puerto Rico	http://www.hgcinc.com/tmdl/states/prtmdltables.html#top
Rhode Island	http://www.dem.ri.gov/programs/benviron/water/quality/rest/index.htm
South Carolina	http://www.scdhec.com/environment/water/
South Dakota	http://www.state.sd.us/denr/DES/Surfacewater/TMDL.htm
Tennessee	http://www.state.tn.us/environment/wpc/tmdl/
Texas	http://www.tceq.state.tx.us/implementation/water/tmdl/index.html
Utah	http://www.waterquality.utah.gov/TMDL/index.htm
Vermont	http://www.anr.state.vt.us/dec/waterq/planning/htm/pl_tmdl.htm
Virginia	http://www.deq.state.va.us/tmdl/
Washington	http://www.ecy.wa.gov/programs/wq/tmdl/
West Virginia	http://www.wvdep.org/item.cfm?ssid=11&ss1id=930
Wisconsin	http://www.dnr.state.wi.us/org/water/wm/wqs/303d/
Wyoming	http://deq.state.wy.us/wqd/watershed/#TMDL

Other TMDL Web Sites

Agency/Program	Web site
U.S. Department of Agriculture	http://www.nal.usda.gov/wqic/TMDL.shtml
U.S. Geological Survey	http://water.usgs.gov/owq/tmdl/
TMDLs.NET	http://www.tmdls.net/
Center for TMDL and Watershed Studies at Virginia Tech	http://www.tmdl.bse.vt.edu/

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CHAPTER 8
RECOMMENDATIONS FOR DRINKING WATER UTILITIES

The CWA requires states to provide opportunities for stakeholder involvement in the development of the 303(d) list, as well as TMDLs This is a key opportunity for drinking water utilities to leverage non-SDWA programs to assist with the protection of public water supplies Greater involvement in TMDL processes can yield a number of benefits to drinking water utilities, including:

- Improved source water quality
- Reduced public health risks
- Reduced treatment processes and costs
- Decreases in the amount of chemicals necessary for treatment processes
- Reduced disinfection byproducts
- Increased reservoir volumes
- Good public relations
- More efficient regulatory interactions
- Improved availability of water quality information
- More effective planning

The following recommendations are made to drinking water utilities based on the findings of this project

Educate yourselves If you are confused by the TMDL process, refer to the tools provided in this report to learn the procedures involved with designating waters, developing 303(d) lists, setting ambient water quality criteria, setting WQS, and developing TMDLs Call your state TMDL coordinator and ask any questions you may have Embrace the philosophy that the only stupid question is the question you wanted answered but did not ask

Understand that a TMDL may be under development for your source water based on impairment of a designated use other than it being a drinking water supply Consider this an opportunity to get involved nonetheless Engage in the process to ensure your water quality concerns are addressed, if possible At a minimum, be involved enough to forestall any action that might interfere with your plans to protect your source water

Check that your surface water source has been properly categorized by the state as a drinking water supply Your source may have several designated uses, but check that drinking water supply, or potable water supply, is one of them

Review the state ambient WQS for drinking water supplies to see if your source water is not meeting any of those standards If it isn't, your source may be impaired and should perhaps be included on your state's 303(d) List of Impaired Waters Review and (if necessary) comment on your state's draft 303(d) list to ensure your source water is appropriately represented Water utility input on a 303(d) list can also result in higher prioritization of a drinking water source on the TMDL development list The lists are submitted by states to EPA biennially

Every participant and stakeholder looks at water quality from their own perspective Approach the TMDL development process with an understanding of state WQS and how they relate to drinking water standards In many states, acceptable levels vary significantly between

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the CWA and SDWA programs. Utilities need to understand how varying levels will impact water quality at their intakes in order to protect their supply's drinking water quality.

If you think your state's WQS are not protective enough, get involved in the state's triennial review process. You may be able to convince your state that different WQS should be adopted in order to protect potable water supplies more adequately.

Participate in the TMDL development and review process. If a TMDL is being developed for your source, provide source water quality data and any other input (e.g., intake location, susceptible areas) that may be instrumental to developing an accurate, protective TMDL.

Be proactive. Early involvement in the TMDL process will increase opportunities for drinking water utilities to effectively communicate with interested parties and will allow the utility to provide input on its water quality goals and needs. By getting involved early, there will be greater opportunity for developing consensus among stakeholders during the TMDL process, rather than spending time and resources resolving differences after a TMDL has been developed.

Share data and information with participating organizations. Utilities often have water quality data that can help characterize the water body impairment(s) and help identify mitigation measures. Sharing this information can avoid duplication of effort, improve understanding, and conserve resources for new information collection activities. You may also have a recently completed source water assessment of the watershed or a sanitary survey that can provide helpful information for TMDL development. Although these are state-generated documents, offer to share this information in case it was not successfully transferred from the state's SDWA program to its TMDL program.

When participating in the TMDL process, you may be able to provide input on the selection of TMDL endpoints (which may need to be different in zones surrounding intakes), identification of potential sources of contamination, and selection of areas to focus pollutant reduction activities during the implementation of the TMDL. Encourage states to consider susceptible areas when allocating loads and developing reduction targets for TMDLs for potable water supplies. Susceptible areas are zones where potential contaminant sources or land use activities have the greatest potential to affect the water supply.

Finally, maintain reasonable expectations. Remember that a TMDL is basically a pollutant budget for a water body or segment of a water body. While TMDLs set loading caps for pollutants, they do not in themselves result in the attainment of those caps. Point source discharges are permitted and regulated based on their allocations in the TMDL. Most nonpoint sources, however, are not regulated and, as a result, most watersheds cannot enforce load allocations assigned for nonpoint sources.

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CHAPTER 9
CONCLUSIONS

The goal of this project was to provide water utilities with information and tools that help them better utilize the TMDL process so they can protect and improve their source water quality. The project's goal was achieved by pursuing two objectives. The first objective was to identify successful strategies used by utilities to protect their source waters through the TMDL regulatory process. To do this, case studies were developed for utilities that have been involved or are preparing to get involved with the development of TMDLs for their source waters. As part of those case studies, successful strategies used by the utilities were identified, as were missed opportunities, so readers could benefit from lessons the utilities learned during TMDL implementation. In addition, state drinking water and TMDL administrators were asked what recommendations they have for improving water utility involvement. Those recommendations are discussed in more detail in the next chapter. Finally, user-friendly information and tools were developed to help utilities understand and navigate the Clean Water Act as it pertains to TMDLs.

The second objective of the project was to identify specific measures that are being used to include drinking water objectives in TMDLs. The tasks related to achieving this objective focused primarily on how the federal and state governments are implementing the TMDL requirement. Results of a recent study conducted by The Cadmus Group for EPA were summarized and reviewed with this objective in mind. The goal of the EPA project was to determine the percentage of surface water intakes in waters designated as drinking water sources and to begin establishing a national inventory of WQS that support drinking water sources. The study, known as the *WQS-CWS Baseline Project*, was a part of EPA's Strategic Plan. In addition, a survey was conducted for this Water Research Foundation project of state drinking water and TMDL administrators, as well as personnel from EPA's regional offices, to learn if and how the drinking water and TMDL programs were integrated at the state level and how that integration could be improved.

SUCCESSFUL STRATEGIES USED BY DRINKING WATER UTILITIES TO PROTECT SOURCE WATERS USING THE TMDL REGULATORY PROCESS

When asked about drinking water utility involvement in the TMDL process, 22 of 40 states responding to the survey reported that utilities are involved, although not always. While some states may actively seek utility participation, many seem to view utilities as one of several stakeholders that can comment along with everyone else. States where this is the case should consider whether they would like water utilities to play a more active role in TMDL development. If so, they should consider notifying the utility that a TMDL is being developed and alert them of opportunities for participation in its development and for its review.

In cases where utilities have been involved, their roles have included: reviewing TMDL draft reports and participation in public meetings; sharing water quality data for use in developing a TMDL; acting as a catalyst to develop forums or watershed groups to take part in TMDL implementation; funding recommended BMPs in the watershed; and providing input on watershed management issues. The most significant role has been as a source of water quality data beyond what is required by the SDWA regulations.

Reasons provided by state personnel surveyed for why utilities are not more involved include the fact that few TMDLs have been completed for water bodies used for drinking water;

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lack of utility personnel's time and resources; and lack of utility personnel's technical expertise except in some of the larger utilities. One state noted that since the majority of utilities are local municipalities, many become involved in the TMDL process because they are concerned about increasing compliance costs if impairments are found to be caused by municipal point source discharges and/or stormwater. This last point seems to have been true for several of the case studies presented in this report, including those for the Cities of Philadelphia, Columbus and Wilmington.

The case studies provided several examples of how utilities became successfully involved in the TMDL development process and affected the outcome. Some positive lessons learned from the case studies are:

- Water utility representatives can influence whether their source water body is listed on the state's 303(d) list.
- TMDL allocations can be modified if better water quality data are collected and presented to EPA and the states. By conducting a more detailed study of storm events, the City of Wilmington was able to gather more accurate pollutant loading information that resulted in the revision of the high flow bacteria and sediment TMDL.
- Municipalities that oversee point source discharges as well as the water utility should be especially motivated to get involved in the TMDL process because they may be stakeholders in more than one way. They may be engaged in the watershed because of their water supplies, as managers of CSOs and MS4s, as well as other permitted discharges. It is important that TMDLs developed for such a watershed be sufficiently protective of the source water quality of the water supply. It is also important, however, that pollutant loads assigned to permitted discharges are accurate and achievable.
- The more data available to populate models used during TMDL development, the more accurately the TMDL will reflect conditions in the watershed. It is usually in the best interest of the utility to gather additional data that fills gaps, or to provide additional data the utility has already collected.
- Different water quality concerns under low flow and high flow conditions have been addressed by developing two TMDLs: one for water quality parameters under low flow conditions, which in the Wilmington case study dealt primarily with NPDES permitted discharges; and one for water quality parameters under high flow conditions, which for Wilmington's watershed addressed in more detail nonpoint source loading, CSO, and municipal storm sewers.

SPECIFIC MEASURES USED TO INCLUDE DRINKING WATER OBJECTIVES IN TMDLS

The project survey of state drinking water and water administrators found that programs and staff that were located in close proximity to one another, especially those integrated in one program, worked more effectively to incorporate drinking water objectives into TMDLs. Creating links across CWA and SDWA programs has been effective for several states trying to further integration efforts between the two programs.

Thirty of the states responding (75% of respondents) to the survey reported working between programs, at least sometimes, to develop WQS under CWA Section 303(c). When asked "to what extent drinking water regulations are considered when the state develops its water quality standards," 90% of respondents reported that consideration is given always or sometimes. Several

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states are considering aligning WQS to more closely reflect MCLs Some states have adopted drinking water MCLs into their WQS, while other states expressed concern that using drinking water MCL standards in ambient water may make water body restoration goals unattainable

Of the states responding to the survey, 76% reported they work together, at least some - times, to identify water bodies that are drinking water supplies not meeting the WQS The survey found 54% of states reported they share and review draft 303(d) lists with their drinking water program counterparts

Survey respondents discussed examples of effective joint committees where personnel are included from both the state CWA and SDWA programs in planning activities Examples provided addressed

- Developing source water protection strategies or watershed management frameworks
- Coordinating WQS among groundwater, surface water, and drinking water programs
- Improving communication between source water assessment programs and state revolving loan fund programs
- Coordinating on discharge and water allocation permit decisions and wastewater reuse projects
- Having staff from one program serve on regulatory development committees of the other program (and vice versa)

Data sharing efforts among state programs have also enhanced integration and improved implementation of both programs All states that responded indicated they have access to latitude and longitude coordinates for all drinking water intakes in their state At least fourteen states have developed map overlays in GIS format that identify designated uses and WQS for surface waters in which drinking water intakes are located Many state drinking water programs shared source water assessment information with their CWA counterparts Some states mentioned taking care to consider source water protection areas during NPDES permitting

Several states noted the importance of training across programs such as providing presentations on the drinking water SWAP to TMDL staff to highlight the potential use of SWAP results as a tool for water quality Joint attendance at workshops on topics like source water protection can also facilitate communication and highlight potential integration opportunities

PROJECT HYPOTHESES

This project was also guided by four general hypotheses, described below with summaries of related findings

Hypothesis 1: State Programs Responsible for Implementing the TMDL and SDWA Could Work Together More Efficiently and Effectively. True.

While both the CWA and SDWA share a common goal of protecting water bodies from pollutant impairment, there is not enough overlap and integration of activities carried out by the two programs While not traditionally used as a means of protecting sources of drinking water, the TMDL program (and other CWA programs) could further the efforts of drinking water programs in protecting potable water supplies

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Reasons given by survey respondents for lack of drinking water program involvement in TMDLs include failure to be asked, lack of impaired water bodies that are designated as sources of drinking water, and lack of time, resources or technical expertise. Of the 40 states that responded to the surveys, 27 states have both the drinking water and TMDL programs within the same state agency. Of these, 56% reported that the SDWA and TMDL programs were "well integrated." Of the 13 states with programs in different agencies, only 23% felt that their programs were well integrated. As one might expect, those states with the TMDL and drinking water programs in the same state agency considered the two programs better integrated. Nonetheless it was only 56% of respondents who felt that way, which suggests that even when the two programs are in the same state agency they are not working together that closely. It is noteworthy that most drinking water program respondents did not perceive they have a major role in developing TMDLs, while the TMDL coordinators saw a more important and robust role for drinking water staff.

None of the three EPA Regions that responded to the survey felt like the two programs were well integrated at the EPA Regional level, although a number of suggestions were made regarding steps currently underway to improve integration efforts. Many of these suggestions addressed enhancing communication, coordination, and data sharing. In some regions, personnel have rotated through both the TMDL and SDWA programs, which enhances the comprehensive understanding of these programs. In one Region, a Watershed Coordinator has been appointed for each of the states to ensure cross-program integration between the CWA and SDWA programs (among other programs).

The survey identified three general areas where integration could be improved: communication, data sharing, and program activities. Summaries of findings and recommendations pertaining to these areas are described below.

Increase and Enhance Communication

Most states agreed communication plays a large role in ensuring effective integration of the SDWA and TMDL programs. Several states noted that personnel from both programs are encouraged by management to work together on a regular basis. Some ways for states to increase or enhance communication between programs are

- Locate programs and staff in close proximity to one another to facilitate discussion.
- Plan periodic information meetings at the staff level, as well as section chief and director levels.
- Form joint committees where staff from both programs are included in program planning such as developing source water protection strategies or watershed management frameworks, which can assist with TMDL development.
- Form joint committees to coordinate WQS among groundwater, surface water, and drinking water programs.
- Coordinate on discharge and water allocation permit decisions and wastewater reuse projects.
- Have personnel from one program serve on regulatory development committees of the other program and vice versa.
- Provide training across programs such as presenting information on the drinking water SWAP to TMDL staff to highlight the potential use of SWAP results as a tool for water quality. Joint attendance at workshops on topics like source water protection can facilitate communication and highlight opportunities for integration.

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Data Sharing/New Technologies

Similar to the issue of communication, data sharing can enhance integration and provide pooled resources and information that can improve implementation of both programs. To facilitate TMDL development, 24 state drinking water programs noted they shared source water assessment information with their CWA counterparts. Most of the states that have not yet shared this information are trying to get it into a format that can best be used by CWA staff. All states that responded have access to lat/long coordinates for all drinking water intakes in the states. Fourteen of those states have developed map overlays in GIS format that identify designated uses and WQS for surface waters in which drinking water intakes are located.

Examples of data sharing identified by the states in the surveys include:

- Cross-program GIS mapping with data layers available for use in several programs
- Exchanging and sharing data on water quality and source water assessments
- Comparing customer complaints
- Providing access to databases and Web sites
- Coordinating on ambient monitoring at intakes
- Integrating drinking water issues into the CWA state monitoring plan

Additional approaches endorsed by states to improve sharing data among programs were to

- Educate and train states and EPA Regions on new data systems, including the NTTS and ATTAINS, which will offer enhanced capabilities for coordination between the CWA and SDWA programs
- Use newer technologies like Web applications that can easily enable data sharing such as verification of intake latitudes and longitudes within a Drinking Water Protection Area.

The surveys found 54% of states reported they share and review draft 303(d) lists with the drinking water program. A key reason provided for not sharing the reports was that few of the impaired waters support drinking water as a designated use and that criteria are based on aquatic life rather than drinking water standards. Other reasons included staffing limitations, lack of priority, and lack of communication and request for input.

Program Integration

Differing goals of the two programs contribute to the difficulty of integrating their actions. Some suggestions made by survey respondents regarding how to improve integration of efforts being made by state CWA and SDWA programs are

- Consider source water protection areas during NPDES permitting and integrate the source water protection program into the state's Nonpoint Source Management Plan.
- Develop a meaningful way to include drinkable criteria for use support ratings as well as elevate drinking WQS and criteria to the same level as aquatic organism protection.
- Include drinking water parameters such as *Cryptosporidium* and TOC as part of ambient monitoring programs of surface waters.

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- Increase awareness of TMDL development efforts across state programs as well as with utilities in impacted watersheds.
- Educate each state program on the objectives and limitations of various funding sources
- Communicate and coordinate better when a facility is first proposed to ensure proper sitting and minimize adverse effects by state rules on existing dischargers (e.g., prohibition of some discharges within a certain distance of a designated drinking water source).

Hypothesis 2: Water Quality Standards Assigned to Water Bodies Designated as Potable Water Supplies Could Address the Water Quality Concerns of Utilities More Directly. True.

SDWA standards tend to focus on finished water and WQS usually focus on source waters. In many cases, MCLs and WQS for the same contaminant differ on account of the differing goals on which they are established. However, states are increasingly taking steps to adopt MCLs as numeric criteria to protect surface water bodies designated as public water supplies. Adopting MCLs as ambient water quality criteria helps to improve the level of public health protection provided by state and WQS.

There are still many contaminants for which the human health criterion (upon which a WQS is based) is less stringent than the MCL. Lack of program communication between state surface water and drinking water programs is often the primary reason. States are required to review their WQS at least once every 3 years (normally referred to as "triennial reviews").

Although EPA has not finalized the results of the *WQS-CWS Baseline Project*, review of publicly available state WQS indicate the following regarding jurisdictions' use of human health criteria and MCLs to protect drinking water sources:

- More than two thirds of jurisdictions adopt criteria that are generally equivalent to the Section 304(a) human health criteria for water and organisms as the water quality criteria that protect drinking water sources.
- Approximately 10 jurisdictions adopt water quality criteria for toxic contaminants that are generally equivalent to MCLs. In more than half of these cases, criteria for some contaminants (e.g., nitrates, nitrite) are not adopted, and the criteria for other contaminants (e.g., arsenic) are out of date." In some of the ten jurisdictions, human health criteria for water and organisms apply in addition to criteria that are equivalent to the MCLs. Where a state drinking water program sets drinking water MCLs that are more stringent than Federal MCLs, ambient criteria that are set at MCL levels are equivalent to state (not Federal) MCLs.
- In almost half of jurisdictions, criteria intended to protect aquatic life apply to all waters designated as drinking water sources. This happens because the aquatic life criteria apply statewide, or because all drinking water sources are also designated for aquatic life.

EPA has not developed ambient water criteria specifically for drinking water sources. However, several states have adopted biological criteria that apply to drinking water sources, either directly or indirectly. Although the results have not been finalized, the following observations were

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made as part of the *WQS-CWS Baseline Project* based on an analysis of publicly available state WQS:

- Nineteen of the 51 jurisdictions have established water quality criteria for bacterial indicators that directly support the drinking water designated uses In the majority of these 19 jurisdictions, fecal coliform is the indicator organism used
- All but nine of the jurisdictions have established water quality bacterial criteria that apply either "directly" (meaning that that they are associated specifically with the drinking water use) or "indirectly" (meaning that they are statewide or associated with another use such as recreation, but apply in all water bodies that also have a drinking water designated use) to drinking water source

Hypothesis 3: Tools and Guidance Materials Need to Be Provided Specifically for Water Utilities to Help Them Learn How to Navigate the TMDL Process. True.

During this project's search for information and literature about water utility involvement in TMDL development, there was a paucity of materials available to educate and inform water utilities on the topic This hypothesis was not pursued further than the background search Instead, the authors and the project's PAC agreed to proceed with developing new tools and information for water utility representatives so they can be better prepared to engage actively in the TMDL development process

Hypothesis 4: The Inability to Enforce Load Allocations for Nonpoint Sources Can Impede TMDL Implementation and, as a Result, Water Utilities May Be Skeptical About the Effectiveness of TMDL Implementation. True.

Several utilities pointed out during their case study development that the lack of enforce-ability of nonpoint source allocations limits the effectiveness of TMDLs However, no entities, either water utilities or states responding to the survey, recommended enforcing nonpoint source loads The case study utilities all recognized that reductions in nonpoint source loading in order to meet TMDL load allocations would result primarily from voluntary actions by stakeholders in the watershed

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CHAPTER 10
ADDITIONAL NEEDS AND RESEARCH

The following needs have been identified based on findings made during this project:

1. **TMDL Workshops for Water Utilities.** Water utility staff would benefit from hands-on training to help them become familiar with the TMDL process and illustrate how they can become involved. Tools and explanations such as those described in Chapter 7 could be provided. The training could be presented as a workshop accompanying a conference such as AWWA's annual conference. Attendees to such a workshop could also benefit from a question and answer session with a panel of experienced representatives from utilities, state CWA and SDWA programs, and other applicable programs.
2. **Designate All Water Bodies with Intakes as Drinking Water Sources.** A review of information available on 4,026 intakes located in 32 states indicated that 19 percent of the intakes (more than 750 of the 4,026 intakes analyzed) were located in waters that were not properly designated as drinking water sources. This analysis was based on EPA's interpretation of state codes for intakes that have been indexed to the national hydrography dataset, and the results were not reviewed by states or EPA's Regional offices (EPA 2008b). This issue should be considered more closely. State agencies and water utilities should check that all intakes have been identified and the waters in which they are located have been properly designated as drinking water sources.
3. **Review Bacteria Indicator Concentrations for Drinking Water Sources.** States should consider reviewing indicator bacteria concentrations that are used as water quality criteria to see that they sufficiently protect drinking water sources and are consistent with SDWA regulations. For example, EPA's recommended criteria for *E. coli* for primary contact recreation differ from the source water *E. coli* concentrations set by LT2ESWTR as thresholds for water systems serving fewer than 10,000 people. Under LT2ESWTR, if those thresholds are exceeded in source water samples collected by drinking water utilities, the utilities must then monitor their source water for *Cryptosporidium*, a significantly more expensive test. Moreover, if state water quality standards for drinking water sources are not as rigorous as SDWA source water microbiological standards, water utilities may be more likely to have to install expensive treatment in order to meet the SDWA standards.
4. **Improve Integration of SDWA and CWA Programs.** While the integration of SDWA and CWA state programs is generally improving, additional actions need to be taken. Many of those actions are described in Chapter 5 and should be taken by states. The following are additional suggestions to further help with the integration of SDWA and CWA programs:
   - Develop materials for states to use for cross-program training and presentations.
   - Develop more data sharing mechanisms, which include GIS integration capabilities.
   - Educate and train state staff (including drinking water program staff) on EPA's newest databases, including the National TMDL Tracking System (NTTS) and Assessment, TMDL Tracking and Analytical Integrated National System (ATTAINS).
   - Identify ways to better utilize Source Water Assessment Program (SWAP) results when evaluating use support as part of the 303(d) listing process.

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- Develop meaningful ways to include drinking water criteria as part of designated use support assessments.
- Consider including drinking water parameters such as *Cryptosporidium* and total organic carbon (TOC) as part of ambient monitoring programs for surface waters.
- Communicate and coordinate better when a permitted point source discharge facility is first proposed to ensure proper siting and minimize adverse regulatory effects on existing dischargers (e.g., prohibition of some discharges within a certain distance of a designated drinking water source).

5. **Showcase Innovative Approaches to Reducing Nonpoint Source Pollution.** TMDLs set loading caps for pollutants, but they do not in themselves result in the attainment of those caps. Point source discharges are permitted and regulated to meet their allocations in the TMDL. Nonpoint sources, however, are generally not regulated and, as a result, most states cannot enforce load allocations assigned to them. In order for TMDLs to be attained in most impaired watersheds, an active effort needs to be made to reduce nonpoint source pollution. Across the U.S., approaches are being taken to nonpoint source pollution control (e.g., water quality trading) that provide examples of alternatives to a regulatory approach. It would be helpful for watershed stakeholders if these successful approaches were showcased and explained in an accessible manner and better publicized.

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APPENDIX A
SURVEYS

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Drinking Water Source Protection Through Effective Use of TMDL Processes
Water Research Foundation Project No. 4007

State Drinking Water Administrator Survey

The Cadmus Group, Inc. is working on a project sponsored by the Awwa Research Foundation (AwwaRF) to investigate and report on successful strategies used by drinking water utilities and other entities to protect source waters using the TMDL regulatory process. This survey is part of the Water Research Foundation project (No. 4007), which is designed to provide drinking water utilities and states with information and tools to enable them to better utilize the TMDL process to protect and improve source water. By surveying state drinking water program managers, as well as state TMDL program managers, we will capture current state efforts to integrate the Clean Water Act and Safe Drinking Water Act and identify ways to further improve this integration. Your participation in this survey is appreciated.

Name: _____ **Date Completed:** _____
State: _____ **Agency:** _____
Division/Department: _____
Phone number: _____ **Email:** _____

1. Is the Clean Water Act (CWA) administered within your agency?

   Yes __ No __

2. If no, what agency is it in? _____

3. Do you consider the SDWA and CWA programs in your state to be well integrated?

   Yes __ No __

4. If yes, what steps have you taken to foster this integration?
   a. _____
   b. _____
   c. _____
   d. _____

5. If no, how can the SDWA and CWA programs in your state improve integration?
   a. _____
   b. _____
   c. _____
   d. _____

6. Do you work with your CWA program to help develop water quality standards (WQS) under CWA Section 303 (c)?

   Yes __ No __ Sometimes __

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7. If yes, what standards have been developed related to drinking water quality? _____
_____

8. If no, why not? _____
_____
_____
_____

9. To what extent are drinking water regulations taken into consideration when your state develops its water quality standards?

   Always __ Sometimes __ Never __

10. Do you work with your CWA program to identify water bodies for designation as drinking water supplies?

    Yes __ No __ Sometimes __

11. If no, why not? _____
_____
_____
_____

12. If yes, have all water bodies that serve as drinking water supplies in your state been appropriately designated?

    Yes __ No __

13. Do you work with your CWA program to identify water bodies that are drinking water supplies and that do not meet water quality standards under CWA Section 303(d)?

    Yes __ No __ Sometimes __

14. Do you review the draft 303(d) lists with your state's TMDL staff and provide comments?

    Yes __ No __

15. If no, why not? _____
_____
_____

16. How many water bodies in your state currently used as a source of drinking water are considered impaired (not meeting designated use criteria) as identified in your state's 305(b)/303(d) Water Quality Assessment Integrated Report? _____

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17. What are the pollutants currently impairing water bodies used as drinking water supplies?

_____
_____
_____

18. Are you working with your CWA program to help develop TMDLs for these water bodies?

Yes __ No __ Sometimes __

19. If no, why not? _____
_____
_____

20. If yes, how are drinking water uses and concerns being factored into TMDL prioritization?

_____
_____
_____

21. What role(s) does SDWA staff have in the TMDL development process?

_____
_____
_____
_____

22. Are drinking water utilities with intakes located in impaired water bodies involved in the TMDL process?

Yes __ No __ Sometimes __

23. If yes, what role(s) have drinking water utilities usually played in the TMDL process?

_____
_____
_____

24. Have you shared your source water assessment findings with your CWA program?

Yes __ No __

25. If no, why not? _____
_____
_____
_____

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26. Does your program have access to latitude/longitude coordinates for all drinking water intakes in your state?

    Yes __ No __

27. Has your state developed any map overlays that identify designated uses and water quality standards for of surface waters in which drinking water intakes are located?

    Yes __ No __

28. If yes, what format are they in (i.e., paper, GIS, other electronic format)? _____
    _____
    _____

29. May we contact you for additional information? Yes __ No __

Thank You for Completing the Survey

Please return it by email, fax, or mail:

Vanessa M. Leiby
The Cadmus Group, Inc.
10808 Longmeadow Dr.
Damascus, MD 20872

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Drinking Water Source Protection through Effective Use of TMDL Processes
Water Research Foundation Project No. 4007

State TMDL Program Manager Survey

The Cadmus Group, Inc. is working on a project sponsored by the Awwa Research Foundation (AwwaRF) to investigate and report on successful strategies used by drinking water utilities and other entities to protect source waters using the TMDL regulatory process. This survey is part of the Water Research Foundation project (No. 4007), which is designed to provide drinking water utilities and states with information and tools to enable them to better utilize the TMDL process to protect and improve source water. By surveying state TMDL program managers, as well as state drinking water program managers, we will capture current state efforts to integrate the Clean Water Act and Safe Drinking Water Act and identify ways to further improve this integration. Your participation in this survey is appreciated.

Name: _____ **Date Completed:** _____
State: _____ **Agency:** _____
Division/Department: _____
Phone number: _____ **Email:** _____

30. Is the Safe Drinking Water Act (SDWA) administered within your agency?

Yes __ No __

31. If no, what agency is it in?_____

32. Do you consider the CWA and SDWA programs in your state to be well integrated?

Yes __ No __

33. If yes, what steps have you taken to foster this integration?
a. _____
b. _____
c. _____
d. _____

34. If no, how can the CWA and SDWA programs in your state improve integration?
a. _____
b. _____
c. _____
d. _____

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35. Do you work with your SDWA program to help develop water quality standards (WQS) under CWA Section 303 (c)?

    Yes __ No __ Sometimes __

36. If yes, what standards have been developed related to drinking water quality?

    _____

37. If no, why not? _____

    _____

    _____

    _____

38. To what extent are drinking water regulations taken into consideration when your state develops its water quality standards?

    Always __ Sometimes __ Never __

39. Do you work with your SDWA program to identify water bodies for designation as drinking water supplies?

    Yes __ No __ Sometimes __

40. If no, why not? _____

    _____

    _____

    _____

41. If yes, have all water bodies that serve as drinking water supplies in your state been appropriately designated?

    Yes __ No __

42. Do you work with your SDWA program to identify water bodies that are drinking water supplies and that do not meet WQS under CWA Section 303 (d)?

    Yes __ No __ Sometimes __

43. Do you send your draft 303(d) lists to your SDWA program for review/comment?

    Yes __ No __

44. If no, why not? _____

    _____

    _____

    _____

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45. How many water bodies in your state currently used as a source of drinking water are considered impaired (not meeting designated use criteria) as identified in your state's 305(b)/303(d) Water Quality Assessment Integrated Report? _____

46. What are the pollutants currently impairing water bodies used as drinking water supplies?

_____
_____
_____

47. How are drinking water uses and concerns factored into TMDL prioritization?

_____
_____
_____

48. Do SDWA staff participate in the development of TMDLs for these water bodies?

Yes __ No __ Sometimes __

49. If no, why not? _____
_____
_____
_____

50. If yes, what role(s) do SDWA staff have in the TMDL development process?

_____
_____
_____
_____

51. Are drinking water utilities with intakes located in impaired water bodies involved in the TMDL process?

Yes __ No __ Sometimes __

52. If no, why do you think they do not get more involved? _____
_____
_____
_____
_____
_____

53. If yes, for which TMDLs were drinking water utilities involved in the process?

_____
_____
_____
_____

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54. What role(s) have participating drinking water utilities had in the TMDL development process?

_____
_____
_____
_____

55. Does your SDWA program have access to latitude/longitude coordinates for all drinking water intakes in your state?

Yes __ No __

56. Have you developed map overlays that identify the designated uses and water quality standards for surface waters in which drinking water intakes are located?

Yes __ No __

57. If yes, what format are they in (i.e., paper, GIS, other electronic format? _____
_____
_____

58. May we contact you for additional information? Yes __ No __

Thank You for Completing the Survey

Please return it to the Cadmus Group by email, fax, or mail:

Laura Blake
The Cadmus Group, Inc.
57 Water Street
Watertown, MA 02472

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Drinking Water Source Protection through Effective Use of TMDL Processes
Water Research Foundation Project No. 4007

EPA Program Manager Survey

The Cadmus Group, Inc. is working on a project sponsored by the Awwa Research Foundation (AwwaRF) to investigate and report on successful strategies used by drinking water utilities and other entities to protect source waters using the TMDL regulatory process. This survey is part of the Water Research Foundation project (No. 4007), which is designed to provide drinking water utilities and states with information and tools to enable them to better utilize the TMDL process to protect and improve source water. By surveying EPA Regional TMDL Program Managers, as well as EPA Regional Drinking Water Program Managers, we will capture current efforts to integrate the Clean Water Act and Safe Drinking Water Act and identify ways to further improve this integration. Your participation in this survey is appreciated.

Name: _____ **Date Completed:** _____
EPA Region: _____ **Phone number:** _____ **Email:** _____

59. Do you consider the CWA and SDWA programs at the Region level to be well integrated?

    Yes ___ No _____

60. If yes, what steps have been taken to foster this integration?
    a. _____
    b. _____
    c. _____
    d. _____

61. If no, how can the CWA and SDWA programs in your Region improve integration?
    a. _____
    b. _____
    c. _____
    d. _____

62. Does your Region's SDWA program help with the development, review, and approval of state water quality standards (WQS) under CWA Section 303(c)?

    Yes __ No __ Sometimes __

63. If yes, can you provide an example of standards that have been developed (in one of your states) related to drinking water quality?

    _____

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64. If no, why not? _____

65. To what extent are drinking water regulations taken into consideration when the states in your Region develop their water quality standards?

Always __ Sometimes __ Never __

66. When reviewing state water quality standards, does your Region's CWA program work with your Region's SDWA program to ensure proper designation of drinking water supplies?

Yes __ No __ Sometimes __

67. If no, why not? _____

68. If yes, have all water bodies that serve as drinking water supplies in your Region been appropriately designated?

Yes __ No __

69. Does your Region's CWA program work with your Region's SDWA program to identify water bodies that are drinking water supplies and that do not meet WQS under CWA Section 303(d)?

Yes __ No __ Sometimes __

70. Does your Region's CWA program send your states' draft 303(d) lists to your SDWA program for review/comment?

Yes __ No __

71. If no, why not? _____

72. How many water bodies in your Region currently used as a source of drinking water are considered impaired (not meeting designated use criteria) as identified in the states' 305(b)/303(d) Water Quality Assessment Integrated Report? _____

73. What are the pollutants currently impairing water bodies used as drinking water supplies?

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74. How are drinking water uses and concerns factored into TMDL prioritization for the states in your Region?

_____

_____

75. In your experience, do state and EPA SDWA staff participate in the development of TMDLs for these water bodies?

Yes __ No __ Sometimes __

76. If no, why not? _____

_____

77. If yes, what role(s) do SDWA staff (both state and EPA) have in the TMDL development process?

_____

_____

78. Does your SDWA program have access to latitude/longitude coordinates for all drinking water intakes in your Region?

Yes __ No __

79. Have you developed or obtained from your states map overlays that identify the designated uses and water quality standards for surface waters in which drinking water intakes are located?

Yes __ No __

80. If yes, what format are they in (i.e., paper, GIS, other electronic format? _____

_____

_____

81. May we contact you for additional information? Yes __ No __

Thank You for Completing the Survey

Please return it to the Cadmus Group by email, fax, or mail:

Corey Godfrey
The Cadmus Group, Inc.
57 Water Street
Watertown, MA 02472

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APPENDIX B
EPA REGION 8 LIST OF MCLS RECOMMENDED FOR ADOPTION INTO STATE/TRIBAL WQS TO PROTECT THE WATER SUPPLY DESIGNATED USE

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EPA REGION 8
LIST OF MCLS RECOMMENDED
FOR ADOPTION INTO STATE/TRIBAL WATER QUALITY STANDARDS
TO PROTECT THE WATER SUPPLY DESIGNATED USE
January, 2004

All concentrations expressed as ug/l, except where noted.

Chemical Name	CASRN	SDWA MCL	SDWA MCLG	CWA § 304(a) Water & Org(1)	Adopted Water Supply Criterion CO	MT	ND	SD	UT	WY	CSKT	FTPECK	Potential Health Effects from Ingestion of Water (2)
PRIORITY POLLUTANTS													
Beryllium	7440-41-7	4	4	-	4	4	4	-	-	4	4	4	Intestinal lesions
Cadmium	7440-43-9	5	5	-	5	5	5	(3)	10	5	5	5	Kidneys
Chlorobenzene	108-90-7	100	100	130 (20#)	100	100	100	680	680	20	100	20	Liver, kidneys
Chromium (total)	7440-47-3	100	100	-	50	100	100	(3)	50	100	100	100	Allergic dermatitis
1,1-Dichloroethylene	75-35-4	(4)	(4)	330	7	0.57	0.057	0.057	0.057	0.057	0.057	0.57	Liver
Dichloroethylene (1,2-trans)	156-60-5	100	100	140	100	100	100	700	700	100	100	100	Liver
Lead	7439-92-1	TT(5)	zero	-	50	15	15	(3)	50	15	15	15	Physical/mental development (children), kidneys, high blood pressure (adults)
Lindane	58-89-9	0.2	0.2	0.98	0.2	0.14	0.019	0.019	0.019	0.019	0.019	0.019	Liver, kidneys
Nickel	7440-02-0	(6)	(6)	610	100	100	100	610	610	100	100	100	Heart, liver (7)
Selenium	7782-49-2	50	50	170	50	50	50	(3)	10	50	50	50	Hair, fingernails, numbness, circulatory system
Toluene	108-88-3	1000	1000	1,300	1000	1000	1000	6800	6800	1000	1000	1000	Nervous system, kidneys, liver
1,1,1-Trichloroethane	71-55-6	200	200	-	200	200	200	-	-	200	200	200	Liver, nervous system, circulatory system
NON-PRIORITY POLLUTANTS													
Alachlor	15972-60-8	2	zero	-	2	2	2	-	-	2	2	2	Eye, liver, kidneys, spleen, anemia, cancer
Atrazine	1912-24-9	3	3	-	3	3	3	-	-	3	3	3	Cardiovascular system, reproductive system
Bromate	7789-38-0	10	zero	-	-	-	-	-	-	-	-	-	Cancer
Carbofuran	1563-66-2	40	40	-	40	40	40	-	-	40	40	40	Blood, nervous system, reproductive system
Chlorite	7758-19-2	1,000	800	-	-	-	-	-	-	-	-	-	Anemia; infants/young children : nervous system
Dalapon	75-99-0	200	200	-	200	200	200	-	-	200	200	200	Kidneys
Di(2-ethylhexyl)adipate	103-23-1	400	400	-	400	300	400	-	-	400	400	400	Weight loss, liver, reproductive system
Dibromochloropropane	96-12-8	0.2	zero	-	0.2	0.2	0.2	-	-	0.2	0.2	0.2	Reproductive system, cancer
Dichloroethylene (cis-1,2-)	156-59-2	70	70	-	70	70	70	-	-	70	70	70	Liver
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	70	70	100 rb	70	70	70	-	100	70	70	100	Kidneys, liver, adrenal glands
Dinoseb	88-85-7	7	7	-	7	7	7	-	-	7	7	7	Reproductive system
Diquat	85-00-7	20	20	-	20	20	20	-	-	20	20	20	Cataracts

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EPA REGION 8
LIST OF MCLS RECOMMENDED
FOR ADOPTION INTO STATE/TRIBAL WATER QUALITY STANDARDS
TO PROTECT THE WATER SUPPLY DESIGNATED USE
January, 2004

All concentrations expressed as ug/l, except where noted.

Chemical Name	CASRN	SDWA MCL	SDWA MCLG	CWA § 304(a) Water & Org(1)	Adopted Water Supply Criterion CO	MT	ND	SD	UT	WY (8)	CSKT	FTPECK	Potential Health Effects from Ingestion of Water (2)
Endothall	145-73-3	**100**	100	-	100	100	100	-	-	100	100	100	Stomach, intestines
Ethylene dibromide (EDB)	106-93-4	**0.05**	zero	-	0.05	0.005	0.05	-	-	0.05	0.05	0.004	Liver, stomach, reproductive system, kidneys, cancer
Fluoride	7782-41-4	**4,000**	4,000	-	2000	4000	4000	4000	(9)	4000	4000	4000	Bone disease; children: mottled teeth
Glyphosate	1071-83-6	**700**	700	-	700	700	700	-	-	700	700	700	Kidneys, reproductive system
Haloacetic acids (10)	various	**60**	-	-	-	-	-	-	-	-	-	-	Cancer
Methoxychlor	72-43-5	**40**	40	100 rb	40	40	40	-	100	40	40	40	Reproductive system
Nitrite	14797-65-0	**1,000**	1,000	-	1000	1000	1000	-	-	1000	1000	1000	Methemoglobulinemia
Oxamyl (Vydate)	23135-22-0	**200**	200	-	200	200	200	-	-	200	200	200	Nervous system
Picloram	1918-02-1	**500**	500	-	500	500	500	-	-	500	500	500	Liver
Simazine	122-34-9	**4**	4	-	4	4	4	-	-	4	4	4	Blood
Styrene	100-42-5	**100**	100	-	100	100	100	-	-	100	100	100	Liver, kidneys, circulatory system
Xylenes	1330-20-7	**10,000**	10,000	-	10000	10000	10000	-	-	10000	10000	10000	Nervous system
RADIONUCLIDES													
Gross alpha particle activity		**15 pCi/L**	zero	-	-	1.5 pCi/L	15 pCi/L	-	15 pCi/L	15 pCi/L	15 pCi/L	15 pCi/L	Cancer
Beta particle and photon activity		**4 mrem/y**	zero	-	-	0.4 mrem/y	4 mrem/y	-	50 pCi/L	4 mrem/y	4 mrem/y	4 mrem/y	Cancer
Combined Radium 226 & 228	7440-14-4	**5 pCi/L**	zero	-	5 pCi/L	5 pCi/L	5 pCi/L	5 pCi/L (11)	5 pCi/L	5 pCi/L	5 pCi/L	20 pCi/L	Cancer
Uranium	7440-61-1	**30**	zero	-	-	20	-	-	-	30	-	30 pCi/L	Cancer, kidneys

BACKGROUND AND NOTES

This document contains an updated version of the Region's list of Safe Drinking Water Act (SDWA) Maximum Contaminant Limits (MCLs) recommended for adoption into State and Tribal Clean Water Act water quality standards. We recommend adoption of these MCLs as numeric criteria to protect the water supply designated use. Two previous versions of this list were distributed with transmittal letters dated January 24, 1996 and January 26, 1999, respectively. The Region continues to recommend use of the current CWA § 304(a) "water & organisms" human health criteria as the primary source of information for reviewing and revising State and Tribal water quality standards to protect the water supply designated use. However, for some substances the current CWA § 304(a) human health criterion is less stringent than the MCL. For other substances, an MCL has been promulgated, but no CWA § 304(a) criterion is available. In either case, if the State or Tribe has not already done so, the MCL should be adopted as a numeric criterion to protect the water supply designated use.

The Region believes that this approach will improve the level of public health protection provided by State and Tribal water quality standards. Adoption of the identified MCLs as ambient water quality criteria will help to:

- reduce the likelihood that source waters for public water systems will degrade to levels that exceed an MCL and cause public water system noncompliance problems,
- avoid potential adverse health effects associated with long-term consumption of water containing concentrations in excess of the MCL,
- assess water quality conditions and establish protective discharge limitations for point source discharges where appropriate, and
- ensure that numeric criteria are available when needed for all substances which are regulated under the SDWA or addressed by CWA § 304(a) human health criteria.

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Changes to the 2004 list include:

- MCLs for 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, ethylbenzene, hexachlorobutadiene, cyanide, and antimony have been removed because the recently updated CWA § 304(a) "water & organisms" criteria are now more stringent than the MCLs for these chemicals. The revised CWA § 304(a) criteria for these pollutants are consistent with the revised CWA § 304(a) human health criteria methodology that was finalized in 2000.
- The MCLs for bromate, chlorite, haloacetic acids (total), and uranium have been added. The MCLs for these pollutants were included in final drinking water regulations promulgated for bromate, chlorite, and haloacetic acids (disinfection byproducts, 1998) and uranium (radionuclides, 2000), respectively.
- The MCLs for 1,1-dichloroethylene and lindane have been added. The MCLs for these pollutants have remained the same while the CWA § 304(a) criteria have been revised to a less stringent level. As a result of the changes to the CWA § 304(a) criteria, the MCLs are more stringent for these chemicals. See also footnote (4) regarding dichloroethylene.
- The CWA § 304(a) criteria for chlorobenzene, 1,2-trans-dichloroethylene, and toluene have been updated consistent with the revisions recently published by EPA. Although the CWA criteria are now more stringent, they are still less stringent than the MCL, and so the MCLs for these pollutants have been retained on the list.
- Updates have also been made to State and Tribal water supply criteria (for the pollutants included on the list) consistent with recent revisions adopted by States and Tribes.

Notes:

(1) This column shows current published CWA § 304(a) human health criteria, which typically assume consumption of 2 liters of water and 17.5 grams of aquatic organisms per day. Values for carcinogens are calculated at a 10^{-6} incremental risk level.

(2) The potential health effects are based on consumption of water containing pollutant concentrations that exceed the MCL, in most cases, over many years. The listed effects are consistent with those that drinking water systems must disclose to the public, on an annual basis, where MCLs have been exceeded during the year covered by the report. See 63 Federal Register 44512-44536, 40 CFR Parts 141 and 142, National Primary Drinking Water Regulation: Consumer Confidence Reports, Final Rule, August 19, 1998.

(3) South Dakota has adopted an aquatic life criterion that will also protect water supply uses.

(4) For 1,1-dichloroethylene, the CWA § 304(a) "water & organisms" criterion was recently revised from 0.057 ug/L to 330 ug/L consistent with the revised human health methodology and the revised risk assessment which has been added to the Agency's Integrated Risk Information System (IRIS). The MCL and MCLG, however, remain at 7 ug/L; this value is based on the old EPA risk assessment. In the future, the MCL and MCLG will be reviewed and revised based on the updated risk assessment. Because of differences in how drinking water standards and § 304(a) criteria are calculated, it is expected that the revised MCL/MCLG, based on the new reference dose (0.05 mg/kg-day), will be 30-40 ug/L. Because it is likely to remain unchanged for a few years, it may be appropriate to adopt (or retain) the 7 ug/L MCL as a water supply criterion.

(5) For lead, the MCL requires a Treatment Technology; however, the action level is 15 ug/l.

(6) In early 1995, the nickel MCLG and MCL of 100 ug/l were remanded, based on an agreement between EPA and the Nickel Development Institute (and other industry parties). It was agreed that EPA had not fully addressed in the public record the petitioner's comments on the proposed methodology for deriving the nickel MCLG. To provide guidance for the period prior to new regulations for nickel, the EPA issued a lifetime health advisory for nickel of 100 ug/l. Nickel is included on the Agency's contaminant candidate list (CCL) to signify the Agency's intention to complete regulatory action for this contaminant.

(7) Potential health effects for nickel are taken from *Is Your Drinking Water Safe?*, EPA 810-F-94-002, May, 1994.

(8) Wyoming has adopted the latest MCLs for radionuclides by narrative reference.

(9) Utah's fluoride criterion ranges from 1400-2400 ug/l, and varies as a function of the daily maximum mean air temperature.

(10) The MCL is for a total measurement of 5 haloacetic acids: dichloroacetic acid, trichloroacetic acid, monochloroacetic acid, bromoacetic acid, and dibromoacetic acid.

(11) The South Dakota radium criterion is for radium 226 only.

\# Indicates § 304(a) criteria which are based on organoleptic (taste and odor) effects. Organoleptic-based criteria were recommended in the 1980 CWA § 304(a) criteria documents either where the organoleptic endpoint resulted in a more stringent value than the toxicity-based endpoint or where there were not sufficient data to calculate a toxicity-based criterion. Adoption of these criteria may be appropriate to ensure full protection of designated and existing uses.

rb The § 304(a) criteria for 2,4-D and methoxychlor were included in EPA's Red Book, *Quality Criteria for Water*, 1976.

Acronyms:

CASRN	Chemical Abstracts Service Registry Number
CSKT	Confederated Salish and Kootenai Indian Tribes of the Flathead Indian Reservation
CWA	Clean Water Act
FTPECK	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation
MCL	Maximum Contaminant Limit
MCLG	Maximum Contaminant Limit Goal
SDWA	Safe Drinking Water Act

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APPENDIX C
CONTRA COSTA WATER DISTRICT TMDL COMMENT LETTER

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LF6

CONTRA COSTA
WATER DISTRICT

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SACRAMENTO
CVRWQCB
JAN 22 PM 2:42

Directors
Joseph L. Campbell
President

Elizabeth R. Anello
Vice President

Bette Boatmun
James Pretti
Karl L. Wandry

Walter J. Bishop
General Manager

January 20, 2004

Leslie Grober
Regional Water Quality Control Board, Central Valley
11020 Sun Center Drive #200
Rancho Cordova, CA 95670-6114

RE: Proposed Amendments to the Sacramento – San Joaquin Rivers Basin Plan for the Control of Salt and Boron Discharges into the San Joaquin River

Dear Mr. Grober:

Contra Costa Water District (CCWD or District) appreciates the opportunity to comment on the Central Valley Regional Water Quality Control Board's Proposed Amendments to the Sacramento – San Joaquin Rivers Basin Plan for the Control of Salt and Boron Discharges into the San Joaquin River (Proposed BPA). CCWD is a municipal and industrial water supplier that relies on the Sacramento – San Joaquin Delta for its drinking water supply. CCWD has a long history of participation in salinity issues in the Sacramento – San Joaquin Delta and would support solutions that reduce salinity in the San Joaquin River without redirecting those impacts to municipal water suppliers downstream. CCWD has a long-standing opposition to the construction of an out-of-valley San Joaquin Valley drain which would deliver highly saline water to the vicinity of CCWD water supply intakes.

Contra Costa Water District supplies water to over 450,000 people in Contra Costa County in northern California. The primary source of water for is surface water diverted from the Sacramento-San Joaquin Delta. Water is delivered to CCWD's raw water municipal and industrial customers, stored in the Los Vaqueros Reservoir, or treated and delivered to CCWD's treated water customers.

CCWD is encouraged that the Central Valley Regional Water Quality Control Board is addressing the problem of consistent exceedances of salinity standards in the lower San Joaquin River. CCWD offers the following comments for your consideration:

Drinking water quality in the Delta is most impaired in the late fall months (October through the first seasonal rains), and often requires releases from upstream reservoirs to meet governing standards. This is the same period of time when the Proposed BPA assumes the most "real-time assimilative capacity" in the San Joaquin River.

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Leslie Grober, CVRWQCB
CCWD Comments on the Proposed BPA for Salt and Boron in the San Joaquin River
January 20, 2004
Page 2

CCWD requests that the Regional Board coordinate with the State Water Resources Control Board on this issue, and consider using the status of the Delta as a trigger for real-time management so that Vernalis salinity is not allowed to increase when the Delta is in balance under SWRCB Decision 1641 (D-1641).

There is little to no discussion of other activities within the Delta and their relationship to this TMDL. For example, the California Bay-Delta Program's Drinking Water Quality Program's goal is to improve drinking water quality in the Delta (including salinity reduction) over the life of the program, it is not clear how the use of real-time load allocations, which degrade the water quality of the Delta, impacts the ability to achieve this goal of continuous improvement. D-1641 also requires the study of recirculation as a means to reduce the salinity of the lower San Joaquin River. CCWD encourages the Regional Board to adopt a Basin Plan Amendment which will result in the permanent reduction of salinity and boron in both the San Joaquin River and the Delta.

CCWD is also encouraged that the Regional Board intends to establish additional water quality objectives upstream of Vernalis. These compliance locations will lead to better identification and control of the significant sources of contamination and facilitate improvement in water quality along the full length of the San Joaquin River, not just Vernalis.

If you have any questions regarding these comments, please contact me at (925) 688-8187 or rdenton@ccwater.com or Lisa Holm at (925) 688-8106 or lholm@ccwater.com.

Sincerely,

Richard A. Denton
Water Resources Manager

RAD/LMH

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ABBREVIATIONS

AVGWLF	Arcview Generalized Watershed Loading Function
AwwaRF	Awwa Research Foundation
BMP	best management practice
BOD	biological oxygen demand
CAFO	concentrated animal feeding operation
CBOD	carbonaceous biological oxygen demand
CSO	combined sewer overflow
CWA	Clean Water Act
CWD	Cobbossee Watershed District
DEP	Department of Environmental Protection
DO	dissolved oxygen
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
Fed. Reg.	*Federal Register*
FPC	Fairmount Park Commission
HAA	haloacetic acid
IOCs	inorganic compound
kg	kilogram
lbs/year	pounds per year
MACD	Maine Association of Conservation Districts
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDNR	Missouri Department of Natural Resources
MGD	million gallons per day
mg/L	milligrams per liter
mi^2	square mile
MIB	2-methylisoborneal
mm	millimeter
MOA	memorandum of agreement
MS4	municipal separate storm sewer system
µg/L	micrograms per liter

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NFR	non-filterable residue
NIER	National Institute for Environmental Renewal
NO_X	nixtrous oxide
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NTU	nephelometric turbidity unit
PA DEP	Pennsylvania Department of Environmental Protection
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenol
ppb	parts per billion
ppm	parts per million
PWD	Philadelphia Water District
PWSS	Public Water System Supervision
SDWA	Safe Drinking Water Act
SFWMD	South Florida Water Management District
SPU	standard platinum unit
SMCL	secondary maximum contaminant level
SWCD	Soil and Water Conservation District
TBS	total body solids
TDS	total dissolved solids
THM	trihalomethane
TKN	total kjedahl nitrogen
TMDL	total maximum daily load
TN	total nitrogen
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	ultraviolet
VLMP	Maine Volunteer Lake Monitoring Program
WERF	Water Environment Research Foundation
WQS	water quality standards
WVWA	Wissahickon Valley Watershed Association

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U.S. Environmental Protection Agency
NDWAC LEAD AND COPPER WORKING GROUP

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May 29-30, 2014

Agenda

Meeting Objectives/Desired Outcomes:

- **Welcome new members;**
- **Share follow up ideas and questions concerning corrosion control topic from last meeting;**
- **Provide input on questions related to sample site selection; and**
- **Plan next steps.**

Advance materials: LCR White Paper; Sample Site Selection Primer

Thursday May 29th, 2014

8:45-9:00 Informal gathering

9:00-9:30 Welcome, Introductions, Meeting Objectives/Agenda, Materials and Logistics

Advance materials: Proposed agenda

Welcome: Eric Burneson, Director, Standards and Risk Management Division, Office of Groundwater and Drinking Water
Introductions: Gail Bingham, *facilitator*

9:30-10:45 Discussion: Follow up on Key Points from Meeting One and the Webinar
Objectives: Recap topics covered by speakers on corrosion control at the March meeting and on sample site selection on the May webinar. Address any unanswered or follow up questions (see printout of webinar Q&A and Chat Room). Share "take-aways."

10:45-11:00 BREAK

11:00-12:15 Discussion: Sample Site Selection (Targeting Sites)
Objectives: Provide initial input on questions posed in the white paper and on the webinar. Initial ideas will be included in the meeting summary for members to reflect upon and consider for inclusion in final report.

Suggested Discussion Questions:

- How should sample site selection tiering criteria be developed to capture the highest risk sites for both lead and copper in a simple, health protective, and cost effective way? What factors should be considered?
- At what sites should lead and/or copper samples be taken to be representative of the greatest release for each contaminant?
- Other questions from the webinar?

12:15-1:30 LUNCH *[on your own]*

1:30-1:45 Public Comment

1:45-3:00 Discussion: Sample Site Selection (Sampling Schemes LSL and Non-LSL systems)
Objectives: Provide initial input on questions posed in the white paper and on the webinar. Initial ideas will be included in the meeting summary for members to reflect upon and consider for inclusion in final report.

Suggested Discussion Questions:

- Under what circumstances and how could sampling for lead and copper occur at separate sites? If so, what could the potential sampling scheme look like?
- Should the sample site selection criteria for LSL systems and non-LSL systems differ to prioritize sampling from locations likely to demonstrate the greatest release for each contaminant? If so, what would that sample site selection criteria look like?
- In LSL systems, what are the advantages and disadvantages of relying on lead from the lead service lines as the lone sentinel for optimal corrosion control?
- Other questions from the webinar?

3:15-3:30 BREAK

3:30-4:30 Discussion: Sample Site Selection (Number of Samples and Cost)
Objectives: Provide initial input on questions posed in the white paper and on the webinar. Initial ideas will be included in the meeting summary for members to reflect upon and consider for inclusion in final report.

Suggested Discussion Questions:

- How many samples for each contaminant would be needed to be statistically significant?
- What are the cost implications of developing separate sampling sites and maintaining separate sampling pools?
- Other questions from the webinar? (e.g. implications of invalidation criteria for the number of samples needed. *Note: other questions related to invalidation criteria may be more applicable at September meeting.*)

4:30-5:00 Discussion: Sample Site Selection (Targeting Sites 'reprise')

Suggested Discussion Questions: Return to the morning discussion questions and questions raised on the webinar, e.g. based on what we know now, what should we consider when we look to change the sampling criteria of the LCR?

5:00 ADJOURN FOR THE DAY

Friday, May 30th, 2014

8:45-9:00 Informal gathering

9:00-9:15 Review Day Two Agenda
Objective: Reflections from Day One and confirm agenda for today.

9:15-10:30 Discussion: Sample Site Selection (Copper-specific questions)
Objectives: Provide initial input on questions posed in the white paper and on the webinar. Initial ideas will be included in the meeting summary for members to reflect upon and consider for inclusion in final report.

Suggested Discussion Questions:

- What age copper piping should be sampled in order to capture the greatest likelihood of copper release?
- Would taking copper samples from pipe rigs (with copper the same age as in the distribution system) be useful in helping to reduce sampling burden for large systems? If so, how, and how should the data be used to determine action level compliance?
- Other questions from the webinar?

10:30-10:45 BREAK

10:45-12:15 Discussion: Sample Site Selection (Copper Waivers and Water Quality Parameters)
Objectives: Provide initial input on questions posed in the white paper and on the webinar. Initial ideas will be included in the meeting summary for members to reflect upon and consider for inclusion in final report.

Suggested Discussion Questions:

- What age copper piping should be sampled in order to capture the greatest likelihood of copper release? What are the challenges and opportunities?
- How could water quality parameter data be used to accurately assess which systems are likely to need copper monitoring and which do not?
  - How might these data be used to develop copper monitoring waivers for systems meeting specific water quality criteria?
  - Do you have or know of data that EPA could consider to develop such waivers
- What strategies could be used to help identify systems with zones of water quality aggressive to copper? For lead?
- What might copper waiver conditions look like, including water quality and non-water quality based conditions?
- Does the WQP monitoring necessary to obtain and maintain the copper waiver offset the savings of not monitoring for copper for small and medium systems?
- Other questions from the webinar?

12:15-1:30 LUNCH *[on your own]*

1:30-1:45	Public Comment
1:45-2:45	Open Discussion *Objectives: Return to "targeting sites" questions as needed. Reflect on what can be answered given current knowledge of both lead and copper. Provide initial input on other questions/topics of interest to working group members.*
2:45-3:00	Wrap up and Next Steps
3:00	ADJOURN MEETING