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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 141 and 142

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RIN 2040-AF15

National Primary Drinking Water Regulations: Proposed Lead and Copper Rule Revisions

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule, request for public comment.

SUMMARY: The Environmental Protection Agency (EPA) proposes regulatory revisions to the National Primary Drinking Water Regulation (NPDWR) for lead and copper under the authority of the Safe Drinking Water Act (SDWA). This proposed rule provides more effective protection of public health by reducing exposure to lead and copper in drinking water. This proposed rule also strengthens procedures and requirements related to health protection and the implementation of the existing Lead and Copper Rule (LCR) in the following areas: lead tap sampling; corrosion control treatment; lead service line replacement; consumer awareness; and public education. This proposal does not include revisions to the copper requirements of the existing LCR. In addition, this proposal includes new requirements for community water systems to conduct lead in drinking water testing and public education in schools and child care facilities.

DATES: Comments must be received on or before [*insert date 60 days after publication in the* Federal Register]. Under the Paperwork Reduction Act (PRA), comments on the information collection provisions are best assured of consideration if the Office of Management and Budget (OMB) receives a copy of your comments on or before *[insert date 30 days after date of publication in the* Federal Register*]*.

ADDRESSES: Submit your comments identified by Docket ID No. **EPA-HQ-OW-2017-0300**, at http://www.regulations.gov. Follow the online instructions for submitting comments. Once submitted, comments cannot be edited or removed from http://www.regulations.gov. The EPA may publish any comment received to its public docket. Do not submit electronically any information you consider to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Multimedia submissions (audio, video, etc.) must be accompanied by a written comment. The written comment is considered the official comment and should include discussion of all points you wish to make. The EPA will generally not consider comments or comment contents located outside of the primary submission (*i.e.*, on the web, cloud, or other file sharing system). For additional submission methods, the full EPA public comment policy, information about CBI or multimedia submissions, and general guidance on making effective comments, please visit https://www.epa.gov/dockets/commenting-epa-dockets. All submissions received must include the Docket ID No. for this rulemaking. Comments received may be posted without change to https://www.regulations.gov/, including any personal information provided.

FOR FURTHER INFORMATION CONTACT: Erik Helm, Standards and Risk Management Division, Office of Ground Water and Drinking Water, U.S. Environmental Protection Agency, 1200 Pennsylvania Ave, NW, Mail Code 4607M, Washington, D.C., 20460; telephone number: (202) 566-1049 (TTY 800-877-8339);; email address: Helm.Erik@EPA.gov. For more information visit https://www.epa.gov/dwreginfo/lead-and-copper-rule.

I. General Information

A. What is the EPA Proposing?

B. Does This Action Apply to Me?

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L. Consultations with the Science Advisory Board and the National Drinking Water Advisory Council

M. Consultation with Health and Human Services

IX. References

I. General Information

The United States has made tremendous progress in lowering children's blood lead levels. As a result of multiple Federal laws and regulations, including the 1973 phase-out of lead in automobile gasoline (40 CFR part 80, subpart B), the 1978 Federal regulation banning lead paint for residential and consumer use (16 CFR part 1303), the 1991 LCR (40 CFR part 141, subpart I), and the 1995 ban on lead in solder in food cans (21 CFR 189.240), the median concentration of lead in the blood of children aged 1 to 5 years dropped from 15 micrograms per deciliter in 1976–1980 to 0.7 micrograms per deciliter in 2013–2014, a decrease of 95 percent.

Although childhood blood lead levels have been substantially reduced as a result of these actions, data evaluated by the National Toxicology Program (NTP), 2012 demonstrates that there is sufficient evidence to conclude that there are adverse health effects associated with low-level lead exposure. Sources of lead include lead-based paint, drinking water, and soil contaminated by historical sources. The Federal Action Plan (Action Plan) to Reduce Childhood Lead Exposures and Associated Health Impacts, issued in December 2018, provides a blueprint for reducing further lead exposure and associated harm through collaboration among Federal agencies and with a range of stakeholders, including States, tribes, and local communities, along with businesses, property owners, and parents. The Action Plan is the product of the President's Task Force on Environmental Health Risks and Safety Risks to Children (Task Force). The Task Force is comprised of 17 Federal departments and offices including the Department of Health and Human Services (HHS) and the Department of Housing and Urban Development, which co-chaired the development of the Action Plan with EPA.

Through this plan, the EPA committed to reducing lead exposures from multiple sources including: paint, ambient air, and soil and dust contamination, especially children who are among the most vulnerable to the effects of lead. To reduce exposure to lead in paint, the EPA published new, tighter standards for lead in dust on floors and windowsills to protect children from the harmful effects of lead exposure (84 FR 32632). These revised, strengthened standards will reduce the amount of lead in dust that causes adverse health effects and that may warrant measures to reduce risks. To address lead in soil, the EPA will continue to remove, remediate, and take corrective actions at contaminated sites, expand the use of Soil Screening, Health, Outreach and Partnership (SoilSHOP) health education events, and manage lead contamination at Superfund, a Resource Conservation and Recovery Act (RCRA) Corrective Action, and other sites. The EPA will also continue to work with State and tribal air agencies to implement the National Ambient Air Quality Standards and evaluate the impacts of lead emissions from aviation fuel. The EPA is also focused on conducting critical research and improving public awareness by consolidating and streamlining Federal messaging.

Lead and copper enter drinking water mainly from corrosion of lead and copper containing plumbing materials. Lead was widely used in plumbing materials until Congress banned its use in 1986, and there are an estimated 6.3 to 9.3 million homes served by lead service lines (LSLs) in thousands of communities nationwide, in addition to millions of older buildings with lead solder, and brass/bronze fittings and faucets across the U.S. To reduce exposure to lead through drinking water, the Action Plan highlights several key actions, including the EPA's commitment to making regulatory changes to the definition of lead-free plumbing products and assisting schools and childcare centers with the 3Ts approach (Training, Testing and Taking Action) for lead in drinking water. The Action Plan also highlights the EPA's continued support to States and communities by providing funding opportunities through the Drinking Water State Revolving Fund and the Water Infrastructure Finance and Innovation Act loan program for updating and replacing drinking water infrastructure. In addition, the Action Plan highlights three newly authorized grant programs under the Water Infrastructure Improvements for the Nation Act, for which Congress appropriated $50 million in FY2018, to fund grants to small and disadvantaged communities for developing and maintaining infrastructure, for lead reduction projects, and to support the voluntary testing of drinking water in schools and child care centers. The Action Plan also highlights the importance of preventing lead exposure from drinking water by working with States, tribes, and local stakeholders to share best practices and tools to better implement the NPDWR for Lead and Copper. For more information about the Federal Lead Action Plan see https://www.epa.gov/sites/production/files/2018-12/documents/fedactionplan_lead_final.pdf.

Since the implementation of the Lead and Copper Rule (LCR), drinking water exposures have declined significantly, resulting in major improvements in public health. For example, the number of the nation's large drinking water systems that have exceeded the LCR action level of 15 parts per billion has decreased by over 90 percent and over 95 percent of the all water systems have not reported an action level exceedance in the last three years (EPA-815-F-19-007). Despite this progress, there is a compelling need to modernize and improve the rule by strengthening its public health protections and clarifying its implementation requirements to make it more effective and more readily enforceable. Also, due to the financial and practical challenges of wide-spread replacement of lead pipes around the country, it is important to use our nation's resources wisely, and thus target actions where they are most needed and can provide the most good.

The LCR is a more complicated drinking water treatment technique regulation due to the need to control corrosivity of treated drinking water as it travels through often antiquated distribution and plumbing systems on the way to the consumer's tap. States and public water systems require expertise and resources to identify the sampling locations and to work with customers to collect samples for analysis. Even greater expertise is needed for systems and states to identify the optimal corrosion control treatment and water quality parameter monitoring to assure that lead and copper levels are reduced to the extent feasible. The current structure of the rule compels additional protective actions on the part of a water system only after a potential problem has been identified (i.e., the lead action level is exceeded), which may result in periods where the public is exposed to elevated levels of lead while the system evaluates and implements the actions required.

Water systems cannot unilaterally implement the actions that are needed to reduce levels of lead in drinking water. Homeowners must be engaged to assure successful lead service line replacement because in most communities, LSLs are partially owned by the water system and partially owned by the homeowner. Water systems must also engage with consumers to encourage actions such as flushing that reduce their exposure to lead in drinking water. The ability of water systems to successfully engage with consumers to reduce lead exposure can pose challenges to achieving the goals of the LCR.

The EPA has sought input over an extended period on ways in which the Agency could address the challenges to achieving the goals for the LCR. Section VIII of this notice describes the engagements the Agency has had with small water systems, state and local officials, the Science Advisory Board and the National Drinking Water Advisory Council (NDWAC). The Science Advisory Board provided their recommendations in 2012 (SAB, 2012). The NDWAC provided extensive recommendations on potential LCR revisions to the EPA in December 2015 (NDWAC, 2015).

This notice's proposal includes a suite of actions that approach the problem of lead contamination in drinking water from different perspectives but that taken together can further reduce lead exposure in drinking water. This approach focuses on six key areas:

1. **Identifying areas most impacted**. To help identify areas most in need of remediation, the EPA is proposing that all water systems complete and maintain a lead service line (LSL) inventory and collect tap samples from homes with LSLs if

present in the distribution system. To reduce elevated levels of lead in certain locations, the EPA proposes to require water systems to "find-and-fix" the causes of these elevated levels (see Section III.K. of this notice).

2. **Strengthening treatment requirements.** The EPA is proposing to revise requirements for corrosion control treatment (CCT) based on the tap sampling results. The EPA's proposal also establishes a new trigger level of 10 µg/L. At this trigger level, systems that currently treat for corrosion would be required to re-optimize their existing treatment. Systems that do not currently treat for corrosion would be required to conduct a corrosion control study.
3. **Replacing Lead Service Lines.** The EPA is proposing to require water systems to replace the water system-owned portion of an LSL when a customer chooses to replace their customer-owned portion of the line. The EPA is also proposing to require water systems to initiate full lead service line replacement programs where tap sampling shows that lead levels in tap water exceed the existing action level and the proposed trigger level. The proposal requires systems that are above the trigger level but at or below the lead action level to set an annual goal for conducting replacements and for systems that are above the action level to annually replace a minimum of three percent of the number of known or potential LSLs in the inventory at the time the action level exceedance occurs. The proposal also prevents systems from avoiding LSLR by "testing out" with an LSL sample as is allowed in the current LCR.
4. **Increasing sampling reliability**. The EPA is proposing to prohibit tap sampling instructions that call for pre-stagnation flushing, the cleaning or removing of faucet aerators, and a requirement that tap samples be collected in bottles with a wide-mouth

configuration. The EPA is also changing the criteria for selecting homes with LSLs when collecting tap samples. For example, the EPA is proposing tap sample site selection focus on sites with LSLs rather than copper pipe with lead solder.

5. **Improving risk communication.** The EPA is proposing to require systems to notify customers of an action level exceedance within 24 hours. It also requires systems to conduct regular outreach to the homeowners with LSLs. The EPA is also proposing to require that the LSL inventory, which would include location identifiers, be made publicly available.
6. **Protecting Children in Schools.** Since children risk the most significant harm from lead exposure, the EPA is proposing that community water systems (CWS) sample drinking water outlets at each school and each child care facility served by the system. The system would be required to provide the results to the school or child care facility and to provide information about the actions the school or child care facility can take to reduce lead in drinking water.

Through strengthened treatment procedures, expanded sampling, and improved protocols for identifying lead, the EPA's proposed revisions will require more water systems to progressively take more actions to reduce lead levels at the tap. Additionally, by improving transparency and communication, the proposed rule is expected to increase community awareness and further reduce sources of lead through enhanced LSLR. By taking the collective actions discussed throughout the proposal, the EPA, States, and water systems will be implementing a proactive holistic approach to more aggressively manage lead in drinking water.

A. What is the EPA Proposing?

The EPA is proposing revisions to the LCR that strengthen public health protection and improve implementation of the regulation in the following areas: lead tap sampling; CCT; LSLR; consumer awareness; and public education (PE). This proposal adopts a regulatory framework recommended in part by State co-regulators through the Association of State Drinking Water Administrators (ASDWA) and incorporates many recommendations provided to the EPA by the National Drinking Water Advisory Council (NDWAC). NDWAC is a Federal Advisory Committee that provides EPA with advice and recommendations related to the national drinking water program. The Council was established under the Safe Drinking Water Act of 1974. The EPA is proposing revisions to the LCR that would require water systems to take actions at lower lead tap water levels than currently required to reduce lead in drinking water and better protect public health. The agency is proposing to establish a new lead "trigger level" of 10 µg/L in addition to the 15 µg/L lead action level in the current LCR. Public health improvements would be achieved by requiring more water systems to take a progressive set of actions to reduce lead levels at the tap. These proposed actions are designed to reduce lead and copper exposure by ensuring effective CCT and re-optimization of CCT when water quality declines; enhanced water quality parameter WQP) monitoring; establishment of a "find-and-fix" provision to evaluate and remediate elevated lead at a site where the individual tap sample exceeds the lead action level requiring water systems to create an LSL inventory to ensure tap sampling pools are targeted to the sites with elevated lead, and making consumers aware of the presence of a LSL, if applicable, and to facilitate replacement of LSLs. The LCR proposed revisions are expected to improve tap sampling by better targeting higher risk sites for lead contamination, *i.e.*, sites with lead service lines or lead containing plumbing materials and improving the sampling protocol. The EPA also proposes revisions to the LCR PE and Consumer Confidence Report (CCR) requirements to improve communication with consumers. In addition, this proposal includes requirements for community water systems (CWSs) to conduct lead in drinking water testing and PE in schools and child care facilities.

Together, these proposed revisions to the framework and specific requirements of the current LCR would result in greater public health protection at all sizes CWSs and non-transient non-community water systems (NTNCWSs). Implementation of the proposed revisions would better identify when and where lead contamination occurs, or has the potential to occur, and require systems to take actions to address it more effectively and sooner than required under the current rule.

The following table compares the major differences between the current Lead and Copper Rule (LCR) and proposed Lead and Copper Rule revisions (LCRR). In general, requirements that are unchanged are not listed. Comparison of current LCR and proposed LCR revisions (LCRR)

CURRENT LCR	PROPOSED LCRR
Action Level (AL) and Trigger Level (TL)	
• 90^{th} percentile (P90) level above lead AL of 15 µg/L or copper AL of 1.3 mg/L requires additional actions.	• 90^{th} percentile (P90) level above lead AL of 15 µg/L or copper AL of 1.3 mg/L requires more actions than the current rule. • Defines trigger level (TL) of P90 > 10 and ≤15 µg/L that triggers additional planning, monitoring, and treatment requirements.
Lead and Copper Tap Monitoring	
Sample Site Selection • Prioritizes collection of samples from sites with sources of lead in contact with drinking water. • Highest priority given to sites served by copper pipes with lead solder installed after 1982 but before the State ban on lead pipes and/or lead service lines (LSLs). • Systems must collect 50% of samples from LSLs, if available.	**Sample Site Selection** • Changes priorities for collection of samples with a greater focus on lead service lines • Prioritizes collecting samples from sites served by LSLs. • No distinction in prioritization of copper pipes with lead solder by installation date. • Systems must collect all samples from sites served by LSLs, if available.
Collection Procedure	**Collection Procedure**

CURRENT LCR	PROPOSED LCRR
• Requires collection of a one liter sample after water has sat stagnant for a minimum of 6 hours.	• Adds requirement that samples must be collected in wide-mouth bottles. • Prohibits sampling instructions that include recommendations for aerator cleaning/removal and pre-stagnation flushing prior to sample collection.

Monitoring Frequency
• Samples are analyzed for both lead and copper.
• Systems must collect standard number of samples, based on population; semi-annually unless they qualify for reduced monitoring.
• Systems can qualify for annual or triennial monitoring at reduced number of sites. Schedule based on number of consecutive years meeting the following criteria:
  o Serves ≤ 50,000 people and ≤ lead & copper ALs.
  o Serves any population size, meets State-specified optimal water quality parameters (OWQPs), and ≤ lead AL.
• Triennial monitoring also applies to any system with lead and copper 90^{th} percentile levels ≤ 0.005 mg/L and ≤ 0.65 mg/L, respectively, for 2 consecutive 6-month monitoring periods.
• 9-year monitoring waiver available to systems serving ≤ 3,300.
	Monitoring Frequency
	• Some samples may be analyzed for lead only when lead monitoring is conducted more frequently than copper.
	• Copper follows the same criteria as the current rule.
	• Lead monitoring schedule is based on P90 level for all systems as follows:
	  o **P90 > 15 µg/L**: Semi-annually at the standard number of sites.
	  o **P90 > 10 to 15 µg/L**: Annually at the standard number of sites.
	  o **P90 ≤ 10 µg/L**:
	    ▪ Annually and triennially at reduced number of sites using same criteria as current rule except copper 90^{th} percentile level is not considered.
	    ▪ Every 9 years based on current rule requirements for a 9-year monitoring waiver.

impact the optimized corrosion control treatment as well as have an impact on other national primary drinking water regulations.

VI. Economic Analysis

This section summarizes the Economic Analysis (EA) supporting document (USEPA, 2019a) for the proposed Lead and Copper Rule (LCR) revisions, which is written in compliance with section 1412(b)(3)(C)(ii) of the 1996 Amendments to the Safe Drinking Water Act (SDWA). This section of the Act states that when proposing a national primary drinking water regulation (NPDWR) that includes a treatment technique, the Administrator shall publish and seek public comment on an analysis of the health risk reduction benefits and costs likely to be experienced as the result of compliance with the treatment technique and alternative treatment techniques that are being considered, taking into account, as appropriate, the factors required under section 1412(b)(3)(C)(i). Clause (i) lists the analytical elements required in a Health Risk Reduction and Cost Analysis (HRRCA) which is applicable to a NPDWR that includes a maximum contaminant level. The prescribed HRRCA elements include: (1) quantifiable and non-quantifiable health risk reduction benefits; (2) quantifiable and non-quantifiable health risk reduction benefits from reductions in co-occurring contaminants; (3) quantifiable and non-quantifiable costs that are likely to occur solely as a result of compliance; (4) incremental costs and benefits of rule options; (5) effects of the contaminant on the general population and sensitive subpopulations including infants, children, pregnant women, the elderly, and individuals with a history of serious illness; (6) any increased health risks that may occur as a result of compliance, including risks associated with co-occurring contaminants; and (7) other relevant factors such as uncertainties in the analysis and factors with respect to the degree and nature of the risk.

Costs discussed in this section are presented as annualized present values in 2016 dollars, which is consistent with the timeframe for the EPA's water system characteristic data used in the analysis. The EPA estimated the year or years in which all costs occur over a 35-year time period. Thirty-five years was selected to capture costs associated with rule implementation as well as water systems installing and operating corrosion control treatment and implementing lead service line replacement (LSLR) programs. The EPA then determined the present value of these costs using discount rates of 3 and 7 percent.

Benefits, in terms of health risk reduction for the proposed LCR revisions are characterized by the activities performed by water systems, which are expected to reduce risk to the public from exposure to lead and copper in drinking water at the tap. The EPA quantifies and monetizes some of this health risk reduction from lead exposure by estimating the decrease in lead exposure resulting to children from 0 to 7 years of age from the installation and re-optimization of corrosion control treatment (CCT), LSLRs, and the implementation of point-of-use (POU) filter devices.

A. Affected Entities and Major Data Sources Used to Characterize the Sample Universe

The entities potentially affected by the proposed LCR revisions are public water systems (PWSs) that are classified as either community water systems (CWSs) or non-transient non-community water systems (NTNCWSs). These water systems can be publicly or privately owned. In the economic analysis modeling performed in support of this proposal, the EPA began with the 50,067 CWSs and 17,589 NTNCWS in the Safe Drinking Water Information System Fed Data Warehouse (SDWIS/Fed) as its foundational data set.

The EPA used a variety of data sources to develop the drinking water industry characterization for the regulatory analysis. Exhibit 6-1 lists the major data sources, describes the data used from each source, and explains how it was used in the EA. Additional detailed descriptions of these data sources and how they were used in the characterization of baseline industry conditions can be found in Chapter 4 of the EA.

Exhibit 6-1: Data Sources Used to Develop the Baseline Industry Characterization

Data Source	Baseline Data Derived from the Source
SDWIS/Fed third quarter 2016 "frozen" dataset[1]	• Public water system inventory, including population served, number of service connections, source water type, and water system type. Also used to identify water systems that are schools and child care facilities. • Status of CCT, including identification of water systems with CCT and the proportion of water systems serving ≤ 50,000 people that installed CCT in response to the current LCR. • Analysis of lead 90th percentile concentrations to identify water systems at or below the TL of 10 µg/L, above the TL, and above the AL of 15 µg/L at the start of the proposed rule implementation by water system size, water system type, source water type, and CCT status.[2] • The proportion of water systems that are on various reduced monitoring schedules for lead and copper tap and WQP monitoring. • The frequency of source and treatment changes and those source changes that can result in additional source water monitoring. • Length of time that water systems replace LSLs if required under the current LCR.
2006 CWSS	• Number of distribution system entry points per system. • PWS labor rates.
Geometries and Characteristics of Public Water Systems (USEPA, 2000)	• Design and average daily flow per water system.
1988 AWWA Lead Information Survey	• LSL inventory, including the number of water systems with LSLs, and the average number of LSLs per water system, as reported in

Data Source	Baseline Data Derived from the Source
	the 1991 LCR RIA (Weston and EES, 1990).
2011 and 2013 AWWA Surveys of Lead Service Line Occurrence (as summarized in Cornwell et al., 2016)	• LSL inventory, including the number of water systems with LSLs and the average number of LSLs per water system.
Six-Year Review 3 of Drinking Water Standards	• Individual lead tap sampling results used to estimate percent of samples above 15 µg/L. • Baseline distribution of pH for various CCT conditions. • Baseline orthophosphate dose for CCT.

Acronyms: AL = action level; AWWA = American Water Works Association; CCT = corrosion control treatment; CWSS = Community Water System Survey; LCR = Lead and Copper Rule; LSL = lead service line; RIA = regulatory impact assessment; SDWIS/Fed: Safe Drinking Water Information System/Federal Version; TL = trigger level; WQP = water quality parameter; USEPA = United States Environmental Protection Agency.

Note:

[1]Contains information reported through June 30, 2016.

[2]As detailed in Chapter 3 of the Economic Analysis for the Proposed Lead and Copper Rule Revisions(USEPA, 2019a), a system's lead 90th percentile level is a key factor in determining a system's requirements under the current rule and proposed LCR.

B. Overview of the Cost-Benefit Model

Under the regulatory provisions of the proposed rule, PWSs will face different compliance scenarios depending on the size, the type of water system, the presence of LSLs, and existing corrosion controls. In addition, PWSs will also face different unit costs based on water system size, type, and number of entry points (*e.g.*, labor rates and CCT capital, and operations and maintenance (O&M) unit costs). PWSs have a great deal of inherent variability across the water system characteristics that dictate both compliance activities and cost.

Because of this variability, to accurately estimate the national level compliance costs (and benefits) of the proposed LCR revisions, as well as describe how compliance costs are expected to vary across types of PWSs, the cost-benefits model creates a sample of representative "model PWSs" by combining the PWS-specific data available in SDWIS/Fed with data on baseline and compliance characteristics available at the PWS category level. In some cases, the categorical data are simple point estimates. In this case, every model PWS in a category is assigned the same value. In other cases, where more robust data representing system variability are available the category-level data includes a distribution of potential values. In the case of distributional information, the model assigns each model PWS a value sampled from the distribution, in order to characterize the variability in this input across PWSs. The model follows each model PWS in the sample through each year of analysis – determining how the PWS will comply with each requirement of the proposed rule, estimating the yearly compliance cost, and tracking the impact of the compliance actions on drinking water lead concentrations. It also tracks how other events, such as changing a water source or treatment affect the water system's compliance requirements for the next year.

The model's detailed output provides results for 36 PWS categories, or strata. Each PWS reporting category is defined by the water system type (CWS and NTNCWS), primary source water (ground and surface), and size category (there are nine). This proposal presents summarized national cost and benefit totals by regulatory categories. The detailed output across the 36 PWS categories can be found in Appendix C of the EA.

In constructing the initial model PWS sample for the cost-benefit analysis, the EPA began with the 50,067 CWSs and 17,589 NTNCWS in SDWIS/Fed. Also, from SDWIS/Fed, the EPA knows each water system's type (CWS or NTNCWS); primary water source (surface water or groundwater); population served; CCT status (yes/no); ownership (public or private); and number of connections.

The available LCR data limited the EPA's ability to quantify uncertainty in the cost-benefit model. During the development of the model, it became clear that not only were many of the inputs uncertain, but for many LCR specific inputs, the EPA only has limited midpoint, high, and low estimates available and does not have information on the relative likelihood of the available estimates. This includes major drivers of the cost of compliance including: the baseline number of systems with LSLs and the percent of connections in those system that are LSLs; the number of PWSs that will exceed the AL and/or TL under the proposed revised tap sampling requirements; the cost of LSL replacement; the cost of CCT; and the effectiveness of CCT in PWSs with LSLs. Therefore, the EPA estimated proposed LCRR compliance costs under low and high bracketing scenarios. These low and high cost scenarios are defined by the assignment of low and high values for the set of uncertain cost drivers listed above. Detailed descriptions of these five uncertain variables and the derivation of their values under the low and high cost scenarios can be found in Chapter 5, Section 5.2.4 of the EA (USEPA, 2019a). With the exception of the five uncertain variables which define the difference between the low and high cost scenarios the remaining baseline water system and compliance characteristics are assigned to model PWSs, as described above, and remain constant across the scenarios. This allows the EPA to define the uncertainty characterized in the cost range provided by the low and high scenarios and maintains consistency between the estimation of costs for the current and proposed rules (*e.g.*, percentage of lead tap water samples that will be invalidated). Chapters 4 and 5 of the EA describe in greater detail the baseline and major cost driving data elements, their derivation, and the inherent sources of uncertainty in the developed data elements. Section 5.2 and 5.3 of the EA discuss how each data element is used in the estimation of costs and provides examples and references to how these data were developed.

Because PWS baseline characteristics are being assigned from distributional source data to capture the variability across PWS characteristics, the EPA needed to ensure that its sample size was large enough that the results of the cost-benefit model were stable for each of the 36 PWS categories. To insure stability in modeled results, the EPA oversampled the SDWIS/Fed inventory to increase the number of water systems in each PWS category. For every PWS category, the EPA set the target minimum number of model PWSs to 5,000. To calculate the total estimated costs for each PWS category, the model weights the estimated per water system costs so that when summed the total cost is appropriate for the actual number of water systems known to be in the category.

The exception to the assignment of water system characteristics discussed above are the 21 very large water systems serving more than one million people. Because of the small number of water systems in this size category, the uniqueness of their system characteristics, and the potential large cost for these systems to comply with the proposed regulatory requirements, using the methods described above to assign system attributes could result in substantial error in the estimation of the national costs. Therefore, the EPA attempted to collect information on very large water systems' CCT practices and chemical doses, pH measurements and pH adjustment practices, number of LSLs, service populations, and average annual flow rates for each entry point to the distribution system. The EPA gathered this information from publicly available data such as SDWIS/Fed facility-level data, Consumer Confidence Reports, and water system websites. In addition, the American Water Works Association (AWWA) provided additional data from member water systems to fill in gaps. When facility-specific data was available, the EPA used it to estimate compliance costs for the very large water systems. If data was not available, the EPA assigned baseline characteristics using the same process as previously described. See Appendix B, Section B.2 of the EA for a summary of the data the EPA collected on these very large systems (USEPA, 2019a).

The cost model estimates the incremental cost of the proposed LCR revisions over a 35-year period. In accordance with the EPA's policy, and based on guidance from the Office of Management and Budget (OMB), when calculating social costs and benefits, the EPA discounted future costs (and benefits) under two alternative social discount rates, 3 percent and 7 percent.

When evaluating the economic impacts on PWSs and households, the EPA uses the estimated PWS cost of capital to discount future costs, as this best represents the actual costs of compliance that water systems would incur over time. The EPA used data from the 2006 Community Water System Survey (CWSS) to estimate the PWS cost of capital. The EPA calculated the overall weighted average cost of capital (across all funding sources and loan periods) for each size/ownership category, weighted by the percentage of funding from each source. The cost of capital for each CWS size category and ownership type is shown in Appendix B, Exhibit B.3 of the EA. Since similar cost of capital information is not available for NTNCWS, the EPA used the CWS cost of capital when calculating the annualized cost per NTNCWS. Total estimated cost of capital may be greater than actual costs water systems bear when complying with future regulatory revisions because financing support for lead reduction efforts may be available from State and local governments, EPA programs (e.g., the Drinking Water State Revolving Fund (DWSRF), the WIFIA Program, and the Water Infrastructure Improvements for the Nation Act of 2016 (WIIN Act) grant programs), and other federal agencies (e.g., HUD's Community Development Block Grants).

The availability of funds from government sources, while potentially reducing the cost to individual PWSs, does not reduce the social cost of capital to society. See Chapters 4 and 5 of the EA for a discussion of uncertainties in the cost estimates.

The EPA projects that rule implementation activities will begin immediately after rule promulgation. These activities will include one-time PWS and State costs for staff to read the rule, become familiar with its provisions, and develop training materials and train employees on the new rule. States will also incur burden hours associated with adopting the rule into State requirements, updating their LCR program policies and practices, and modifying data record keeping systems. PWSs will incur costs to comply with the lead service line materials inventory requirements and develop an initial lead service line replacement plan in years one through three of the analysis. The EPA expects that water systems will begin complying with all other proposed rule requirements three years after promulgation, or in year four of the analysis.

Some requirements of the proposed rule must be implemented by water systems regardless of their water quality and tap sampling results (*e.g.*, CWS school and child care facilities sampling programs), however, most of the major cost drivers are a function of a water systems 90^{th} percentile lead tap sample value. The 90^{th} percentile value, and if it exceeds the lead trigger level or action level, dictates: the tap water sampling and water quality parameter (WQP) monitoring schedules, the installation/re-optimization of CCT, "find-and-fix" adjustments (triggered by single lead tap sample exceedances of the 15 μg/L action level, which has an increasing likelihood in the model as 90^{th} percentile tap sample results increase) to corrosion control treatment, the installation of point-of-use filters at water systems selecting this treatment option as part of the small water system flexibilities of the proposed rule, the goal-based or mandatory removal of lead service lines and water system and State administrative costs. Because of uncertainty in the estimation of the 90^{th} percentile values the Agency developed low and high estimates for this cost driving variable. The EPA used both the minimum and maximum

90th percentile tap sample values from SDWIS/Fed over the period from 2007 to 2015, to assign a percentage of PWSs by size, and CCT and LSL status to each of three groups, those at the trigger level (TL) or below, those above the lead trigger but at or below the action level (AL), and those above the lead action level. These assignments represent the status of systems under the current rule. See Chapters 4 and 5 of the EA for additional information.

Because the tap sampling requirements under the proposed LCR revisions call for 100% of lead tap samples to be taken from sites with LSLs, for water systems with LSLs, the likelihood that a PWS would have a lead 90th percentile greater than the TL or AL is higher under the proposed rule compared to under the current LCR. The EPA used information from Slabaugh et al. (2015) to develop two adjustment factors, the lower being applied to the low cost scenario LSL system 90th percentile values and the greater factor being used to adjust the high cost scenario 90th percentile values for LSL systems. The EPA then reassigned the LSL system to the three 90th percentile value groups, those without a TL or AL exceedance, those with a TL but not an AL exceedance, and those with an AL exceedance. A detailed discussion of the development of the 90th percentile value group placement, the adjustment made for the LSL water systems given the proposed tap sampling requirements, and the percentages of systems assigned to the 90th percentile value groups under both the current and proposed LCRR for the low and high cost scenarios are found in Chapter 5, section 5.2.4.2.2 of the EA.

Once water systems are assigned to the groupings based on their CCT and LSL status, individual 90th percentile lead tap sample values are assigned from the distribution of 90th percentile values within each grouping.

Several proposed regulatory compliance activities are assumed to not affect a water system's 90th percentile value. These include, for example, developing an inventory of LSLs, CWS sampling at schools and child care facilities, and public education. In the model, the only compliance activities that will change a water system's 90th percentile lead tap sample are: installation of CCT; re-optimization of existing CCT; removal of LSLs; and a water system-wide "find-and-fix" activity (assumed to be a system-wide increase in pH). In addition to these proposed rule compliance activities, changing a water source or treatment technology can also result in a change in a water system's 90th percentile tap sample value.

Because a water system's 90th percentile value is so important to determining regulatory requirements and cost under the proposed rule, the cost model, under both the low and high cost scenarios, tracks each water system's 90th percentile value over each annual time step in the model. Based on the initial 90th percentile values, a number of proposed rule compliance actions are triggered. With the implementation of CCT, LSLR, and "find-and-fix" corrections, 90th percentile tap sample values are expected to decrease. The model allows for future increases in 90th percentile values as a result of changes in source water and treatment. The likelihood of these events occuring have been derived from SDWIS/Fed data (see Chapter 4 of the EA). When a change in source or treatment occurs in a modeled year, a new 90th percentile value is assigned to the water system. This value may be higher or lower than the current value thus potentially triggering new corrective actions. In the model, if a water system already has "optimized" CCT in place, it is assumed that no additional action is needed and that the current treatment is adequate, therefore the 90th percentile will not change.

C. Cost Analysis

This section summarizes the cost elements and estimates total cost of compliance for the existing LCR, the proposed LCR revisions and the incremental cost of the proposed rule, under both the low and high cost scenarios, by the major regulatory components and discounted at 3 and 7 percent. These components include sampling costs, CCT costs, LSL inventory and replacement costs, POU costs, public education and outreach costs, and implementation and administrative costs for water systems and States. This section also quantifies the potential increase in phosphates that would result from the increased use of corrosion inhibitors under the proposed rule, the resulting cost for treating to remove the additional phosphates at downstream waste water treatment plants that may be constrained by nutrient discharge limits, and discusses the ecological impacts that may result from increased phosphorus loads to surface waters.

1. *Sampling Costs*

The proposed LCR revisions affect most of the LCR's sampling requirements, including: lead tap sample monitoring, lead WQP monitoring, copper WQP monitoring, and source water monitoring. The proposed rule also includes new requirements for CWS to sample at schools and child care facilities within their distribution systems. Only the copper tap sampling requirements of the current rule are not impacted by the proposed regulatory changes and therefore do not appear in the summarized sampling costs. Additional lead WQP monitoring and lead tap sampling that is specifically required by the current rule and proposed revisions after the installation or re-optimization of corrosion control treatment is accounted for in the CCT costs and not in the WQP monitoring or tap sampling costs.

Lead tap sampling site selection tiering requirements have been strengthened under the proposed rule, increasing the cost to water systems with lead service lines for the development of a tap sampling pool that consists of all LSL sites. The other cost components of lead tap sampling remain unchanged and generally include sample collection, analysis, and reporting cost. The frequency of required lead tap sampling will also increase based on lead tap sample 90^{th} percentile values.

Both the lead and copper WQP monitoring cost totals represent collection and lab analysis cost of samples both at entry points and taps within the distribution system, as well as PWS reporting costs. The schedules for conducting these activities at modeled water systems are dependent on a water system's projected lead 90th percentile value, the presence of CCT, and past sampling results.

The proposed rule will require source water monitoring the first time a PWS has an action level exceedance. This monitoring will not be required again unless the water system has a change in source water.

Sampling at schools and child care facilities represents totally new requirements for CWSs under the proposed LCR revisions. Unlike the other sampling requirements of the proposed rule, school and child care facility sampling is not affected by a water system's 90th percentile lead tap sample value. The proposed rule requires that all schools and child care facilities must be sampled every five years (schools and child care facilities may refuse the sampling, but the water system must document this refusal to the State). This program's costs are reported with sampling cost, but they also represent public education costs and requirements of the proposed LCRR. The costs of complying with the proposed rule include water systems: 1) identifying schools and child care facilities in their service area and preparing and distributing an initial letter explaining the sampling program and the 3Ts Toolkit, 2) coordinating with the school or child care facility to determine the sampling schedule and the logistics of collecting the samples, 3) conducting a walkthrough at the school or child care facility before the start of sampling, 4) sample collection from the school or child care facility, 5) sample analysis, and 6) providing sampling results to the school or child care facility, the State, and the local or State health department.

Exhibit 6-2 and 6-3 show the national annualized sampling costs for both the low and high estimate scenarios, under the current LCR, the proposed LCRR, and the incremental cost, discounted at 3 and 7 percent, respectively. Additional information on the estimation of sampling cost can be found in the Chapter 5, section 5.3.1 of the EA. An alternative option to the school and child care facility sampling program can be found in section VI.F of this notice and in Chapter 9 of the EA (USEPA, 2019a).

Exhibit 6.2: National Annualized Sampling Costs at 3% Discount Rate (2016$)

	Low Cost Estimate			**High Cost Estimate**		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
Lead Tap Sampling Monitoring	$33,803,000	$37,672,000	$3,869,000	$33,780,000	$42,944,000	$9,164,000
Lead Water Quality Parameters Monitoring	$7,396,000	$7,536,000	$140,000	$8,823,000	$9,274,000	$451,000
Copper Water Quality Parameters Monitoring	$163,000	$179,000	$16,000	$158,000	$178,000	$20,000
Source Water Monitoring	$15,000	$4,321	$-10,679	$47,000	$17,000	$-30,000
School Sampling	$0	$28,540,000	$28,540,000	$0	$28,540,000	$28,540,000
Total Annual Sampling Costs	$41,376,000	$73,931,000	$32,555,000	$42,809,000	$80,955,000	$38,146,000
	Low Cost Estimate			**High Cost Estimate**		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
Lead Tap Sampling Monitoring	$32,736,000	$36,959,000	$4,223,000	$32,718,000	$43,977,000	$11,259,000
Lead Water Quality Parameters Monitoring	$7,156,000	$7,242,000	$86,000	$9,106,000	$9,583,000	$477,000
Copper Water Quality Parameters Monitoring	$156,000	$170,000	$14,000	$151,000	$170,000	$19,000
Lead Water Quality Parameters Monitoring	$7,156,000	$7,242,000	$86,000	$9,106,000	$9,583,000	$477,000
Lead Tap Sampling Monitoring	$32,736,000	$36,959,000	$4,223,000	$32,718,000	$43,977,000	$11,259,000
Source Water Monitoring	$17,000	$5,496	$-11,504	$64,000	$25,000	$-39,000
School Sampling	$0	$27,520,000	$27,520,000	$0	$27,520,000	$27,520,000

Exhibit 6.2: National Annualized Sampling Costs at 3% Discount Rate (2016$)

	Low Cost Estimate			High Cost Estimate		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
Total Annual Sampling Costs	$40,064,000	$71,897,000	$31,833,000	$42,039,000	$81,276,000	$39,237,000

2. *Corrosion Control Treatment Costs*

Under the proposed LCRR, drinking water systems may be required to install CCT, re-optimize their existing CCT, or perform a "find-and-fix" adjustment to their CCT based on their current level of CCT in place, if their lead tap sample 90th percentile exceeds the trigger level or action level, and/or individual lead tap samples exceed 15 µg/L. In the cost model, a 90th percentile lead tap sample exceedance can be triggered by a change in water system source water or treatment technology. Small CWSs serving 10,000 or fewer people and all NTNCWSs may also elect to conduct LSLR or implement POU filters as part of the regulatory flexibilities proposed in the LCRR. See section III.E of this notice for additional information on the compliance alternatives available to small CWSs and NTNCWSs, and section VI.C.4 for a discussion of the modeling and a summary of the number of systems selecting each alternative compliance option.

The capital and operations and maintenance (O&M) costs for water systems installing or optimizing CCT are based on the assumption that water systems will obtain the finished water characteristics of 3.2 mg/L of orthophosphate and pH at or above 7.2 (for water systems with starting pH values less than 8.2). For those water systems assigned higher initial pH values in the model, between 8.2 and 9.2, the EPA assumed the CCT optimization would require adjusting pH to meet or exceed 9.2 (no orthophosphate addition would be needed). The distributions of water system starting values for orthophosphate and pH, used in the cost model, are both drawn from SDWIS and Six-Year Review ICR data (see Chapter 5, section 5.3.1 of the EA).

All capital cost equations are a function of design flow, and all O&M costs are a function of average daily flow. Since CCT is conducted at the water system's entry points (EPs), the cost model calculates the design flow and average daily flow of each EP. The cost model uses two different sets of unit cost functions representing the low and high capital cost scenarios developed in the engineering Work Breakdown Structure models for CCT (Chapter 5, Section 5.2.4.2 and Appendix A, Section 1 of the EA). Using these bracketing capital cost values is designed to characterize uncertainty in the cost model estimates and when combined with O&M costs and EP flow values, are used to calculate the low and high CCT cost estimates per model PWS. Note that optimization O&M costs are obtained through an incremental cost assessment. The cost model calculated the O&M existing cost and subtracts them from the optimized O&M cost to obtain the incremental re-optimization costs.

In the cost model, water systems are assumed to always install and optimize their CCT, to the standards described above, before making any adjustment to CCT as a result of being triggered into the "find-and-fix" requirements of the proposed rule. If a water system is required to implement "find-and-fix," one of two things are assumed to occur at a single-entry point: a water system that has orthophosphate dosing and the pH target of 7.2 or greater will increase pH to 7.5, or a water system that previously optimized to a pH value of 9.2 will increase pH to 9.4. If "find-and-fix" is triggered again after an adjustment at a single EP, a water system is assumed to adjust all EPs to the new target pHs of 7.5 or 9.4, depending on the current treatment in place.

Using O&M cost functions estimated for the "find-and-fix", see Appendix A of the EA, the cost model first calculates the total annual O&M cost for treating to the "find-and-fix" standards previously listed as if no CCT was installed, then subtracts the PWS's current CCT annual O&M cost from the new "find-and-fix" annual O&M cost, to derive the share of the PWS's annual CCT O&M costs attributable to "find-and-fix" actions. The model also calculates the capital cost to retrofit the CCT water system for additional pH adjustment under both the low and high cost model scenarios. If a water system is triggered into a second round of "find-and-fix" CCT adjustment, the 7.5 or 9.4 pH requirements will be applied to all entry points. Individual entry point costs are summed to obtain total water system costs under the low and high model runs.

In addition to the capital and O&M cost of CCT installation, re-optimization, or "find-and-fix," water systems will also face several ancillary costs associated with changes in CCT status. Before the installation or re-optimization of CCT at a water system, a CCT study would need to be conducted or revised and the water system would consult with the State on the proposed changes to CCT (these costs also apply to water systems undergoing source water or treatment changes). After the change in CCT, a water system would conduct follow-up tap sampling, WQP monitoring at entry points and at taps in the distribution system, report the results of the initial post CCT change findings to the State, and review WQP data with the State on an ongoing basis as part of the water system's sanitary surveys.

Water systems with individual lead tap samples over 15 µg/L must: collect and analyze a follow-up tap sample from the location that exceeded the 15 µg/L value, coordinate with the State on the location for a follow-up WQP sample in proximity to the location that exceeded 15 µg/L, collect and analyze the WQP sample, and review with the State the collected data to determine "find-and-fix" CCT required changes.

Exhibits 6-4 and 6-5 show the range of estimated national costs for CCT under the current LCR, the proposed LCR revisions, and the incremental cost, discounted at 3 and 7 percent, respectively. Note that a range of CCT capital costs are used in this assessment but the total range in Exhibits 6-4 and 6-5 is impacted by all five of the uncertain variables which enter the model as low and high estimates. See Section VI.B of this notice and Chapter 5, Section 5.2.4 of the EA, for additional information on the variables that define the low and high cost scenarios. The CCT Operation and Maintenance (Existing) category in these exhibits are the EPA's estimate of the ongoing cost of operating corrosion control at PWS where CCT was in place at the beginning of the period of analysis. Additional information on the estimation of CCT costs can be found in Chapter 5, section 5.3.2 of the EA.

Exhibit 6-4: National Annualized Corrosion Control Technology Costs at 3% Discount Rate (2016$)

	Low Cost Estimate			High Cost Estimate		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
CCT Installation	$13,364,000	$6,847,000	$-6,517,000	$38,857,000	$16,566,000	$-22,291,000
CCT Installation Ancillary Activities	$1,360,000	$1,440,000	$80,000	$1,506,000	$1,986,000	$480,000
CCT Optimization	$5,106	$11,287,000	$11,281,894	$163,000	$44,199,000	$44,036,000
CCT Operations and Maintenance (Existing)	$313,830,000	$313,830,000	$0	$314,091,000	$314,091,000	$0
CCT Optimization Ancillary Activities	$10,000	$327,000	$317,000	$132,000	$722,000	$590,000
Find and Fix Installation	$0	$12,912,000	$12,912,000	$0	$47,837,000	$47,837,000
Find and Fix Ancillary Activities	$0	$5,234,000	$5,234,000	$0	$6,465,000	$6,465,000
Total Annual Corrosion Control Technology Costs	$328,569,000	$351,877,000	$23,308,000	$354,750,000	$431,866,000	$77,116,000

Exhibit 6-5: National Annualized Corrosion Control Technology Costs at 7% Discount Rate (2016$)

	Low Cost Estimate			High Cost Estimate		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
CCT Installation	$11,687,000	$5,938,000	$-5,749,000	$37,547,000	$15,739,000	$-21,808,000
CCT Installation Ancillary Activities	$1,312,000	$1,405,000	$93,000	$1,496,000	$2,155,000	$659,000
CCT Optimization	$8,474	$9,515,000	$9,506,526	$268,000	$44,128,000	$43,860,000
CCT Operations and Maintenance (Existing)	$299,344,000	$299,344,000	$0	$299,593,000	$299,593,000	$0
CCT Optimization Ancillary Activities	$13,000	$328,000	$315,000	$172,000	$846,000	$674,000
Find and Fix Installation	$0	$10,655,000	$10,655,000	$0	$45,834,000	$45,834,000
Find and Fix Ancillary Activities	$0	$5,123,000	$5,123,000	$0	$6,672,000	$6,672,000
Total Annual Corrosion Control Technology Costs	$312,364,000	$332,309,000	$19,945,000	$339,077,000	$414,967,000	$75,890,000

3. *Lead Service Line Inventory and Replacement Costs*

The proposed LCR revisions require all water systems to create an LSL materials inventory during the first three years after rule promulgation or demonstrate to the State that the water system does not have LSLs. Because many water systems have already complied with State inventory requirements (*e.g.*, Ohio, see http://codes.ohio.gov/orc/6109.121) that are at least as stringent as those required under the proposed LCRR, the EPA adjusted the probability of conducting an inventory downward to reflect the State requirements. Water system inventory costs also reflect the development, by all water systems with LSLs, of an initial LSLR plan. The plan would include procedures to conduct full lead service line replacement, a strategy for informing customers before a full or partial lead service line replacement, a lead service line replacement goal rate in the event of a lead trigger level exceedance, a pitcher filter tracking and maintenance system, a procedure for customers to flush service lines and premise plumbing of particulate lead, and a funding strategy for conducting lead service line replacements.

Depending on a water system's 90th percentile lead tap sample value, it may be required to initiate a LSLR program. Small CWSs, serving 10,000 or fewer people, and NTNCWSs have flexibility in the selection of a compliance option if the trigger or action levels are exceeded. These water systems may select to implement CCT or POU devices and not receive LSLR costs in the model. See section III.E of this notice for additional information on the compliance alternatives available to small CWSs and NTNCWSs. The cost model under both the low and high scenarios applies the estimated LSLR costs to those CWS serving 10,000 or fewer people and any NTNCWSs for which the LSLR option is determined to be the least cost compliance alternative. Under both the low and high cost scenarios, the model estimates the cost for implementing LSLR, CCT, and POU for each water system that meets the small water system flexibility criteria and maintains only the cost associated with the least costly option for each system. See section VI.C.4 of this notice for a discussion of the modeling and a summary of the number of systems selecting each alternative compliance option.

The EPA collected LSLR unit cost information primarily from four surveys. Given the small number of observations collected and lack of systematic sampling techniques utilized in the surveys the resultant estimates of replacement costs based on these data were highly uncertain. Therefore, the EPA develop low- and high-end LSLR cost values that are used in the cost model to provide a low/high cost range to inform the understanding of uncertainty (Note four other factors used to produce the low and high cost estimates also influence the LSLR total cost estimates). See Chapter 5, section 5.2.4 and Appendix A, Section 3 for more information on the development of the LSLR unit cost range.

LSLR cost includes not only the physical replacement of the service line but also prior notification of LSLRs as part of water system maintenance operations; contacting customers and site visits to confirm service line material and site conditions before replacement; providing customers with flushing procedures following a replacement; delivering pitcher filters and cartridges concurrent with the LSLR, and maintenance for three months; collecting and analyzing a tap sample three to six months after the replacement of a LSL; and informing the customer of the results.

Under the proposed rule, water systems with a 90th percentile lead tap sample value greater than 10 μg/L and less than or equal to 15 μg/L are considered to have a trigger level exceedance. These water systems are required to develop and implement a "goal-based" LSLR program where the annual replacement goal is set locally through a water system and State determination process. Ancillary costs incurred by these water systems include: the development and delivery of outreach materials to known and potential LSL households and submitting annual reports to the State on program activities. For water systems that do not meet the annual "goal-based" replacement rate, the proposed rule requires that additional outreach to lead service line customers be conducted. The additional outreach conducted is determined in conjunction with the State and is progressive, increasing with additional missed annual goals.

Under this proposal, water systems with 90th percentile tap sample data that exceed 15 μg/L (action level) are required to fully replace 3 percent of their LSLs per year for as long as the water system remains above the action level for any portion of a monitoring year. These water systems must also submit to the State an annual report on program activities.

In order to estimate the share of the LSLR cost that is paid by customers, the EPA made the conservative assumption that customers under the "goal-based" plan always pay for the part of the LSL belonging to them both when a full LSL is replaced and when the customer side is being replaced after a water system had completed a partial LSLR in the past. Customers do not pay for pig tail/gooseneck replacements in the model. Under mandatory replacement the EPA assumes that the system pays for all replacements both full and partial.

Exhibits 6-6 and 6-7 show the estimated annualized national cost for both the low and high cost scenarios, discounted at 3 and 7 percent, respectively, of water systems developing the LSL inventory, water systems conducting the goal-based and mandatory LSLR programs, and household removal costs for the customer-owned portion of the LSL under the current LCR, the proposed LCRR, and the incremental cost. The EPA did not estimate costs to CWSs for replacing the water system-owned portion of an LSL in response to receiving notification that a customer-owned portion of an LSL was replaced outside of a water system replacement program. The EPA expects that a small number of these types of replacements would happen annually. Detailed information on the estimation of LSLR costs can be found in Chapter 5, section 5.3.3 of the EA.

Exhibit 6-6: National Annualized Lead Service Line Replacement Costs at 3% Discount Rate (2016$)

	Low Cost Estimate			High Cost Estimate		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
Lead Service Line Inventory	$0	$5,068,000	$5,068,000	$0	$8,075,000	$8,075,000
System Lead Service Line Replacement	$579,000	$8,235,000	$7,656,000	$22,399,000	$68,264,000	$45,865,000
Lead Service Line Replacement Ancillary Activities	$59,000	$3,206,000	$3,147,000	$715,000	$4,879,000	$4,164,000
Activities Triggered by Not Meeting Voluntary Target	$0	$4,149,000	$4,149,000	$0	$16,138,000	$16,138,000
Total Annual PWS Lead Service Replacement Costs	$638,000	$20,658,000	$20,020,000	$23,113,000	$97,357,000	$74,244,000
Household Lead Service Line Replacement	$234,000	$5,478,000	$5,244,000	$9,063,000	$20,003,000	$10,940,000
Total Annual Lead Service Replacement Costs	$872,000	$26,137,000	$25,265,000	$32,176,000	$117,359,000	$85,183,000

Exhibit 6-7: National Annualized Lead Service Line Replacement Costs at 7% Discount Rate (2016$)

	Low Cost Estimate			High Cost Estimate		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
Lead Service Line Inventory	$0	$5,633,000	$5,633,000	$0	$8,617,000	$8,617,000
System Lead Service Line Replacement	$520,000	$8,197,000	$7,677,000	$30,793,000	$86,480,000	$55,687,000
Lead Service Line Replacement Ancillary Activities	$53,000	$4,314,000	$4,261,000	$983,000	$6,726,000	$5,743,000
Activities Triggered by Not Meeting Voluntary Target	$0	$4,191,000	$4,191,000	$0	$20,447,000	$20,447,000
Total Annual PWS Lead Service Replacement Costs	$573,000	$22,335,000	$21,762,000	$31,776,000	$122,270,000	$90,494,000
Household Lead Service Line Replacement	$210,000	$5,290,000	$5,080,000	$12,459,000	$22,501,000	$10,042,000
Total Annual Lead Service Replacement Costs	$783,000	$27,625,000	$26,842,000	$44,234,000	$144,771,000	$100,537,000

4. *Point-of-Use Costs*

Under the proposed rule requirements, small CWSs, serving 10,000 or fewer people, and NTNCWS with a 90th percentile lead value above the action level of 15 µg/L may choose between LSLR, CCT installation, or POU device installation and maintenance. See section III.E of this notice for additional information on the compliance alternatives available to small CWSs and NTNCWSs. In addition to the cost to provide and maintain POU devices, water systems selecting the POU compliance option face additional ancillary costs in the form of: 1) POU implementation planning for installation, maintenance, and monitoring of the devices, 2) educating customers on the proper use of the POU device, 3) sampling POU devises to insure the device is working correctly, and 4) coordination and obtaining approvals from the State.

The cost model applies these POU costs to those CWS serving 10,000 or fewer people and any NTNCWSs for which the POU option is estimated to be the least cost compliance alternative. The determination of the least cost compliance alternative is computed across each representative model PWS in the cost model based on its assigned characteristics including: the number of lead service lines, cost of LSLR, the presence of corrosion control, the cost and effectiveness of CCT, the starting WQPs, the number of entry points, the unit cost of POU, and the number of households. For a larger discussion on the assignment of system characteristics, see section VI.B of this notice and Chapter 5 of the EA. These characteristics are the primary drivers in determining the costs once a water system has been triggered into CCT installation or re-optimization, lead service line replacement, or POU provision and maintenance. The model estimates the net present value for implementing each compliance alternative and selects the least cost alternative to retain in the summarized proposed rule costs.

The EPA is estimating low and high cost scenarios, to characterize uncertainty in the cost model results. These scenarios are functions of assigning different low and high input values to a number of the variables that affect the relative cost of the small system compliance choices (see Chapter 5 section 5.2.4 of the EA for additional information on uncertain variable value assignment). Therefore, as the model output shows, the choice of compliance technology is different across the low and high cost scenarios.

Exhibits 6-8 and 6-9 show the total number of CWS serving 10,000 or fewer people and NTNCWSs, the total number of systems by type and population size that would select one of the small system compliance options, the number of NTNCWSs selecting each compliance alternative in the model, and the number of CWSs by population size selecting each compliance alternative in the model, under both the low and high cost scenarios. In general, the exhibits show across both the low and high scenarios that the majority of water systems would select re-optimizing under the small system compliance options. If a system has CCT in place, the incremental costs of re-optimization are low compared to all other alternatives. The POU device implementation seems to be the least cost alternative when the number of households in the system is low as demonstrated by the decrease in the selection of the POU option as CWS population size increases in the model. The pattern seen in the selection of LSLR between the low and high cost scenarios demonstrates that the choice of compliance by small systems is driven by relative costs. Under the low cost scenario far greater numbers of systems select LSLR given the assumed lower numbers of LSLs per system and lower cost of replacement under this scenario. While CCT installation cost is also lower under the low cost scenario the difference in cost between the high and low scenarios is relatively small compared to the reduction in cost for LSLR between the scenarios. POU cost remains unchanged between the low cost and high cost scenarios. The installation of CCT becomes more cost effective as system population size increases, but in the larger system size categories you can also see the effect of the relative cost of LSLR in the low cost scenario.

Exhibit 6-8: NTNCWS and Small System Counts Impacted Under Flexibility Option **- Low Cost Scenario (Over 35 Year Period of Analysis)**

	NTNCWS	**CWS**				
	All Systems	***≤100***	***101-500***	***501-1,000***	***1,001-3,300***	***3,301-10,000***
Total PWS Count in System Size Category	17,589	12,046	15,307	5,396	8,035	4,974
Total PWS Count of Systems with LSLR, POU, or CCT activity	1,453	1,521	2,498	1,148	1,544	2,037
Number of PWSs with Lead Service Line Removals	34	474	975	541	608	1,535
Number of PWSs that Install CCT	15	25	438	189	288	80
Number of PWSs that Re-optimize CCT	287	398	851	410	649	423
Number of PWSs that Install POU	1,117	625	234	8	0	0

Exhibit 6-9: NTNCWS and Small System Counts Impacted Under Flexibility Option - High Cost Scenario (Over 35 Year Period of Analysis)

	NTNCWS	CWS				
	All Systems	*≤100*	*100-500*	*501-1,000*	*1,001-3,300*	*3,301-10,000*
Total PWS Count in System Size Category	17,589	12,046	15,307	5,396	8,035	4,974
Total PWS Count of Systems with LSLR, POU, or CCT activity	2,354	1,938	2,782	1,677	3,274	1,314
Number of PWSs with Lead Service Line Removals	94	139	118	476	1,246	86
Number of PWSs that Install CCT	14	10	491	327	477	195
Number of PWSs that Re-optimize CCT	347	368	1,319	813	1,540	1,032
Number of PWSs that Install POU	1,900	1,422	855	61	10	1

The estimated national annualized point-of-use device installation and maintenance costs for the proposed rule, under the low cost scenario, are \$3,995,000 at a 3 percent discount rate and \$3,492,000 at a 7 percent discount rate. The POU impacts of the proposed rule for the high cost scenario are \$16,400,000 discounted at 3 percent and \$15,485,000 discounted at 7 percent. Since POU costs are zero under the current LCR, the incremental costs range from \$3,995,000 to \$16,400,000 at a 3 percent discount rate and from \$3,492,000 to \$15,485,000 at a 7 percent discount rate, under the low and high cost scenarios respectively. Additional information on the estimation of POU costs can be found in Chapter 5, section 5.3.4 of the EA.

5. *Public Education and Outreach Costs*

In addition to the current LCR public education requirements for water systems with a lead action level exceedance, the cost model includes proposed rule requirements for ongoing lead education that applies to all water systems with LSLs, regardless of the 90th percentile level, and requirements in response to a single tap sample exceeding the 15 μg/L lead action level.

The proposed rule requires a number of updates to existing public education and additional outreach activities associated with LSLs. The public education requirements costed for all water systems, regardless of their lead 90th percentile tap sample levels, include: 1) updating

Consumer Confidence Report language, 2) developing a lead outreach plan and materials for new customers, 3) developing an approach for improved public access to lead information, 4) participating in joint communication efforts with the State to provide increased information on lead education to health care providers, and 5) providing annual documentation and certification to the State that public outreach on lead has been completed. The costed proposed LCR public education requirements applying to all water systems with lead service lines are: 1) the planning, initially implementing and maintaining customer and public access to LSL location information, and 2) the development of lead educational materials for water-related utility work and delivery of those materials to affected households during water-related work that could result in service line disturbance.

The proposed rule public education costs that are applied to water systems that exceed the 15 μg/L action level include: 1) the development of lead language for public education in response to a lead action level exceedance, 2) delivery of education materials to customers for CWSs and posting of lead information for NTNCWs, 3) water systems contacting public health agencies to obtain a list of additional community organizations that should receive PE materials, 4) water systems notifying public health agencies and other community organizations, 5) large water systems posting a lead notice on their website, 6) water system issuing a press release, 7) water systems consulting with the State on the materials development and appropriate activities while the action level is exceeded, and 8) annually certifying public education activities have been completed.

The proposed rule also includes a requirement for water systems to notify affected customers within 24 hours of becoming aware of an individual tap sample exceeding the 15 μg/L lead action level. The model includes the development cost of the notification and education materials to be delivered to affected households and the incremental cost of expedited delivery of the notification. Note that materials costs related to follow-up testing when a sample exceeds 15 µg/L are included in the tap sampling costs in section VI.C.1 of this notice. The estimated annualized national water system public education and outreach costs for the current LCR range from $48,000 to $1,093,000 at a 3 percent discount rate under the low and high cost scenarios respectively. At a 7 percent discount rate the annualized estimated current rule PE cost range is from $65,000 to $1,513,000. Under the proposed rule low cost scenario, the estimated impacts are $29,364,000 at a 3 percent discount rate and $28,765,000 at a 7 percent discount rate. Under the high scenario the estimated annualized costs are $35,491,000 at a 3 percent discount rate and $35,525,000 at a 7 percent discount rate. Therefore, the incremental estimated public education and outreach costs for water systems range from $29,316,000 to $34,398,000 at a 3 percent discount rate and $28,700,000 to 34,012,000 at a 7 percent discount rate. See Chapter 5, section 5.3.5 of the EA for additional detailed information on the estimation of public education and outreach costs.

6. *Drinking Water System Implementation and Administrative Costs*

All water systems will have one-time start-up activities associated with the implementation of the proposed rule. These compliance costs include: water system burden to read and understand the revised rule; water systems assigning personnel and resources for rule implementation; water system personnel time for attending trainings provided by the State; and clarifying regulatory requirements with the State during rule implementation. This category of cost is not impacted by the variable that define the low and high cost scenarios, therefore only one set of estimated costs exist in the category. The estimated annualized national PWS implementation and administrative costs for the proposed LCR revisions are $1,863,000 at a 3 percent discount rate and $3,092,000 at a 7 percent discount rate. Since there are no costs under the current LCR, the PWS implementation and administrative incremental costs are also $1,863,000 at a 3 percent discount rate and $3,092,000 at a 7 percent discount rate. Additional information on the estimation of water system implementation and administrative costs can be found in Chapter 5, section 5.3.6 of the EA.

7. *Annualized Per Household Costs*

The cost model calculates the annualized cost per household, by first calculating the cost per gallon of water produced by the CWS. This cost per gallon represents the cost incurred by the system to comply with the requirements of the proposed LCRR. This includes CCT cost, inventory creation, system payed customer-side LSLR , tap sampling, public education, and administrative costs. Because of uncertainty in five important LCRR cost driver input variables, discussed in section VI.A. of this notice, the Agency developed low and high cost scenarios. These scenarios produce a range in the estimated cost per gallon and two estimates for annualized per household costs.

The model multiplies this low and high scenario costs per gallon by the average annual household consumption (in gallons) to determine the cost per household per year associated with increased costs borne by the CWS. The EPA then adds to both these values the total consumer-side lead service line replacement cost borne by households in the system, divided by the number of households served by the system, to derive the CWS's average annual household low and high scenario cost estimates. Exhibits 6-10 and 6-11 show the distributions of incremental annualized costs for CWS households by primary water source and size category. Note, the percentiles represent the distribution of average household costs across CWSs in a category, not the distribution of costs across all households in a CWS category. Some households that pay for a customer-side LSLR will bear a much greater annual household burden. The EPA estimates the cost of removing the customer-owned side of a service line range from $1,480 to $4,440, with a central tendency of $2,960. The percentage of customers in each water system paying the higher customer-side LSL costs depends on the number of LSL in the water system, the rate of replacement, and the details of the water systems LSLR program.

Exhibit 10: Annualized Incremental Cost per Household by CWS Category - Low Cost Scenario (2016$)

Source Water	Size	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Ground	100 or Fewer	$-5.36	$5.33	$8.61	$13.79	$23.01
Ground	101 to 500	$0.85	$1.43	$2.62	$4.20	$6.85
Ground	501 to 1,000	$0.28	$0.35	$0.47	$0.67	$1.57
Ground	1,001 to 3,300	$0.11	$0.16	$0.24	$0.34	$0.76
Ground	3,301 to 10,000	$0.19	$0.26	$0.39	$0.52	$1.00
Ground	10,001 to 50,000	$0.04	$0.07	$0.13	$0.21	$0.38
Ground	50,001 to 100,000	$0.08	$0.10	$0.20	$0.25	$0.30
Ground	100,001 to 1,000,000	$0.07	$0.14	$0.23	$0.34	$0.48
Ground	Greater than 1,000,000	$0.17	$0.17	$0.24	$0.26	$0.26
Surface	100 or Fewer	$2.87	$4.96	$8.86	$15.52	$23.87
Surface	101 to 500	$0.73	$1.31	$2.17	$3.66	$7.56
Surface	501 to 1,000	$0.26	$0.34	$0.52	$0.81	$2.11
Surface	1,001 to 3,300	$0.11	$0.15	$0.25	$0.39	$0.82
Surface	3,301 to 10,000	$0.20	$0.26	$0.43	$0.78	$1.56
Surface	10,001 to 50,000	$0.05	$0.09	$0.19	$0.38	$1.55
Surface	50,001 to 100,000	$0.08	$0.11	$0.25	$0.32	$1.07
Surface	100,001 to 1,000,000	$0.06	$0.14	$0.26	$0.42	$0.84
Surface	Greater than 1,000,000	$0.09	$0.18	$0.21	$0.29	$0.32

Exhibit 11: Annualized Incremental Cost per Household by CWS Category - High Cost Scenario (2016$)

Source Water	Size	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Ground	100 or Fewer	$-10.22	$4.78	$8.60	$15.22	$28.73

Exhibit 11: Annualized Incremental Cost per Household by CWS Category - High Cost Scenario (2016$)

Source Water	Size	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Ground	101 to 500	$-1.06	$1.36	$2.87	$4.85	$11.54
Ground	501 to 1,000	$-0.19	$0.36	$0.55	$1.30	$4.72
Ground	1,001 to 3,300	$0.10	$0.16	$0.28	$0.56	$2.61
Ground	3,301 to 10,000	$0.19	$0.28	$0.45	$0.91	$3.53
Ground	10,001 to 50,000	$0.05	$0.08	$0.14	$0.29	$2.61
Ground	50,001 to 100,000	$0.07	$0.09	$0.13	$0.27	$2.44
Ground	100,001 to 1,000,000	$0.12	$0.17	$0.29	$0.59	$3.17
Ground	Greater than 1,000,000	$0.17	$0.17	$0.24	$0.26	$0.26
Surface	100 or Fewer	$-9.24	$4.09	$10.29	$18.82	$40.74
Surface	101 to 500	$-2.99	$1.13	$2.73	$5.82	$15.96
Surface	501 to 1,000	$-3.18	$0.33	$0.89	$1.62	$4.98
Surface	1,001 to 3,300	$-1.80	$0.16	$0.31	$0.65	$2.30
Surface	3,301 to 10,000	$-0.24	$0.29	$0.72	$1.28	$4.49
Surface	10,001 to 50,000	$0.05	$0.11	$0.24	$1.25	$4.61
Surface	50,001 to 100,000	$0.08	$0.10	$0.23	$0.53	$2.61
Surface	100,001 to 1,000,000	$0.10	$0.20	$0.34	$1.31	$3.46
Surface	Greater than 1,000,000	$0.09	$0.18	$0.21	$0.29	$0.32

8. *Primacy Agency Costs*

For each of the drinking water cost sections previously described, primacy agencies (*i.e.*, States) have associated costs. These include start-up and implementation costs; reviewing water quality parameter, source water, and school monitoring reports; reviewing and approving lead tap sampling plans, sampling frequencies, results, and reports; consultation and reviews during CCT, LSLR, and POU device installation; and reviewing and approving the lead public education materials and consulting on specific outreach requirements. In the EPA cost model, the majority of the costs associated with States are determined on a per water system basis. State actions and costs are largely driven by the proposed rule required actions that are triggered for the individual water systems. These per water system primacy agency costs are then summed to obtain aggregate costs for this category.

The State implementation and administration costs of complying with the proposed LCR revisions include: reading and understanding the rule; adopting the rule and developing an implementation program; modifying data recording systems; training staff; providing water system staff with initial and on-going technical assistance and training; coordinating annual administration tasks with the EPA; and reporting data to SDWIS/Fed.

State activities regarding sampling include reviewing:

- PWS reports on lead and copper WQP monitoring from entry points and distribution system taps;
- Lead tap sampling plans, changes in sampling locations, sample invalidations, sampling results and 90th percentile calculations, and certification of customer notification of sampling results;
- 9-year waiver requests;
- Source water sampling results; and
- School sampling results.

The State activities associated with CCT installation, re-optimization, and "find-and-fix" rule requirements include:

- Consulting with water systems on source water and treatment changes;
- Reviewing CCT studies for installation and re-optimization;
- Reviewing post CCT installation WQP monitoring and tap sample results (including sample invalidation);
- Setting optimal water quality parameters;

- Reviewing "find-and-fix" follow-up tap and water quality parameter sampling for each individual lead tap sample greater than 15 µg/L;
- Reviewing water system's "find-and-fix" summary reports;
- Reviewing new the EPA's CCT guidance; and
- Conducting CCT water quality reviews in conjunction with sanitary surveys.

LSLR creates a number of water system/State interactions. States would be required to:

- Review water system inventory data;
- Confer with water systems with LSLs on initial planning for LSLR program activities, including standard operating procedures for conducting replacements, and outreach programs;
- Work with LSL water systems to determine a goal-based LSLR rate;
- Provide templates and targeted public education language for LSLR programs;
- Determine the additional outreach activities required if a water system fails to meet its goal-based LSLR rate; and
- Review annual LSLR program compliance reports from water systems.

State activities associated with CWSs serving 3,300 or fewer people and NTNCWSs that select POU as a treatment alternative include:

- Conferring with water systems on initial planning for POU programs;
- Reviewing public education material for POU devices; and
- Reviewing annual reports on POU programs, including POU device sampling results.

Proposed public education provisions will require a great deal of primacy agency oversight. Activities which produce primacy agency burden include:

- Providing water systems with templates to update CCR language;

- Reviewing water system information developed for new customer outreach;
- Participating in joint communication efforts for sharing lead public education with health care providers;
- Reviewing educational material developed for delivery during water-related work;
- Reviewing water system certifications of lead public education and outreach;
- Reviewing public education language submitted by water systems in response to an individual tap sample above the action level;
- Consulting with water systems on public education response to a lead action level exceedance, including reviewing language; and
- Reviewing the water systems public education self-certification letter following a lead action level exceedance.

The cost model estimates that the Primacy Agencies will incur incremental estimated annualized costs, under the low cost scenario, totaling $14,915,000 at a 3 percent discount rate and $15,054,000 at a 7 percent discount rate. For the high cost scenario total estimated costs is $15,598,000 at a 3 percent discount rate and $15,965,000 at a 7 percent discount rate. Additional information on the estimation of primacy agency costs can be found in Chapter 5, section 5.4 of the EA.

9. *Costs and Ecological Impacts Associated with Additional Phosphate Usage*

Adding phosphate creates a protective inner coating on pipes that can inhibit lead leaching. However, once phosphate is added to the public water system (PWS), some of this incremental loading remains in the water stream as it flows into wastewater treatment plants (WWTPs) downstream. This generates treatment costs for certain WWTPs. In addition, at those locations where treatment does not occur, water with elevated phosphorus concentrations may discharge to water bodies and induce certain ecological impacts.

When water systems add orthophosphate to their finished water for corrosion control purposes, some portion of the orthophosphate added will reach downstream WWTPs. To estimate the potential fate of the orthophosphate added at PWSs, the EPA developed a conceptual mass balance model. The EPA applied this conceptual model to estimate the increase in loading at WWTPs, given an initial loading from corrosion control at water treatment plants. WWTPs could incur costs because of upstream orthophosphate addition if they have permit discharge limits for phosphorus parameters. The percentage of WWTPs with phosphorus limits has increased over time. From 2007 to 2016, in annual percentage rate terms, the growth rate in the percentage of WWTPs with phosphorus limits is 3.3 percent.

The EPA assumed this increase would continue as States transition from narrative to numerical nutrient criteria and set numeric permits limits, especially for impaired waters. The EPA applied the growth rate observed from 2007 to 2016 to estimate the anticipated percentage of WWTPs with phosphorus limits in future years. This growth rate results in an estimated 41 percent of WWTPs with phosphorus discharge limits after 35 years. Applied as the percentage of WWTPs that need to take treatment actions, this estimate is likely conservative, particularly given the potential availability of alternative compliance mechanisms, such as, individual facility variance and nutrient trading programs.

The specific actions a WWTP might need to take to maintain compliance with a National Pollution Discharge Elimination System (NPDES) phosphorus limit will depend on the type of treatment present at the WWTP and the corresponding phosphorus removal provided (if any). Based on a review of NPDES data, it is likely that most of the WWTPs that already have phosphorus limits have some type of treatment to achieve the limit.

Some treatment processes can accommodate incremental increases in influent loading and still maintain their removal efficiency. Such processes might not need significant adjustment to maintain their existing phosphorus removal efficiency, given an incremental increase. Other treatment processes may need modifications to their design or operation to maintain their removal efficiency in the face of an influent loading increase.

The EPA derived a unit cost of $4.59 per pound of phosphorus for removing incremental phosphorus (see Chapter 5, section 5.5.1 of the EA for additional information). This unit cost includes the cost of additional chemical consumption and the operating cost of additional sludge processing and disposal. The costs a WWTP could incur depend on the magnitude of the loading increase relative to the specific WWTP's effluent permit limit. WWTPs, whose current discharge concentrations are closer to their limit, are more likely to have to act. WWTPs whose current concentrations are well below their limit may not incur costs but might, under certain conditions, incur costs (for example, when phosphorus removal achieved by technology is sensitive to incremental phosphorus loading increases). Furthermore, future phosphorus limits could be more stringent than existing limits in certain watersheds.

Therefore, the EPA conservatively assumed that any WWTP with a discharge limit for phosphorus parameters could incur costs. Accordingly, in calculating costs, the EPA used the anticipated percentage of WWTPs with phosphorus discharge limits as the likelihood that incremental orthophosphate loading from a drinking water system would reach a WWTP with a limit. The EPA combined this likelihood and the unit cost (previously estimated) with incremental phosphorus loading to calculate incremental costs to WWTPs for each year of the analysis period. The incremental annualized cost that WWTPs would incur to remove additional phosphorous associated with the proposed LCRR, under the low cost scenario, ranges from

$668,000 to $1,066,000 at a 3 and 7 percent discount rate, respectively. The high cost scenario produced an incremental estimated impact of $1,203,000 using a 3 percent discount rate, and $1,920,000 at a 7 percent discount rate.

The EPA estimates that WWTP treatment reduces phosphorus loads reaching water bodies by 59 percent but they are not eliminated. The proposed rule's national-level total incremental phosphorus loads reaching water bodies are projected to grow over the period of analysis from the low/high scenario range of 202,000 to 460,000 pounds fifteen years after promulgation to the low/high scenario range of 461,000 to 685,000 pounds at year 35. See Chapter 5, section 5.5 of the EA for information on how loading estimates are calculated. The ecological impacts of these increased phosphorous loadings are highly localized: total incremental phosphorus loadings will depend on the amount and timing of the releases, characteristics of the receiving water body, effluent discharge rate, existing total phosphorus levels, and weather and climate conditions. Unfortunately, detailed spatially explicit information on effluents and on receiving water bodies does not exist in a form suitable for this analysis. Rather, to evaluate the potential ecological impacts of the rule, the EPA evaluated the significance of the national-level phosphorus loadings compared to other phosphorous sources in the terrestrial ecosystem.

To put these phosphorus loadings in context, estimates from the USGS SPARROW model suggest that anthropogenic sources deposit roughly 750 million pounds of total phosphorus per year (USEPA, 2019b). The total phosphorus loadings from the proposed LCRR high cost scenario would contribute about 1 percent (7 million/750 million) of total phosphorus entering receiving waterbodies in a given year, and the incremental amount of total phosphorus associated with the proposed LCRR relative to the current LCR grows only 0.09 percent

(685,000/750 million). At the national level, the EPA expects total phosphorus entering waterbodies as a result of the proposed LCR revisions to be small, relative to the total phosphorus load deposited annually from all other sources. National average load impacts may obscure localized ecological impacts in some circumstances, but the existing data do not allow an assessment as to whether this incremental load will induce ecological impacts in particular areas. It is possible, however, that localized impacts may occur in certain water bodies without restrictions on phosphate deposits, or in locations with existing elevated phosphate levels.

An increase in phosphorus loadings can lead to economic impacts and undesirable aesthetic impacts. Excess nutrient pollution can cause eutrophication—excessive plant and algae growth—in lakes, reservoirs, streams, and estuaries throughout the United States. Eutrophication, by inducing primary production, leads to seasonal decomposition of additional biomass, consuming oxygen and creating a State of hypoxia, or low oxygen, within the water body. In extreme cases, the low to no oxygen States can create dead zones, or areas in the water where aquatic life cannot survive. Studies indicate that eutrophication can decrease aquatic diversity for this reason (*e.g.*, Dodds et al. 2009). Eutrophication may also stimulate the growth of harmful algal blooms (HABs), or over-abundant algae populations. Algal blooms can harm the aquatic ecosystem by blocking sunlight and creating diurnal swings in oxygen levels because of overnight respiration. Such conditions can starve and deplete aquatic species.

10. *Summary of Rule Costs*

The estimated annualized low and high scenario costs, discounted at 3 percent and 7 percent, that PWSs, households, and Primacy Agencies will incur in complying with the current LCR, the proposed LCRR, and incrementally are summarized in Exhibits 6-12 and 6-13. The total estimated incremental annualized cost of the proposed LCRR range from $132 to $270 million at a 3 percent discount rate, and $130 to $286 million at a 7 percent discount rate in 2016 dollars. The exhibits also detail the proportion of the annualized costs attributable to each rule component.

Exhibit 6-12: National Annualized Rule Costs at 3% Discount Rate (2016$)

	Low Cost Estimate			High Cost Estimate		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
PWS Annual Costs						
Sampling	$41,376,000	$73,931,000	$32,555,000	$42,809,000	$80,955,000	$38,146,000
PWS Lead Service Line Replacement	$638,000	$20,658,000	$20,020,000	$23,113,000	$97,357,000	$74,244,000
Corrosion Control Technology	$328,569,000	$351,877,000	$23,308,000	$354,750,000	$431,866,000	$77,116,000
Point-of Use Installation and Maintenance	$0	$3,995,000	$3,995,000	$0	$16,400,000	$16,400,000
Public Education and Outreach	$48,000	$29,364,000	$29,316,000	$1,093,000	$35,491,000	$34,398,000
Rule Implementation and Administration	$0	$1,863,000	$1,863,000	$0	$1,863,000	$1,863,000
Total Annual PWS Costs	$370,631,000	$481,688,000	$111,057,000	$421,766,000	$663,931,000	$242,165,000
State Rule Implementation and Administration	$5,661,000	$20,576,000	$14,915,000	$6,718,000	$22,316,000	$15,598,000
Household Lead Service Line Replacement	$234,000	$5,478,000	$5,244,000	$9,063,000	$20,003,000	$10,940,000
Wastewater Treatment Plant Costs	$331,000	$1,019,000	$688,000	$862,000	$2,065,000	$1,203,000
Total Annual Rule Costs	$376,857,000	$508,762,000	$131,905,000	$438,408,000	$708,314,000	$269,906,000

Exhibit 6-13: National Annualized Rule Costs at 7% Discount Rate (2016$)

	Low Cost Estimate			High Cost Estimate		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
PWS Annual Costs						
Sampling	$40,064,000	$71,897,000	$31,833,000	$42,039,000	$81,276,000	$39,237,000
PWS Lead Service Line Replacement	$573,000	$22,335,000	$21,762,000	$31,776,000	$122,270,000	$90,494,000

Exhibit 6-13: National Annualized Rule Costs at 7% Discount Rate (2016$)

	Low Cost Estimate			High Cost Estimate		
	Current LCR	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
Corrosion Control Technology	$312,364,000	$332,309,000	$19,945,000	$339,077,000	$414,967,000	$75,890,000
Point-of Use Installation and Maintenance	$0	$3,492,000	$3,492,000	$0	$15,485,000	$15,485,000
Public Education and Outreach	$65,000	$28,765,000	$28,700,000	$1,513,000	$35,525,000	$34,012,000
Rule Implementation and Administration	$0	$3,092,000	$3,092,000	$0	$3,092,000	$3,092,000
Total Annual PWS Costs	$353,067,000	$461,889,000	$108,822,000	$414,405,000	$672,615,000	$258,210,000
State Rule Implementation and Administration	$5,547,000	$20,601,000	$15,054,000	$6,993,000	$22,958,000	$15,965,000
Household Lead Service Line Replacement	$210,000	$5,290,000	$5,080,000	$12,459,000	$22,501,000	$10,042,000
Wastewater Treatment Plant Costs	$407,000	$1,473,000	$1,066,000	$1,288,000	$3,208,000	$1,920,000
Total Annual Rule Costs	$359,230,000	$489,253,000	$130,023,000	$435,144,000	$721,282,000	$286,138,000

D. Benefits Analysis

The proposed revisions to the LCR are expected to result in significant health benefits, since both lead and copper are associated with adverse health effects. Lead is a highly toxic pollutant that can damage neurological, cardiovascular, immunological, developmental, and other major body systems. The EPA is particularly concerned about exposure experienced by children because lead can affect brain development. Additionally, children through their physiology and water ingestion requirements may be at higher risk. Research shows that, on average, formula-fed infants and young children consume more drinking water per day on a body weight basis than adolescents. Using the USDA Continuing Survey of Food Intakes by Individuals (CSFII) data, Kahn and Stralka (2009) demonstrated this trend, is most pronounced in children under 1 year of age who drink more than double older children and adults per kg of body weight. Additionally, children absorb 2-4 times more lead than adults through the gastrointestinal tract ((Mushak, 1991; WHO, (2011) and Ziegler et al. (1978)). No safe level of lead exposure has been identified (USEPA, 2013). The EPA's health risk reduction and benefits assessment of the proposed LCR revisions concentrates on quantification and monetization of the estimated impact of reductions in lead exposure on childhood IQ. As explained in Appendix D in the Economic Assessment of the Proposed Lead and Copper Rule Revision (EA), there are additional non-quantified lead health impacts to both children and adults that will be realized as a result of this rulemaking.

Although copper is an essential element for health, excess intake of copper has been associated with several adverse health effects. Most commonly, excess exposure to copper results in gastrointestinal symptoms such as nausea, vomiting, and diarrhea (National Research Council, 2000). In susceptible populations, such as children with genetic disorders or predispositions to accumulate copper, chronic exposure to excess copper can result in liver toxicity. Because household level data on the change in copper concentrations that result from changes in CCT are not available, this analysis does not quantify any potential benefits from reduced copper exposure that may result from the proposed rule. See Appendix E in the EA for additional copper health impact information.

To quantify the potential impact to exposed populations of changes in lead tap water concentrations as a result of the proposed LCR revisions, the EPA:

- Estimated potential household lead tap water concentrations under various levels of corrosion control treatment, lead service line replacement, and implementation of POU devices;
- Modeled exposure using the lead tap water concentration data, information on peoples'

water consumption activities, and background lead levels from other potential pathways;

- Derived the potential change in blood lead levels (BLLs) that result from the changes in drinking water lead exposure;
- Used concentration response functions, from the scientific literature, to measure changes in IQ for children given shifts in BLLs;
- Estimated the unit value of a change in childhood IQ; and
- Applied the unit values to the appropriate demographic groups experiencing changes in lead tap water concentrations as a result of the proposed regulatory changes across the period of analysis.

Subsections VI.D.1 through 4 of this notice outline the estimation of lead concentration values in drinking water used to estimate before and after rule implementation concentration scenarios, the corresponding estimated avoided IQ loss in children, and a summary of the monetized benefits of the proposed LCR Revisions.

1. *Modeled Drinking Water Lead Concentrations*

The EPA determined the lead concentrations in drinking water at residential locations through the collection and analysis of consecutive sampling data representing homes pre and post removal of LSLs, including partial removal of LSLs, under differing levels of water system corrosion control treatment. The data was collected from multiple sources including: water systems, the EPA Regional Offices and the Office of Research and Development, and authors of published journal articles (Deshommes et al. 2016). This data includes lead concentrations and information regarding LSL status, location, and date of sample collection, representing 18,039 samples collected from 1,638 homes in 15 cities across the United States and Canada. The EPA grouped the samples into LSL status categories (“LSL,” “Partial,” “No LSL”). Samples were also grouped by CCT treatment, assigning status as having “None,” “Partial,” or “Representative.” “Partial” includes those water systems with some pH adjustment and lower doses of a phosphate corrosion inhibitor, but this treatment is not optimized. “Representative” are those water systems in the dataset that have higher doses of phosphate inhibitors, which in the model are considered optimized (see EA Chapter 6, section 6.2.1 for additional detail and docket number EPA-HQ-OW-2017-0300 for the data).

The EPA fit several regression models (see EA Chapter 6, section 6.2.2 for additional detail) of tap water lead concentration as predicted by LSL presence (“LSL” or “No LSL”), LSL extent (“Partial”), CCT status, and “profile liter.” Profile liter is the cumulative volume a sample represented within a consecutive sampling series at a single location and time. Models to describe the profile liter accounted for the variation among sampling events, sampling sites, and city. The EPA selected one of the regression models based on its fit and parsimony and used it to produce simulated lead concentrations for use in the benefits analysis (Exhibit 6-8, in Chapter 6 of the EA). The selected model suggests that besides water system, residence, and sampling event, the largest effects on lead concentration in tap water come from the presence of LSLs and the number of liters drawn since the last stagnation period. CCT produces smaller effects on lead concentration than LSLs, and these effects are larger in homes with LSLs.

To statistically control for some sources of variability in the input data, the EPA did not use summary statistics from the original data directly in estimating the effects of LSL and CCT status. Instead, the EPA produced simulated mean lead concentrations for 500,000 samples, summarized in Exhibit 6-14, based on the selected regression model. The simulated sample concentrations represent estimates for new cities, sites, and sampling events not included in the original dataset. These simulations rely on estimates of variability and uncertainty from the regression model and given information on LSL and CCT status. Individual estimates are best thought of as the central tendency for a sample concentration given regression model parameters and estimated variance. The simulated samples represent, on average, the lead concentrations taken after a short flushing period of roughly 30 seconds for all combinations of LSL and CCT status. This represents a point near the average peak lead concentration for homes with full or partial LSLs, and a point slightly below the peak lead concentration for homes with no LSLs, regardless of CCT status.

The EPA estimates that improving CCT will produce significant reductions in lead tap water concentration overall. However, for full LSLRs, the final model produced predictions of drinking water concentrations that overlapped almost completely for all CCT conditions. Therefore, the EPA used the pooled estimate of predicted drinking water concentrations for all CCT conditions in residences with no LSL in place for the main analysis in Chapter 6 of the EA. Because, the EPA in using this pooled data the mean and standard deviation values of tap water lead concentrations in Exhibit 6-14 are the same for all three "no LSLs" status rows, regardless of whether there is representative, partial, or no CCT. Effectively, in the primary analysis the EPA did not quantify the incremental benefits of CCT when LSLs are absent. On the other hand, because CCT is done on a system-wide basis, there are no incremental costs associated with providing CCT to homes without LSL when it is being provided for the entire system. The impact of CCT for these no LSL homes likely varies by location depending on the degree to which legacy leaded plumbing materials, including leaded brass fixtures, and lead solder remain at the location.

The EPA does track the number of "no LSL" homes potentially affected by water systems increasing their corrosion control during the 35-year period of analysis. The number of no LSL homes that experience increase in CCT over the 35 years ranges from 14 million in the low cost scenario and 26 million in the high cost scenario. The EPA considered one possible approach to estimating the potential benefits to children of reducing lead water concentrations in these homes (see Appendix F of the EA) but has determined that the data are too limited and the uncertainties too significant to include in the quantified and monetized benefit estimates of this regulation. The EPA, therefore, is requesting comment and additional information about the change in lead concentrations that occur in non-LSL households that experience changes in CCT.

Because small CWSs that serve fewer than 10,000 people have flexibility in the compliance option they select in response to a lead action level exceedance, some CWSs are modeled as installing POU devices at all residences. See section III.E of this notice for additional information on the compliance alternatives available to small CWSs. For individuals in these systems the EPA assumes, in the analysis, that consumers in households with POU devises are exposed to the same lead concentration as residents with “No LSL” and “Representative” CCT in place.

Exhibit 6-14: LSL and CCT Scenarios and Simulated Geometric Mean Tap Water Lead Concentrations and Standard Deviations at the Fifth Liter Drawn After Stagnation for each Combination of LSL and CCT Status

LSL Status	CCT Status	Simulated Mean of Log Lead (µg/L)	Simulated SD [a] of Log Lead (µg/L)	Simulated Geometric Mean Lead (µg/L)	Simulated Geometric SD [a] of Lead (µg/L)
LSL	None	2.92	1.37	18.62	3.95
Partial	None	2.17	1.38	8.78	3.98
No LSL	None	-0.29	1.38	0.75	3.98
LSL	Partial	2.42	1.37	11.27	3.94
Partial	Partial	1.67	1.37	5.32	3.93
No LSL	Partial	-0.29	1.38	0.75	3.98
LSL	Representative	1.95	1.38	7.01	3.96
Partial	Representative	1.19	1.38	3.3	3.96
No LSL	Representative	-0.29	1.38	0.75	3.98
[a] Standard deviations reflect “among-sampling event” variability.					

In the estimation of the costs and benefits of the proposed LCR revisions, each modeled person within a water system is assigned to one of the estimated drinking water concentrations in Exhibit 6-14, depending on the CCT, POU, and LSL status. The EPA estimated benefits under both the low cost and high cost scenarios used in the proposed LCRR which characterize uncertainty in the cost estimates. The low cost scenario and high cost scenario differ in their assumptions made about: (1) the existing number of LSLs in PWSs; (2) the number of PWS above the AL or TL under the current and proposed monitoring requirements; (3) the cost of installing and re-optimizing corrosion control treatment (CCT); (4) the effectiveness of CCT in mitigating lead concentrations; and (5) the cost of lead service line replacement (Section VI.C.3. above and Chapter 5, section 5.2.4 of the EA). The EPA predicted the status of each system under the low and high scenarios at baseline (prior to rule implementation) and in each year of rule implementation. Depending on the timing of required actions that can change CCT, POU, and LSL status under both the baseline and proposed LCRR low and high scenario model runs, changes in lead concentration and resultant blood lead are predicted every year for the total population served by the systems for the 35-year period of analysis. In the primary benefits analysis for the rule, improvements to CCT and the use of installed POU devices are only predicted for individuals in households with LSLs prior to the LCRR (consistent with discussion above about the limits of the data for predicting the impact of CCT when LSL are not present). In the model, LSL removals are predicted by water system, by year, and multiplied by the average number of people per household (across demographic categories) to determine the number of people shifting from one LSL status to another. To predict the changes in exposure that result from an improvement in CCT, the EPA predicts the entire LSL population of a water system will move to the new CCT status at the same time. The EPA also assumes that the entire water system moves to the drinking water lead concentration, assigned to POU when this option is implemented, which implies that everyone in households in a distribution system with LSLs is properly using the POU. See Chapter 6, section 6.3 of the EA for more detailed information on the number of people switching lead concentration categories under the low and high cost scenarios.

2. *Impacts on Childhood IQ*

The 2013 *Integrated Science Assessment for Lead* (USEPA 2013) States that there is a causal relationship between lead exposure and cognitive function decrements in children based on several lines of evidence, including findings from prospective studies in diverse populations supported by evidence in animals, and evidence identifying potential modes of action. The evidence from multiple high-quality studies using large cohorts of children shows an association between blood lead levels and decreased intelligence quotient (IQ). The 2012 National Toxicology Program Monograph concluded that there is sufficient evidence of association between blood lead levels <5 μg/dL and decreases in various general and specific measures of cognitive function in children from three months to 16 years of age. This conclusion is based on prospective and cross-sectional studies using a wide range of tests to assess cognitive function (National Toxicology Program, 2012).

The EPA quantitatively assessed and monetized the benefits of avoided losses in IQ as a result of the proposed LCR revisions. Modeled lead tap water concentrations (previously discussed in this notice) are used to estimate the extent to which the proposed rule would reduce avoidable loss of IQ among children. The first step in the quantification and monetization of avoided IQ loss is to estimate the likely decrease in blood lead levels in children based on the reductions in lead in their drinking water as a result of the proposed LCRR.

The EPA estimated the distribution of current blood lead levels in children, age 0 to 7, using the EPA's Stochastic Human Exposure and Dose Simulation Multimedia (SHEDS-Multimedia) model coupled with its Integrated Exposure and Uptake Biokinetic (IEUBK) model. The coupled SHEDS-IEUBK model framework was peer reviewed by the EPA in June of 2017 as part of exploratory work into developing a health-based benchmark for lead in drinking water (ERG, 2017). For further information on SHEDS-IEUBK model development and evaluation, refer to Zartarian et al. (2017). As a first step in estimating the blood lead levels, the EPA utilized the SHEDS-Multimedia model, which can estimate distributions of lead exposure, using a two-stage Monte Carlo sampling process, given input lead concentrations in various media and human behavior data from the EPA's Consolidated Human Activity Database (CHAD) and CDC's National Health and Nutrition Examination Survey (NHANES). SHEDS-Multimedia, in this case, uses individual time-activity diaries from CDC's NHANES and the EPA's CHAD for children aged 0 to 7 to simulate longitudinal activity diaries. Information from these diaries is then combined with relevant lead input distributions (*e.g.*, outdoor air lead concentrations, inhalation rates) to estimate exposure. Drinking water tap concentrations for each of the modeled LSL and CCT scenarios, above, were used as the drinking water inputs to SHEDS-Multimedia. For more detail on the other lead exposure pathways that are held constant as background in the model, see Chapter 6, section 6.4, of the EA.

In the SHEDS-IEUBK coupled methodology, the SHEDS model takes the place of the exposure and variability components of the IEUBK model by generating a probability distribution of lead intakes across media. These intakes are multiplied by route-specific (*e.g.*, inhalation, ingestion) absorption fractions to obtain a distribution of lead uptakes (see Exhibit 6-21 in the EA Chapter 6, section 6.4). This step is consistent with the uptake estimation that would normally occur within the IEUBK model. The media specific uptakes can be summed across exposure routes to give total lead uptake per day. Next, the EPA used age-based relationships derived from IEUBK, through the use of a polynomial regression analysis, to relate these total lead uptakes to blood lead levels. Exhibit 6-14 presents modeled SHEDS-IEUBK blood lead levels in children by year of life and LSL, CCT status, and POU. The blood lead levels in this exhibit represent what children's blood lead level would be if they lived under the corresponding LSL, POU, and CCT status combination for their entire lives. Note that when "No LSL" is the beginning or post-rule state, 0.75ug/L is the assumed concentration across all levels of CCT status (none, partial, representative). The extent to which changes in CCT status make meaningful difference in lead concentrations for those without LSL cannot be determined from this exhibit.

Exhibit 6-14: Modeled SHEDS-IEUBK Geometric Mean Blood Lead Levels in Children for Each Possible Drinking Water Lead Exposure Scenario for Each Year of Life

Lead Service Line Status	Corrosion Control Treatment Status	Geometric Mean Blood Lead Level (µg/dL) for Specified Year of Life						
		0-1[a]	1-2	2-3	3-4	4-5	5-6	6-7
LSL	None	3.75	2.60	2.73	2.59	2.56	2.72	2.45
Partial	None	2.43	1.88	1.96	1.89	1.87	1.95	1.69
No LSL	None	0.95	1.15	1.16	1.14	1.14	1.19	0.97
LSL	Partial	2.71	2.05	2.20	2.06	2.08	2.17	1.90
Partial	Partial	1.86	1.58	1.65	1.60	1.60	1.66	1.43
No LSL	Partial	0.95	1.15	1.16	1.14	1.14	1.19	0.97
LSL	Representative	2.14	1.75	1.82	1.73	1.75	1.82	1.57
Partial	Representative	1.51	1.41	1.45	1.42	1.40	1.46	1.24
No LSL	Representative	0.95	1.15	1.16	1.14	1.14	1.19	0.97
POU		0.95	1.15	1.16	1.14	1.14	1.19	0.97

[a] Due to lack of available data, blood lead levels for the first year of life are based on regression from IEUBK for 0.5- to 1-year-olds only.
These represent the blood lead for a child living with the LSL/CCT status in the columns to the left. Each year blood lead corresponding to actual modeled child is summed and divided by 7 in the model to estimate lifetime average blood lead.
This table presents modeled SHEDS-IEUBK blood lead levels in children by year of life.

The blood lead levels presented in Exhibit 6-14, are used as inputs for the benefits modeling. For each year of the analysis modeled, children are assigned blood lead levels, which correspond to a water lead concentration representing the LSL, POU and CCT status of their water system (see section 6.3 of the EA). In the proposed LCRR cost-benefit model, individual children in LSL households for each water system are tracked as they move from one LSL, CCT status, or POU to another as a result of LCRR implementation. The tracking occurs for both the low and high cost scenarios. Because the child's drinking water lead concentration can change annually in the model, the EPA chose to estimate lifetime blood lead levels by taking the average across each year of the child's life, up to age 7. With this averaging, age at implementation of the LCRR (changing LSL, CCT, or POU status), is taken into account when calculating lifetime average blood lead level.

In order to relate the child's estimated lifetime average blood lead level to an estimate of avoided IQ loss, the EPA selected a concentration-response function based on lifetime blood lead from the independent analysis by Crump et al. (2013). This study used data from a 2005 paper by Lanphear et al., which has formed the basis of concentration-response functions used in several EPA regulations (National Ambient Air Quality Standard, 2008; TSCA Lead Repair and Renovation Rule, 2008; and Steam Electric Effluent Limitation Guidelines Rule, 2005). The Crump et al. (2013) function was selected over the Lanphear et al. (2005) reanalysis to minimize issues with overestimating predicted IQ loss at the lowest levels of lead exposure (less than 1 µg/dL BLL), which is a result of the use of the log-linear function. The Crump et al. (2013) function avoids this issue by adding one to the estimated blood lead levels prior to log-transformation. Since the proposed revisions to the LCR are expected to reduce chronic exposures to lead, the EPA selected lifetime blood lead as the most appropriate measure with which to evaluate benefits. No threshold has been identified for the neurological effects of lead (Budtz-Jørgensen et al., 2013; Crump et al., 2013; Schwartz et al., 1991; USEPA, 2013).

Therefore, the EPA assumes that there is no threshold for this endpoint and quantified avoided IQ loss associated with all blood lead levels. The EPA, as part of its sensitivity analysis, estimated the BLL to IQ relationship using Lanphear et al. (2005) and Kirrane and Patel (2014)[1]. See Chapter 6, section 6.4.3 and Appendix F of the EA for a more detailed discussion.

The estimated value of an IQ point decrement is derived from the EPA's reanalysis of Salkever (1995), which estimates that a one-point increase in IQ results in a 1.871 percent increase in lifetime earnings for males and a 3.409 percent change in lifetime earnings for females. Lifetime earnings are estimated using the average of 10 American Community Survey (ACS) single-year samples (2008 to 2017) and projected cohort life tables from the Social Security Administration. Projected increases in lifetime earnings are then adjusted for the direct costs of additional years of education and forgone earnings while in school. The reanalysis of Salkever (1995) estimates a change of 0.0812 years of schooling per change in IQ point resulting from a reduction in lead exposure for males and a change of 0.0917 years of schooling for females.

To estimate the uncertainty underlying the model parameters of the Salkever (1995) reanalysis, the EPA used a bootstrap approach to estimate a distribution of model parameters over 10,000 replicates (using random sampling with replacement). For each replicate, the net monetized value of a one-point decrease in IQ is subsequently estimated as the gross value of an IQ point, less the value of additional education costs and lost earnings while in school. The EPA uses an IQ point value discounted to age 7. Based on EPA's reanalysis of Salkever (1995), the mean value of an IQ point in 2016$ discounted to age 7 is $5,708 using a 7 percent discount rate

[1] Lanphear et al., (2005) published a correction in 2019 that revised the results to be consistent with the Kirrane and Patel (2014) corrections.

and $22,503 using a 3 percent discount rate[2]. See Appendix F, of the EA for a sensitivity analysis of avoided IQ loss benefits based on Lin et. al. (2018).

The EPA used the estimated changes in lifetime (age 0 to 7) average blood lead levels that result from changes in LSL, CCT, or POU status as inputs to the concentration response function from the independent analysis by Crump et al. (2013). The resultant annual avoided IQ decrement is then summed and multiplied by the EPA reanalyzed Salkever (1995) value per IQ point which represent a weighted average for males and females (3 or 7 percent depending on the discount rate being used to annualize the stream of benefits across the period of analysis). This annual stream of benefits was annualized at 3 and 7 percent over the 35-year period of analysis, and further discounted to year one of the period of analysis. See Exhibit 6-18 (discounted at 3 percent) and Exhibit 6-19 (discounted at 7 percent) for the estimated benefit from avoided IQ losses from both lead service line removals and improvements to CCT at public water system as a result of the current rule, the proposed LCR revisions, and the incremental difference between the current and proposed rule estimates under both the low and high cost scenarios.

3. *Impacts on Adult Blood Lead Levels*

The EPA identified the potential adverse adult health effects associated with lead utilizing information from the 2013 Integrated Science Assessment for Lead (USEPA, 2013) and the U.S. Department of Health and Human Services' National Toxicology Program Monograph on Health Effects of Low-Level Lead (National Toxicology Program, 2012). In these documents,

[2] It should be noted that these values are slightly different than those used in other recent rulemaking (e.g. the Lead Dust Standard and the Perchlorate rule). This is simply due to the differences in the age of the child when the benefits are accrued in the analysis. Benefits for the LCRR are accrued at age seven and therefore the value of an IQ point is discounted back to age 7 in the LCRR analysis. This results in a slightly higher estimate than the values used for the Perchlorate Rule and the Lead Dust Standard, which are discounted to age zero and age three, respectively. It should also be noted, and is described in Section **Error! Reference source not found.**, that the benefits in the LCRR are further discounted back to year one of the analysis and annualized within SafeWater LCR.

lead has been associated with adverse cardiovascular effects (both morbidity and mortality effects), renal effects, reproductive effects, immunological effects, neurological effects, and cancer. (see Appendix D of the EA).

Although the EPA did not quantify or monetize changes in adult health benefits for the proposed LCRR, the Agency has estimated the potential changes in adult drinking water exposures and thus blood lead levels to illustrate the extent of the lead reduction to the adult population estimated as a result of the proposed LCRR. The EPA estimated blood lead levels in adults for each year of life, beginning at age 20 and ending with age 80. Males and females are assessed separately because data from the CDC's National Health and Nutrition Examination Survey (NHANES) indicate that men have higher average blood lead levels than women. To estimate the changes in blood lead levels in adults associated with the proposed rule, the EPA selected from a number of available models a modified version of its Adult Lead Methodology (ALM). The ALM "uses a simplified representation of lead biokinetics to predict quasi-steady state blood lead concentrations among adults who have relatively steady patterns of site exposures" (USEPA, 2003). The model assumes a linear slope between lead uptake and blood lead levels, which is termed the "biokinetic slope factor" and is described in more detail in Chapter 6 section 6.5 of the EA. Although the model was originally developed to estimate blood lead level impacts from lead in soil, based on the record, the EPA finds the ALM can be tailored for use in estimating blood lead concentrations in any adult exposed population and is able to consider other sources of lead exposure, such as contaminated drinking water. The biokinetic slope factor of 0.4 µg/dL per µg/day is still valid for use in the case of drinking water since it is in part derived from studies that measure both adult blood lead levels and concentrations of lead in drinking water (Pocock et al., 1983; Sherlock et al., 1982).

The EPA estimated expected BLLs for adults with the ALM using the lead tap water concentration data by LSL, CCT, and POU status derived from the profile dataset, discussed in section VI.D.1 and shown in Exhibit 6-14 of this notice. For the background blood lead levels in the model, the EPA used geometric mean blood lead levels for males and females for each year of life between ages 20 and 80 from NHANES 2011-2016, which may result in some minor double counting of exposure from drinking water. Exhibit 6-15 displays the estimated blood lead levels for adults by each LSL, POU or CCT combination summarized by age groups (blood lead values for each year of age are used to determine average BLL). The EPA also estimated BLLs using output for other exposure pathways from SHEDS in the ALM and the All Ages Lead Model, these results are shown in Appendix F of the EA. The All Ages Lead Model results are not used in the primary analysis because an ongoing peer review of the model has not been completed.

Exhibit 6-15: Estimates of Blood Lead Levels in Adults Associated with Drinking Water Lead Exposures from LSL/CCT or POU status combinations

Lead Service Line Status	Corrosion Control Treatment Status	Sex	Geometric Mean Blood Lead Level (µg/dL) for Specified Age Group in Years					
			20-29	30-39	40-49	50-59	60-69	70-80
LSL	None	Males	1.90	2.05	2.26	2.46	2.66	2.93
		Females	1.60	1.73	1.92	2.25	2.38	2.55
Partial	None	Males	1.33	1.46	1.67	1.87	2.04	2.28
		Females	1.03	1.14	1.34	1.66	1.77	1.91
No LSL	None	Males	0.86	0.98	1.19	1.39	1.54	1.75
		Females	0.56	0.66	0.86	1.18	1.27	1.38
LSL	Partial	Males	1.47	1.61	1.82	2.02	2.20	2.44
		Females	1.17	1.29	1.48	1.81	1.92	2.07
Partial	Partial	Males	1.13	1.25	1.46	1.66	1.83	2.05
		Females	0.83	0.93	1.13	1.45	1.55	1.68
No LSL	Partial	Males	0.86	0.98	1.19	1.39	1.54	1.75
		Females	0.56	0.66	0.86	1.18	1.27	1.38
LSL	Representative	Males	1.23	1.36	1.56	1.76	1.93	2.16

Lead Service Line Status	Corrosion Control Treatment Status	Sex	Geometric Mean Blood Lead Level (µg/dL) for Specified Age Group in Years					
			20-29	30-39	40-49	50-59	60-69	70-80
		Females	0.93	1.03	1.23	1.56	1.66	1.79
Partial	Representative	Males	1.01	1.13	1.34	1.54	1.70	1.92
		Females	0.71	0.81	1.01	1.33	1.43	1.55
No LSL	Representative	Males	0.86	0.98	1.19	1.39	1.54	1.75
		Females	0.56	0.66	0.86	1.18	1.27	1.38
POU		Males	0.86	0.98	1.19	1.39	1.54	1.75
		Females	0.56	0.66	0.86	1.18	1.27	1.38

As discussed in the analysis of childhood IQ impacts section VI.D.2 of this notice), the estimated BLLs in Exhibit 6-15 are average adult annual blood lead levels given the corresponding estimated lead tap water concentrations resulting from LSL, CCT, and POU status. In the proposed LCR revisions cost-benefit model, individual males and females in LSL households for each water system are tracked as they move from one LSL, CCT, or POU status to another as a result of rule implementation. Exhibit 6-16 shows the estimated changes in average lifetime blood lead levels for adults that move from the set of initial LSL, CCT, and POU status combinations to a new status as a result of LSL removal, and/or installation of CCT or POU. Note that when "No LSL" is the beginning or post-rule state, 0.75ug/L is the assumed concentration across all levels of CCT status (none, partial, representative). The extent to which changes in CCT status make meaningful difference in lead concentrations for those without LSL cannot be determined from this Exhibit.

Exhibit 6-16: Estimated Lifetime Average Blood Lead Change for Adults Moving Between LSL, CCT, and POU Status Combinations

Pre-Rule Drinking Water			Post-Rule Drinking Water			Estimated Average Blood Lead Change (in geometric means)
Lead Conc. (µg/L)	LSL Status	CCT Status	Lead Conc. (µg/L)	LSL Status	CCT Status	Ages 20-80 (µg/dL)
18.62	LSL	None	0.75	No LSL	None	1.09

18.62	LSL	None	7.01	LSL	Representative	0.71
18.62	LSL	None	0.75	No LSL	Representative	1.09
18.62	LSL	None	0.75	POU		1.09
8.78	Partial	None	0.75	No LSL	None	0.49
8.78	Partial	None	3.3	Partial	Representative	0.34
8.78	Partial	None	0.75	No LSL	Representative	0.49
8.78	Partial	None	0.75	POU		0.49
0.75	No LSL	None	0.75	No LSL	Representative	0.00
0.75	No LSL	None	0.75	POU		0.00
11.27	LSL	Partial	0.75	No LSL	Partial	0.64
11.27	LSL	Partial	7.01	LSL	Representative	0.26
11.27	LSL	Partial	0.75	No LSL	Representative	0.64
11.27	LSL	Partial	0.75	POU		0.64
5.32	Partial	Partial	0.75	No LSL	Partial	0.28
5.32	Partial	Partial	3.3	Partial	Representative	0.12
5.32	Partial	Partial	0.75	No LSL	Representative	0.28
5.32	Partial	Partial	0.75	POU		0.28
0.75	No LSL	Partial	0.75	No LSL	Representative	0.00
0.75	No LSL	Partial	0.75	POU		0.00
7.01	LSL	Representative	0.75	No LSL	Representative	0.38
7.01	LSL	Representative	0.75	POU		0.38
3.3	Partial	Representative	0.75	No LSL	Representative	0.16
3.3	Partial	Representative	0.75	POU		0.16
0.75	No LSL	Representative	0.75	POU		0.00

4. *Total Monetized Benefits*

Exhibits 6-17 and 6-18 show the estimated, monetized national annualized total benefits, under the low and high cost scenarios, from avoided child IQ decrements associated with the current LCR, the proposed LCRR, and the increment of change between the two, for CCT improvements, LSLR, and POU devise implementation discounted at 3 and 7 percent, respectively. The potential changes in adult blood lead levels estimated from changing LSL and CCT status under the proposed LCRR can be found in section VI.D.3 of this notice and Chapter 6 of the EA. The impact of lead on the risk of attention-deficit/hyperactivity disorder and reductions in birth weight are discussed in Appendix H of the EA. It should also be noted that because of the lack of granularity in the assembled lead concentration profile data, with regard to CCT status when samples were collected (see section VI.D.1 of this notice), the benefits of small improvements in CCT, like those modeled under the "find-and-fix," cannot be quantified in the model. For additional information on non-quantified benefits see section VI.E.2 of this notice.

Exhibit 6-17: Summary of Estimated National Annual Benefits, 3% Discount Rate (2016$)

System Type: All Estimate			Low Cost	High Cost Estimate		
Estimated Child IQ Benefits	**Current LCR**	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
Number of Children Impacted (over 35 years)	71,449	1,148,110	1,076,661	1,034,170	3,431,200	2,397,030
Annual IQ Point Decrement Avoided (CCT)	431	8,764	8,333	6,875	28,127	21,252
Annual Value of IQ Impacts Avoided (CCT)	$7,300,000	$152,661,000	$145,361,000	$129,985,000	$521,356,000	$391,371,000
Annual IQ Point Decrement Avoided (LSLR/POU)	297	4,010	3,713	5,065	12,011	6,946
Annual Value of IQ Impacts Avoided (LSLR/POU)	$5,091,000	$70,811,000	$65,720,000	$99,412,000	$229,200,000	$129,788,000
Total Annual Value of IQ Impacts Avoided	$12,391,000	$223,472,000	$211,081,000	$229,397,000	$750,556,000	$521,159,000
This table summarizes the national annual children's benefit for a 3 percent discount rate under High & Low Cost assumptions. This table uses a 3% discount rate over the 35 year analysis period. Children are modeled throughout their lifetime, and their drinking water concentration and BLL can change in each year of the analysis as CCT, POU or LSL changes happen in their modeled PWS.						

Exhibit 6-18: Summary of Estimated National Annual Benefits, 7% Discount Rate (2016$)

System Type: All		**Low Cost Estimate**			**High Cost Estimate**	
Estimated Child IQ Benefits	**Current LCR**	**Proposed LCRR**	**Incremental**	**Current LCR**	**Proposed LCRR**	**Incremental**
Number of Children Impacted (over 35 years)	71,449	1,148,110	1,076,661	1,034,170	3,431,200	2,397,030
Annual IQ Point Decrement Avoided (CCT)	431	8,764	8,333	6,875	28,127	21,252
Annual Value of IQ Impacts Avoided (CCT)	$1,201,000	$26,219,000	$25,018,000	$25,008,000	$97,772,000	$72,764,000
Annual IQ Point Decrement Avoided (LSLR/POU)	297	4,010	3,713	5,065	12,011	6,946
Annual Value of IQ Impacts Avoided (LSLR/POU)	$858,000	$12,453,000	$11,595,000	$20,311,000	$45,005,000	$24,694,000
Total Annual Value of IQ Impacts Avoided	$2,059,000	$38,671,000	$36,612,000	$45,319,000	$142,778,000	$97,459,000
This table summarizes the national annual children's benefit for a 7 percent discount rate under High & Low Cost assumptions. This table uses a 7% discount rate over the 35 year analysis period. Children are modeled throughout their lifetime, and their drinking water concentration and BLL can change in each year of the analysis as CCT, POU or LSL changes happen in their modeled PWS.						

E. Cost-Benefit Comparison

This section summarizes and describes the numeric relationship between the monetized incremental costs and benefits of the proposed LCR revisions. The section also discusses both the non-monetized costs and benefits of the rulemaking. Exhibits 6-19 and 6-20 compare the annualized monetized incremental costs and benefits of the proposed LCRR for the low and high cost scenarios. Under a 3 percent discount rate, the net annualized incremental benefits, under the low and high cost scenarios, range from $79 to $251 million. Under the low and high cost scenarios and a 7 percent discount rate, the net annualized incremental benefits range from a negative $91 to negative $189 million.

Exhibit 6-19: Comparison of Estimated Monetized National Annualized Incremental Costs to Benefits of the Proposed LCRR at 3% Discount Rate

PWS Annual Costs	**Low Cost Scenario**	**High Cost Scenario**
Annualized Incremental Costs	$131,987,000	$269,989,000
Annualized Incremental Benefits	$211,081,000	$521,159,000
Annual Net Benefits	**$79,094,000**	**$251,170,000**

Exhibit 6-20: Comparison of Estimated Monetized National Annualized Incremental Costs to Benefits of the Proposed LCRR at 7% Discount Rate

PWS Annual Costs	Low Cost Scenario	High Cost Scenario
Annualized Incremental Costs	$130,104,000	$286,219,000
Annualized Incremental Benefits	$36,612,000	$97,459,000
Annual Net Benefits	**-$91,492,000**	**-$188,760,000**

1.*Non-monetized Costs*

The proposed LCRR are expected to result in additional phosphate being added to drinking water to reduce the amount of lead leaching into the water in the distribution system. The EPA's cost model estimated that, nationwide, the proposed LCRR will result in total incremental phosphorus loads increasing over the period of analysis, under the low cost and high cost scenarios, by a range of 202,000 to 460,000 pounds fifteen years after promulgation, and increasing under the low cost and high cost scenarios by a range of 461,000 to 685,000 pounds at year 35. At the national level, under the high cost scenario, this additional phosphorous loading is small, less than 0.09 percent of the total phosphorous load deposited annually from all other anthropogenic sources. However, national average load impacts may obscure significant localized ecological impacts. Impacts, such as eutrophication, may occur in water bodies without restrictions on phosphate deposits, or in locations with existing elevated phosphate levels. See Chapter 5, section 5.5.2 of the EA for additional information.

2. *Non-quantified Non-monetized Benefits*

In addition to the benefits monetized in the proposed rule analysis for reductions in lead exposure, there are several other benefits that are not quantified. The risk of adverse health effects due to lead that are expected to decrease as a result of the proposed LCRR are summarized in Appendix D of the EA and are expected to affect both children and adults. The

EPA focused its non-quantified impacts assessment on the endpoint identified using two comprehensive U.S. Government documents summarizing the recent literature on lead exposure health impacts. These documents are the EPA's Integrated Science Assessment for Lead (ISA) (USEPA, 2013); and the U.S. Department of Health and Human Services' National Toxicology Program Monograph on Health Effects of Low-Level Lead (National Toxicology Program (NTP), 2012). Both of these sources present comprehensive reviews of the literature on the risk of adverse health effects associated with lead exposure. The EPA summarized those endpoints to which either the EPA ISA or the NTP Lead Monograph assigned one of the top two tiers of confidence in the relationship between lead exposure and the risk of adverse health effects. These endpoints include: cardiovascular effects, renal effects, reproductive and developmental effects, immunological effects, neurological effects, and cancer.

There are a number of proposed rule requirements that reduce lead exposure to both children and adults that the EPA could not quantify. The proposed rule would require additional lead public education requirements that target consumers directly, schools and child care facilities, health agencies, and specifically people living in homes with lead service lines. Increased education will lead to additional averting behavior on the part of the exposed public, resulting in reductions in the negative impacts of lead. The proposed rule also would require the development of lead service line inventories and making the location of lead service lines publicly accessible. This would give exposed consumers more information, and it would provide potential home buyers this information as well, possibly resulting in additional lead service line removals initiated by homeowners before, during, or following home sale transactions. The benefits of these additional removals are not quantified in the analysis of the proposed LCRR. As indicated in section VI.D.4 of this notice, because of the lack of granularity in the lead tap water concentration data available to the EPA for the proposed rule analysis, the benefits of small improvements in CCT to individuals residing in homes with LSLs, like those modeled under the "find-and-fix," are not quantified.

The EPA also did not quantify the benefits of reduced lead exposure to individuals who reside in homes that do not have lead service lines. The EPA has determined that the revised LCR requirements may result in reduced lead exposure to the occupants of these buildings as a result of improved monitoring and additional actions to optimize CCT. In the analysis of the proposed LCRR, the number of non-LSL homes potentially affected by water systems increasing their corrosion control during the 35-year period of analysis is 14 million in the low cost scenario and 26 million in the high cost scenario. These households, while not having an LSL in place, may still contain leaded plumbing materials, including leaded brass fixtures, and lead solder. These households could potentially see reductions in lead tap water concentrations. The EPA has assessed the potential benefits to children of reducing lead water concentrations in these homes (see Appendix F of the EA) but has determined that the data are too limited and the uncertainties too significant to include in the quantified and monetized benefit estimates of this regulation.

Additionally, the risk of adverse health effects associated with copper that are expected to be reduced by the proposed LCRR are summarized in Appendix E of the EA. These risks include acute gastrointestinal symptoms, which are the most common adverse effect observed among adults and children. In sensitive groups, there may be reductions in chronic hepatic effects, particularly for those with rare conditions such as Wilson's disease and children pre-disposed to genetic cirrhosis syndromes. These diseases disrupt copper homeostasis, leading to excessive accumulation that can be worsened by excessive copper ingestion (National Research Council, 2000).