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2025

MEMORANDUM

TO: The Honorable Louise Lucas
Chair, Senate Finance Committee

The Honorable Luke E. Torian
Chair, House Appropriations Committee

The Honorable Mark D. Sickles
Vice Chair, House Appropriations Committee

FROM: Karen Shelton, MD
State Health Commissioner, Virginia Department of Health

SUBJECT: PFAS and LSL Compliance in Virginia

This report is submitted in compliance with the Virginia Acts of the Assembly – 2024 Session Budget Amendment HB30 Item 280 #1c, which states:

> *Out of this appropriation, $500,000 the first year from the general fund shall be provided for the Virginia Department of Health to conduct a cost analysis of implementing pending federal Per- and Polyfluorinated Substances (PFAS) regulations for Virginia local water systems and to implement pending federal Environmental Protection Agency Copper Rules for water system lead service lines. The report shall include the results of the cost analysis, possible funding models, and identify federal funding that may be available. The department shall submit the report to the Chairs of the House Appropriations and Senate Finance and Appropriations Committees by December 1, 2024*

Should you have any questions or need additional information, please feel free to contact me at (804) 864-7002.

VDH VIRGINIA DEPARTMENT OF HEALTH
To protect the health and promote the well-being of all people in Virginia.

KS/AJ
Enclosure

Pc: The Honorable Janet V. Kelly, Secretary of Health and Human Resources

PFAS AND LSL COMPLIANCE IN VIRGINIA

REPORT TO THE GENERAL ASSEMBLY

2025

VIRGINIA DEPARTMENT OF HEALTH

PREFACE

The Virginia Department of Health (VDH) was tasked with conducting a cost analysis of the impact that certain U.S. Environmental Protection Agency (EPA) regulations will have on Virginia waterworks. Specifically, VDH was directed to assess the anticipated costs to be incurred by Virginia waterworks to comply with the new National Primary Drinking Water Regulation (NPDWR) for per- and polyfluoroalkyl substances (PFAS) as well as recent updates to the Lead and Copper Rule (LCR) (e.g., Lead and Copper Rule Improvements (LCRI) and the Lead and Copper Rule Revisions (LCRR)), referred to collectively as “lead regulations.” As directed in Budget Amendment HB30 Item 280 #1c, the report shall include the results of the cost analysis, possible funding models, and identification of federal funding that may be available. The report was generated by the VDH Office of Drinking Water, which contracted subject matter professionals to support the analysis and preparation of this report, herein referred to as the “Study Team”. The report will be submitted to the Chairs of the House Appropriations and Senate Finance and Appropriations Committees with a due date of December 1, 2024.

STUDY CONTRIBUTORS

Virginia Department of Health

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EXECUTIVE SUMMARY

The Virginia Department of Health (VDH) was tasked with conducting a cost analysis of the impact that certain U.S. Environmental Protection Agency (EPA) regulations will have on Virginia waterworks. Specifically, VDH was directed to assess the anticipated costs to be incurred by Virginia waterworks to comply with the new National Primary Drinking Water Regulation (NPDWR) for per- and polyfluoroalkyl substances (PFAS) as well as recent updates to the Lead and Copper Rule (LCR) (e.g., Lead and Copper Rule Improvements (LCRI) and the Lead and Copper Rule Revisions (LCRR)), referred to collectively as "lead regulations." As directed in Budget Amendment HB30 Item 280 #1c, the report shall include the results of the cost analysis, possible funding models, and identification of federal funding that may be available. The report was generated by the VDH Office of Drinking Water, which contracted subject matter professionals to support the analysis and preparation of this report, herein referred to as the "Study Team". The report will be submitted to the Chairs of the House Appropriations and Senate Finance and Appropriations Committees with a due date of December 1, 2024. Throughout the duration of the study, the Study Team deployed surveys to Virginia community and non-transient noncommunity (NTNC) waterworks, held virtual meetings with certain waterworks, and followed up through email and phone calls with specific questions and clarifications as necessary. The findings of the cost analysis are provided below.

FINDINGS

1. **PFAS Compliance Costs:** Present day estimates of PFAS capital expenditures (CapEx) are between $643M and $904M, which are expected to be incurred by most waterworks between present day and the compliance date of 2029. Present day estimates of PFAS operational expenditures (OpEx) are between $72M and $88M annually and will continue indefinitely. Ongoing PFAS monitoring for compliance purposes will add approximately $0.7M per year in 2024 dollar value. The population served by waterworks with known PFAS contamination that exceed the Maximum Contamination Levels (MCL) set by the EPA is approximately 2.6M people, however, the impacted population is greater than 2.6M people because certain waterworks with known PFAS contamination sell treated water to other waterworks within the Commonwealth. Additionally, the impacted population is expected to be even greater because there are waterworks within the Commonwealth that are yet to sample for PFAS to confirm if they are in compliance. An estimate of additional waterworks and their associated population served that may be impacted by PFAS is provided in the Results section.

2. **Lead Compliance Costs:** Present day estimates of lead service line (LSL) replacement CapEx are between $290M and $670M. The present day OpEx estimate for additional compliance activities (e.g. public outreach and maintaining an LSL inventory) is $43M. The present day OpEx estimate for monitoring costs is between $1M and $2M.

3. **Project Funding:** Overall, larger waterworks are better positioned to afford needed CapEx and OpEx using rate increases to cover costs because of larger customer bases (and resulting economies of scale), while smaller waterworks will have more difficulty in affording the needed CapEx and OpEx using rate increases because of their smaller rate bases. To deliver the capital projects and provide the ongoing operations and maintenance

required, most waterworks are expected to utilize a funding model comprised of a combination of low interest loans through programs such as the Virginia Drinking Water State Revolving Fund (DWSRF), state and federal grants when available, bonds obtained through the Virginia Resources Authority (VRA), rate increases, and in certain circumstances, funds from litigation claims. At the federal level, there are many ongoing programs from which VDH has received grant funds to award waterworks applicants to apply towards PFAS and/or lead compliance projects. Considering the estimated costs for compliance, in most cases, financing through grants and litigation claims will not provide enough financial support for waterworks to avoid raising customer rates. The strategy for funding drinking water treatment plant upgrades, LSL replacements, OpEx, and additional compliance activities for both PFAS and lead projects will differ depending on the waterworks. Additionally, the financial support that waterworks provide to replace customer-owned LSLs will also differ, as waterworks may be restricted from using rate payer funds on private property and will therefore be reliant on funding streams such as DWSRF in order to subsidize the customers' replacement cost.

INTRODUCTION

STUDY MANDATE

The Virginia Department of Health (VDH) was tasked with conducting a cost analysis of the impact that certain U.S. Environmental Protection Agency (EPA) regulations will have on Virginia waterworks. Specifically, VDH was directed to assess the anticipated costs to be incurred by Virginia waterworks to comply with the new National Primary Drinking Water Regulation (NPDWR) for per- and polyfluoroalkyl substances (PFAS) as well as recent updates to the Lead and Copper Rule (LCR) (e.g., Lead and Copper Rule Improvements (LCRI) and the Lead and Copper Rule Revisions (LCRR)), referred to collectively as "lead regulations." As directed in Budget Amendment HB30 Item 280 #1c, the report shall include the results of the cost analysis, possible funding models, and identification of federal funding that may be available. The report will be submitted to the Chairs of the House Appropriations and Senate Finance and Appropriations Committees with a due date of December 1, 2024.

STUDY ACTIVITIES

Throughout the duration of the study, the Study Team deployed surveys to Virginia community and non-transient noncommunity (NTNC)[1] waterworks, held virtual meetings with certain waterworks, and followed up through emails and phone calls with specific questions and clarifications as necessary. In addition to surveys and direct engagement, the Study Team also utilized Commonwealth-held and other publicly available data sets to assist with the cost analysis, which is discussed in detail in the Overview of Approach section. Throughout the study period, the Study Team regularly connected via virtual meetings, emails, and other phone calls to discuss project tasks, methodology, data requests, initial findings, possible challenges, and strategy. A further breakdown of activities performed that included participation by Virginia waterworks is detailed below.

PFAS STUDY

The Study Team began by collecting and reviewing Commonwealth-held and publicly available data for PFAS sampling at waterworks across the Commonwealth. With the understanding of available data, the Study Team prepared a PFAS-focused survey, which was sent via email to Virginia community and NTNC waterworks on September 16, 2024. The survey remained open for submittal for a period of two weeks; however, the survey was reopened as needed when certain waterworks were requested to respond. The PFAS-focused survey was responded to by 502 waterworks (approximately 32% of active community and NTNC waterworks). To supplement the survey and other publicly available data, the Study Team engaged directly through virtual meetings and follow-up emails with the six largest waterworks by population identified to have known or potential PFAS exceedances and that treat their own water (i.e., do not purchase treated drinking water from other waterworks). This direct engagement was conducted to gain a more detailed understanding of their approach to PFAS compliance, required

[1] Non-Community water systems are not included under the purview of the new NPDWR for PFAS or the LCRI and therefore were excluded for consideration in this Study.

drinking water treatment upgrades, other operational changes, and cost considerations (i.e., capital expenditures [CapEx] and operational expenditures [OpEx]).

LSL STUDY

The Study Team began by collecting and reviewing Commonwealth-held and publicly available data related to LSLs and replacement programs across the Commonwealth. With the understanding of available data, the Study Team prepared an LSL-focused survey, which was sent via email to Virginia community and NTNC waterworks on August 30, 2024. The survey remained open for submittal for a period of two weeks; however, the survey was reopened as needed when certain waterworks were requested to respond. The LSL-focused survey was responded to by 568 waterworks (approximately 36% of active community and NTNC waterworks). To supplement the survey and other publicly available data, the Study Team engaged directly through virtual meetings and follow-up emails with one "Very Large" waterworks, as defined by U.S. EPA system size classifications[2]. This direct engagement was conducted to gain a more detailed understanding of the waterworks' LSL replacement program, including their approach to completing an LSL inventory, cost estimates (e.g., CapEx and OpEx), funding options, and additional compliance activities. The Study Team then contacted multiple waterworks representing all system size classifications ("Very Small" through "Very Large" systems[2]) to inquire about known and anticipated costs for additional lead regulation compliance activities and potential rate increases to fund activities. In addition to engaging waterworks as part of this study, VDH was also in the process of collecting service line inventories which were due nationally to Commonwealth primacy agencies (e.g. VDH) by October 16, 2024.

REPORT OUTLINE

The remainder of this report includes an overview of the PFAS and Lead and Copper NPDWRs, the Study Team's approach to assessing the potential needs and costs related to compliance with PFAS and LCRI regulations, the results of the cost analysis, a review of possible funding and financing models, and identification of federal funding mechanisms that may be available for use by the waterworks.

[2] U.S. EPA classifies water treatment works by population served: *Very Small*: 500 or less people served; *Small*: 501 – 3,300 people served; *Medium*: 3,301 – 10,000 people served; *Large*: 10,001 – 100,000 people served; *Very Large*: Greater than 100,000 people served.

OVERVIEW OF PFAS AND LEAD RULES

This report analyzes the anticipated costs for Virginia waterworks to comply with two critical NPDWRs established by the U.S. EPA: the first ever national drinking water standard for PFAS and the recently finalized LCRI. Both regulations are crucial for protecting Americans from contaminated drinking water and play a significant role in ensuring the health and well-being of citizens in Virginia and nationwide. Below are summary-level details of each regulation as they pertain to Virginia.

PFAS RULE

The U.S. EPA finalized the PFAS drinking water regulation on April 10, 2024, establishing limits for six PFAS in drinking water, which include:

- perfluorooctanoic acid (PFOA)
- perfluorooctanesulfonic acid (PFOS)
- perfluorononanoic acid (PFNA)
- perfluorohexanesulfonic acid (PFHxS)
- hexafluoropropylene oxide dimer acid (HFPO-DA) (also known as GenX Chemicals)
- perfluorobutanesulfonic acid (PFBS)

The regulation sets maximum contaminant levels (MCLs) for the specified PFAS chemicals and mixtures. PFOA, PFOS, PFNA, PFHxS, and HFPO-DA have individual MCLs ranging from 4 parts per trillion (ppt) for PFOA and PFOS to 10 ppt for PFNA, PFHxS, and HFPO-DA. Additionally, mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS are regulated using a unitless Hazard Index MCL. Under the new regulation, all public water systems in the U.S. are mandated to monitor for these substances and start providing the public with information on the level of PFAS in their water supplies by 2027. If levels exceed the set MCLs, public water systems are required by 2029 to have implemented corrective measures and notify the public.

PFAS IN PRIVATE WELLS

The recently established U.S. EPA PFAS rule is primarily focused on regulating waterworks and does not specifically address PFAS contamination in private wells. The Code of Virginia only provides VDH with authority to regulate the location and construction of private wells. It is at the sole discretion of the private well owner to sample the well for constituents such as PFOA and PFAS. Furthermore, testing voluntarily conducted by private well owners is not reported to VDH. As such, the estimated number of private wells impacted by PFOA and PFAS is unknown. Private well owners who want to determine if their well is contaminated by PFAS may face costs associated with both testing and treatment solutions if PFAS contamination is found. While initial testing expenses can vary widely, the costs for installing treatment systems—such as point-of-use (POU) or point-of-entry (POE) filters—can be substantial, depending on the level of contamination and the specific technologies employed.

To assist well owners in assessing and treating PFAS contamination, various resources are available. The U.S. EPA offers training and technical assistance programs designed to help private well owners understand their water quality and navigate testing options effectively. Furthermore, well owners can access EPA-approved laboratories for accurate PFAS testing, ensuring reliable results that inform necessary actions.

Programs like "Well Informed Virginia"[3] provide invaluable tools for interpreting test results and exploring appropriate response options based on individual water quality data. These resources aim to empower well owners to make informed decisions about their water safety, potentially mitigating the health risks associated with PFAS exposure. By leveraging these programs, private well owners can better navigate the complexities of PFAS contamination and treatment, ultimately safeguarding their health and the quality of their water supply.

LEAD REGULATIONS

The Lead and Copper Rule (LCR) is a federal regulation established by the U.S. EPA to protect public health by minimizing the presence of lead and copper contaminants in drinking water. The LCR was first promulgated in 1991 as part of the NPDWR in response to growing evidence of lead contamination in public water systems and the associated health risks. Lead is a toxic metal that can cause a range of health effects, especially in young children, pregnant women, and their unborn children. Lead exposure can result in developmental issues, cognitive impairment, and other serious health problems. Copper, while an essential nutrient in small amounts, can cause gastrointestinal distress and, in high concentrations, liver and kidney damage. The LCR set action levels for these contaminants and requires water systems to take corrective actions when levels exceed these limits.

A water service line is the pipe that carries water from the water main into a home or other building. Ownership of water service lines is typically split, with the waterworks owning the portion from the water main to the property line / water meter, and the customer owning the portion from the property line / water meter to the building. As required under the Lead and Copper Rule Revisions (LCRR), initial service line inventories that include material classification (i.e., lead, galvanized requiring replacement[4] (GRR), non-lead, or lead status unknown) were due nationally to Commonwealth primacy agencies on October 16, 2024.

On October 8, 2024, the U.S. EPA issued the final LCRI which further enhances protections against lead exposure by mandating the replacement of all lead service line (LSLs) under the control of the water system within 10 years. The rule also targets service lines classified as GRR. Additional provisions of the LCRI include lowering action levels from 15 µg/L to 10 µg/L, improving LSL inventories and transparency, implementing enhanced sampling protocols, and increasing outreach and support for systems with multiple action level exceedances (ALEs).

[3] https://www.wellwater.bse.vt.edu/well-informed-virginia.php

[4] U.S. EPA's definition of a Galvanized Requiring Replacement service line is a galvanized service line that currently is or ever was downstream of an LSL or is currently downstream of a service line of unknown material.

OVERVIEW OF APPROACH

To assess the potential needs and costs related to compliance with PFAS and lead regulations, the Study Team began by developing an understanding of the potential scale of the issue to be addressed by Virginia waterworks related to both PFAS and LSLs. This involved using known data already available to VDH, deploying surveys, and engaging directly with waterworks. When data was not directly available from certain waterworks, the Study Team used known data from other Virginia waterworks and public sources to extrapolate the potential need associated with PFAS contamination and LSLs, including approaches such as proximity to certain industries as an indicator of potential PFAS contamination. A cost analysis was then prepared using a combination of costs provided by Virginia waterworks as well as other cost curves and estimates made available by U.S. EPA. Cost estimates include both CapEx and OpEx and are profiled over time as related to PFAS and LCRI compliance dates.

PFAS APPROACH

The Study Team began by reviewing available data on PFAS contamination in drinking water across Virginia, including water quality data from the Fifth Unregulated Contaminant Monitoring Rule (UCMR 5) and samples taken by VDH as part of the *Virginia PFAS in Drinking Water Sample Study* from Phase 1 (2021) through Phase 3 (ongoing). The Study Team reviewed data to identify waterworks that are expected to exceed at least one PFAS MCL, and also engaged directly with six of the largest waterworks by population that are responsible for treating their own water and demonstrated the possibility of PFAS exceedances. The Study Team then deployed a survey to Virginia community and NTNC waterworks inquiring on the possibility of PFAS issues within their source and treated water, the availability of PFAS sampling results, plans for compliance (i.e. treatment upgrades or other operational changes), and estimated cost data (CapEx and OpEx).

Past sampling results, survey, and direct engagement data were then used to assess the number of waterworks that could potentially exceed PFAS MCLs. Where waterworks sampling data was not available, the Study Team estimated the remaining systems that could potentially exceed PFAS MCLs based on various data sources, including proximity of PFAS sampling results, geology, surface water intake points, groundwater wells, and facilities listed in the U.S. EPA's Enforcement and Compliance History Online (ECHO) database classified as known to have contributed or have the potential to contribute to PFAS contamination based on their North American Industry Classification System (NAICS) codes. NAICS codes considered by the Study Team were informed by the Environmental Working Group and the report Presumptive Contamination: A New Approach to PFAS Contamination Based on Likely Sources[5], published in *Environmental Science & Technology Letters*.

Where available, the Study Team used actual data for waterworks that reported their plans associated with specific treatment techniques, operational changes, and associated incurred and expected CapEx and OpEx values. Where systems did not report their intended compliance plans and costs, the Study Team utilized U.S. EPA cost curves across multiple treatment techniques to

[5] Full citation: Salvatore, D, et al. (2022). Presumptive Contamination: A New Approach to PFAS Contamination Based on Likely Sources. Environ. Sci. Technol. Lett. 2022, 9, 11, 983–990.

calculate a range of anticipated CapEx and OpEx values. The cost of additional compliance activities, such as monitoring, was also calculated for waterworks across the Commonwealth.

LSL APPROACH

The Study Team began by deploying a survey to Virginia community and NTNC waterworks inquiring on the number of LSLs, GRRs, and service lines with unknown material contained within their systems. Among other topics, the survey also inquired if systems had existing LSL replacement programs in place and if cost data associated with past service line replacements was available. The survey was used to supplement data that would be received as part of the service line inventories required under the LCRR, which were already due to VDH by October 16, 2024. The Study Team also engaged directly with one "Very Large" system, known to have a significant number of service lines requiring replacement as well as an ongoing LSL replacement program. This direct engagement was conducted to further understand the scale of the waterworks' LSL issue, their plans moving forward, and past and future costs associated with the program. Additionally, the Study Team reached out to 12 waterworks representing all size classifications for cost estimates associated with other compliance activities such as service line inventory development, increased sampling requirements, and providing customers with point-of-use filters.

Survey, inventory, and direct engagement data were used to assess the potential number of lead and galvanized service lines requiring replacement across the Commonwealth. Where service lines of unknown material exist and where data was not reported, the Study Team estimated the additional number of service lines requiring replacement based on the percentage of known service lines requiring replacement, historical ALEs, elevated blood lead levels, and other factors, such as commercial real estate building age data. A full statewide cost estimate was then prepared using known replacement costs for certain waterworks, where available, and the average provided by waterworks. Costs were then profiled over time based on assumptions of how long an LSL replacement program would take based on characteristics of the waterworks, such as population and the number of service lines requiring replacement.

RESULTS

The cost analysis is summarized for PFAS and lead separately, and shown as CapEx, annual treatment OpEx, and other compliance activities OpEx. Costs are broken out by the level of known data that contributed to different cost categories. For example, in certain instances, waterworks provided their own cost estimates, whereas in other situations, costs were estimated using U.S. EPA cost estimating guidance.

PFAS COST RESULTS

Costs related to compliance with the new PFAS regulations are provided in the following cost types:

- **CapEx:** Includes the cost to pilot, design, and implement treatment upgrades and other operational changes related to PFAS compliance. For example, a capital cost for one waterworks may include installing a new granular activated carbon (GAC) treatment system, whereas another waterworks may incur costs related to decommissioning a contaminated groundwater well and drilling a new well.
- **OpEx – Annual Treatment:** Includes the annual cost to operate the new / upgraded systems that were necessary for PFAS compliance. This includes, but is not limited to, categories such as operator labor, maintenance materials, process control monitoring, and replacement of the materials, including GAC reactivation, or disposal of spent media.
- **OpEx – Other Compliance Activities:** Includes the increased cost of water quality monitoring based on the new PFAS requirements. According to the NPDWR, quarterly monitoring is required if any sample is greater than or equal to the trigger levels, which are set at half of the MCLs for each regulated PFAS. Triennial monitoring is required if all samples are less than trigger levels at the entry point to the distribution system. Waterworks that install treatment to control PFAS will remain on quarterly monitoring. In addition, to accommodate the small percentage of systems that might prefer a higher sampling frequency than quarterly, the Study Team hypothesized these systems would likely belong to organizations with larger teams and budgets. As a result, the Study Team allocated additional costs to a small percentage of "Medium" to "Very Large" systems.

PFAS related costs were estimated using the following sources:

- **Waterworks Reported Costs:** The Study Team requested waterworks' cost estimates through the survey deployed to Virginia waterworks and through direct engagement with certain waterworks. This category captures CapEx and OpEx values reported directly by waterworks that expect treatment and/or other capital upgrades are necessary and are generally based on engineering cost estimates.
- **Cost Estimates Using U.S. EPA Cost Guidance:** The U.S. EPA provides CapEx and OpEx cost curves for multiple treatment techniques that have been identified as adequate options for PFAS removal. These include GAC, ion exchange (IX) and reverse osmosis (RO). Additionally, POU filters were evaluated as the treatment technique for any waterworks with a population of under 100 and one service connection. POU is not currently a compliance option, however, it is expected that it could become one in the future for small systems. For all treatment techniques, CapEx is contingent upon design capacity of the system, whereas OpEx is contingent on the annual average daily flow of the system.

The analysis has factored in contingency to the cost estimates. According to the U.S. EPA cost estimates for various techniques, a 10-15% contingency applies.

- **Monitoring:** The Study Team estimated the monitoring costs by working with an accredited laboratory located in Virginia that provides both lead and PFAS sample assessment, who provided the relevant pricing structures. The Study Team then assessed and determined the potential frequency of sampling, considering trigger level and MCL exceedances.

Table 1 below provides an explanation of the data sources that were used to estimate costs associated with different categories.

Table 1: Categories for PFAS Cost Estimation

Confidence	Cost Category	Status of PFAS Contamination	Source of CapEx	Source of OpEx – Annual Treatment	Source of OpEx – Other Compliance Activities
Higher	**Waterworks Estimated Costs for Known PFAS Contamination**	Known contamination per UCMR, VDH, or other waterworks sampling data	All CapEx values provided directly by waterworks	OpEx values provided by waterworks, and supplemented with U.S. EPA cost guidance where necessary	Sample costs were developed based on 2024 standard fee structure for a Virginia based laboratory. Frequency of sampling is based on trigger level and MCL exceedances from known sampling
	Estimated Costs for Known PFAS Contamination	Known contamination per UCMR, VDH, or other waterworks sampling data	Range of CapEx values provided for various treatment techniques using U.S. EPA cost guidance (published in 2022)	Range of OpEx values provided for various treatment techniques using U.S. EPA cost guidance (published in 2022)	
Lower	**Estimated Costs for Possible PFAS Contamination**	PFAS sampling data not available. waterworks with possible PFAS contamination identified through extrapolation using known data sets	Range of CapEx values provided for various treatment techniques using U.S. EPA cost guidance (published in 2022)	Range of OpEx values provided for various treatment techniques using U.S. EPA cost guidance (published in 2022)	Sample costs were developed based on 2024 standard fee structure for a Virginia based laboratory. Frequency of sampling is based on MCL exceedances as it provides the highest potential cost point for monitoring activities

Waterworks reported through the PFAS survey whether they are currently in compliance with the PFAS MCLs (Map 1). In instances where PFAS contamination for a given system was unknown due to a lack of information available from direct engagement, the survey, or historical sampling, an analysis conducted in ArcGIS was completed to extrapolate sites with probable PFAS contamination. Extrapolation was also used for sites in which the system responded to the PFAS survey with “Uncertain” regarding whether they had PFAS contamination. Separate ArcGIS analyses were conducted for surface water and groundwater sites (Map 2 and Map 3). For the surface water analysis, the Study Team relied on the following data sources: VA Department of Environmental Quality (DEQ) surface water PFAS sampling, locations of military or industrial sites with NAICS codes linked to known or potential PFAS contamination as identified by the U.S. EPA, hydrologic unit code (HUC)-10 watershed boundaries, and surface water sites with known MCL exceedances. For the groundwater analysis, the Study Team relied on the following data sources: DEQ surface water PFAS sampling, locations of military or industrial sites with NAICS codes linked to known or potential PFAS contamination as identified by the U.S. EPA, groundwater sites with known MCL exceedances, Karst geology formations, and I-95 corridor location. The Study Team considered the inclusion of well screen interval data as part of the groundwater extrapolation, however, due to a lack of available data this consideration is not currently accounted for in the analysis.

The U.S. EPA estimates the nationwide cost of monitoring, communications, treatment, and operational changes to be $1.5B annually. However, the American Water Works Association (AWWA) commissioned an analysis by Black and Veatch which estimated a national expense to comply with the rule of $2.7B to $3.5B annually. This cost study for the Commonwealth of Virginia utilizes U.S. EPA work breakdown structure (WBS) models for various treatment processes. According to the U.S. EPA, the individual treatment WBS models were subjected to external peer review. This study uses the high-cost equations provided by the U.S. EPA.

The results of the PFAS cost analysis are shown in Table 2 below and are provided in 2024 dollars. The costs were adjusted for inflation to present day (September 2024) values from 2022 using the U.S. Bureau of Statistics Consumer Price Index (CPI). Note that OpEx is an annual value incurred each year, as shown in Figure 1.

Table 2: PFAS Cost Estimates (in 2024 dollars)

Category	CapEx		OpEx			System Size	No. of Systems	Population Associated with Systems
			Annual Treatment		Annual Monitoring			
	Low	High	Low[6]	High[7]				
Waterworks Estimated Costs for Known PFAS Contamination	$490M	$529M	$51M	$43M		Very Small	6	614
						Small	1	2,362
						Medium	-	0
						Large	1	47,574
						Very Large	5	2,170,105
Estimated Costs for Known PFAS Contamination	$123M	$233M	$34M	$25M		Very Small	23	3,169
						Small	3	5,940
						Medium	4	27,016
						Large	1	80,995
						Very Large	1	234,220
Estimated Costs for Possible PFAS Contamination	$30M	$142M	$3M	$4M		Very Small	56	10,237
						Small	11	16,531
						Medium	-	-
						Large	-	-
						Very Large	-	-
Estimated Costs for Other Compliance Activities					$0.7M			
Total	**$643M**	**$904M**	**$88M**	**$72M**	**$0.7M**		**112**	**2,598,763**

CapEx and OpEx above were calculated for each waterworks impacted by PFAS. CapEx was identified for multiple treatment techniques and the treatment technique chosen for each waterworks corresponds to the low and high CapEx values. Treatment assignment for each system was based on the relative CapEx costs across treatment technologies. Treatment type was assigned based on two different scenarios: which treatment for each system delivered the lowest CapEx cost and which treatment delivered the highest CapEx cost. The low and high OpEx for each system was tied to the OpEx associated with the treatment type that delivered the lowest and highest CapEx costs, respectively. For instance, considering a reverse osmosis treatment system and an ion exchange treatment system of the same size, the reverse osmosis system will have a higher CapEx but lower OpEx. As a result, the OpEx associated with the reverse osmosis plant, although lower, would be included in the high OpEx scenario due to its dependance on the higher CapEx reverse osmosis treatment technique. This leads to the dynamic where the high OpEx scenario may actually be less than the low OpEx scenario.

Figure 1 shows a time profile of anticipated CapEx, annual treatment OpEx, and other compliance activities OpEx. CapEx is projected through the compliance date of 2029, whereas annual and other compliance activities OpEx will continue indefinitely but is reflected through 2042 for the purposes of this discussion. The cost values presented in Figure 1 use the expected annual inflation as developed by the Federal Reserve Bank of Cleveland through 2042, which on average is just over 2% annually.

[6] Low OpEx for each waterworks is the OpEx associated with the treatment technique selected as the low CapEx
[7] High OpEx for each waterworks is the OpEx associated with the treatment technique selected as the high CapEx

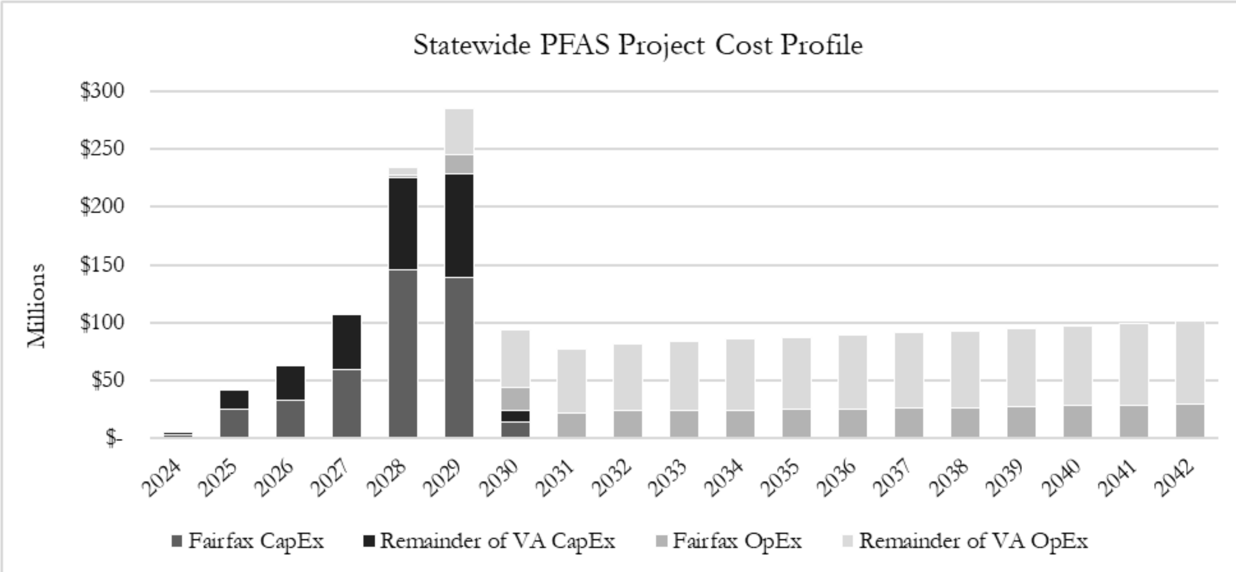


Figure 1: Time Profile of "High" Estimated PFAS Costs

PFAS CASE STUDIES

VERY LARGE WATERWORKS

The EPA defines a "Very Large" waterworks as serving a population of greater than 100,000. As part of the analysis, the Study Team engaged directly with six very large waterworks that had historical PFAS contamination to gather detailed insights on potential treatment options and associated costs. One such waterworks with PFAS contamination in exceedance of the MCLs is planning to implement full-scale treatment utilizing GAC gravity contactors at their treatment plant with PFAS contamination. This investment builds on a Powdered Activated Carbon (PAC) feed system that will also be installed, as the current PAC system is not meeting current needs. Upgrading the PAC in the short-term will help facilitate achieving initial reductions. The total CapEx associated with the proposed treatment options is approximately $389M with an annual OpEx of $20M. The waterworks noted that they are not currently planning on upgrading their other treatment plant that is not currently impacted by PFAS contamination. However, should upgrades to this plant become necessary in the future, total costs could exceed $1B.

As an additional measure, this "Very Large" waterworks has also been actively working to identify potential hotspots or precursors for PFAS contamination in its raw water supply. The waterworks identified industrial, military, and airport sites as known sources and has begun conversations with a nearby industrial user regarding voluntary commitments to treating PFAS in wastewater streams.

MEDIUM WATERWORKS

The EPA defines a "Medium" waterworks as serving a population greater than 3,300 and less than or equal to 10,000. The cost analysis conducted accounts for various considerations for a waterworks that would influence their overall compliance costs. For one example of a "Medium" waterworks with a population of approximately 9,000 supplied by groundwater that registered an MCL exceedance, the cost analysis estimated a present-day low CapEx cost of $4M and annual associated OpEx cost of $0.8M using ion exchange, as well as a high CapEx cost of $7M and annual associated OpEx of $0.6M using reverse osmosis. In addition to CapEx and annual treatment OpEx, this waterworks would also be responsible for quarterly monitoring.

VERY SMALL WATERWORKS

The EPA defines a "Very Small" waterworks serving a population less than 500. The Study Team engaged directly with a company managing multiple waterworks looking to treat PFAS contamination exceeding the MCL at seven of its groundwater wells, six of which serve "Very Small" population sizes (ranging from approximately 30 to 300 people). The proposed treatment approach for these wells cited by the waterworks includes a buffered ion exchange media and exchange tanks. The waterworks plans to have a facility in North Carolina that will empty and refill the ion exchange tanks, minimizing system downtime to a few hours per IX vessel changeout. The overall budget for CapEx treatment for the seven waterworks is $2M, with an associated OpEx of 10% of CapEx per year ($200,000). The IX bed life is estimated to be 4.6 years and it is anticipated that OpEx costs may drop in the future.

LSL AND RELATED COST RESULTS

Costs related to compliance with lead regulations are provided in the following cost types:

- **CapEx:** Includes the overall cost to replace LSLs and GRRs[8].
- **Annual OpEx (Other Compliance Activities):** Includes costs to maintain and update service line inventories, prepare an LSL replacement plan, conduct tap sampling, conduct outreach, and make filters available to customers when necessary.

Lead related costs were estimated using the following sources:

- **Waterworks Estimated Costs:** The Study Team requested waterworks' cost estimates for replacement of partial and full LSLs and GRRs, and also inquired if savings are achieved when LSL replacements are conducted as part of planned work (e.g. a main replacement).
- **Estimated Costs using Virginia waterworks supplied data:** The Study Team evaluated the replacement costs per service line reported by waterworks in the survey and then utilized the average replacement cost for waterworks that did not provide cost data.
- **Other Compliance Costs from Virginia waterworks:** The Study Team requested cost estimates and costs incurred for other compliance activities from twelve waterworks that were identified to have LSL replacement plans in place, receiving information from eight, representing each system size classification. Additional compliance activities could include, but are not limited to, the following: build and maintain an LSL inventory, reimbursements to contractors assisting with pipe identification, creation and maintenance of an LSL replacement plan, public outreach, provisions of Point-of-Use filters, preparation for lower ALEs (15 µg/L to 10 µg/L), and increased sampling frequency.

[8] Overall CapEx costs to replace an LSL or GRR include costs for both the system-owned and customer-owned sides. Waterworks may be restricted from using rate payer funds on private property to replace customer-owned LSLs. Therefore, waterworks will likely pursue other funding streams to pay for or subsidize replacement costs on the customer-side.

Table 3 below provides an explanation of the data sources that were used to estimate costs associated with different categories:

Table 3: Categories for LSL Cost Estimation

<table>
<tr><th>Confidence</th><th>Cost Category</th><th>Status of LSLs and GRRs</th><th>CapEx Source</th><th>Other Compliance Activities Source</th></tr>
<tr><td rowspan="4">Higher
↓
Lower</td><td>Known LSLs and GRRs Reported by waterworks</td><td>Reported to VDH by waterworks via the service line inventory</td><td>Replacement costs per service line provided by specific waterworks, and supplemented with other Virginia waterworks supplied cost data where necessary</td><td rowspan="4">Cost estimates and costs incurred for other compliance activities as reported by certain Virginia waterworks with LSL replacement plans in place, representing each system size classification, were used to estimate costs for other waterworks where data was not available</td></tr>
<tr><td>Potential (but not formally reported) Unknown Service Lines that Could be LSLs or GRRs (based on unknown values reported in service line inventory using EPA methodology to estimate the % of these unknowns that would need to be replaced)</td><td>Represents a likely estimate of service lines, that are of unknown material, but could be lead or GRR based on extrapolating the data from the service line inventory</td><td rowspan="2">Replacement costs per service line provided by specific waterworks, and supplemented with other Virginia waterworks supplied cost data where necessary</td></tr>
<tr><td>Additional Potential (but not formally reported) Unknown Service Lines that Could be LSLs or GRRs (based on upper bound of unknowns reported in the survey)</td><td>Represents a potential upper limit for service lines of unknown material that could be lead and GRRs based on survey response and expectations of the specific waterworks</td></tr>
<tr><td>Unknown Service Lines that Could Potentially be LSLs or GRRs (based on extrapolation from the service line inventory)</td><td>Represents a likely estimate of service lines of unknown material for those waterworks that reported unknowns in the inventory but no LSLs or GRR</td><td>Replacement costs per service line are based on the average of Virginia waterworks supplied cost data</td></tr>
</table>

The Study Team utilized the LSL Survey to understand waterworks with known lead service lines, known lead-free systems, and waterworks where the presence of LSLs required extrapolation (Map 4). For waterworks where extrapolation was required, the Study Team utilized known lead Action Level Exceedances and elevated blood lead levels by county to estimate systems that are likely to have LSLs (Map 5).

The results of the lead cost analysis are shown in Table 4 and are provided in 2024 dollars.

Table 4: LSL CapEx Cost Estimates (in 2024 dollars)

Category	CapEx	
	Low	High
Known LSLs and GRRs Reported by Waterworks	$79M	$79M
Potential (but not formally reported) Unknown Service Lines that Could be LSLs or GRRs (based on unknown values reported in service line inventory using EPA methodology to estimate the % of these unknowns that would need to be replaced)	$199M	$199M
Additional Potential (but not formally reported) Unknown Service Lines that Could be LSLs or GRRs (based on upper bound of unknowns reported in the survey)	-	$379M
Potential LSLs or GRR estimated (assumed to be all full LSLs)	$13M	$13M
Total	**$290M**	**$669M**

Table 5: LSL OpEx Cost Estimates

Category	OpEx (Additional Compliance Activities)	OpEx (Sampling costs)	
		Low	High
Very Small	$0.2M	$0.3M	$0.7M
Small	$0.7M	$0.3M	$0.5M
Medium	$2M	$0.2M	$0.3M
Large	$11M	$0.3M	$0.4M
Very Large	$29M	$0.2M	$0.2M
Total	**$43M**	**$1M**	**$2M**

Table 5 above shows the present day annual OpEx cost estimates for LSL replacement for both sampling and additional compliance activities (inclusive of ongoing LSL inventory updates and public outreach among other activities).

Figure 2 shows a time profile of anticipated CapEx and other compliance activities. CapEx is projected through the LSL replacement compliance date of 2037, whereas certain compliance activities such as tap sampling will continue indefinitely (currently modeled out through 2042). The LCRI requires all LSLs and GRRs to be replaced over a ten-year period beginning in 2027. However, the time profile does not assume that all waterworks will adopt a ten-year replacement schedule. The timing of replacement programs was assumed based on the size of systems and the number of service lines requiring replacement. For example, a replacement program for a "Medium" waterworks with 60 lines requiring replacement may only take five years, assuming that they would gradually ramp up the number of service lines replaced in each year.

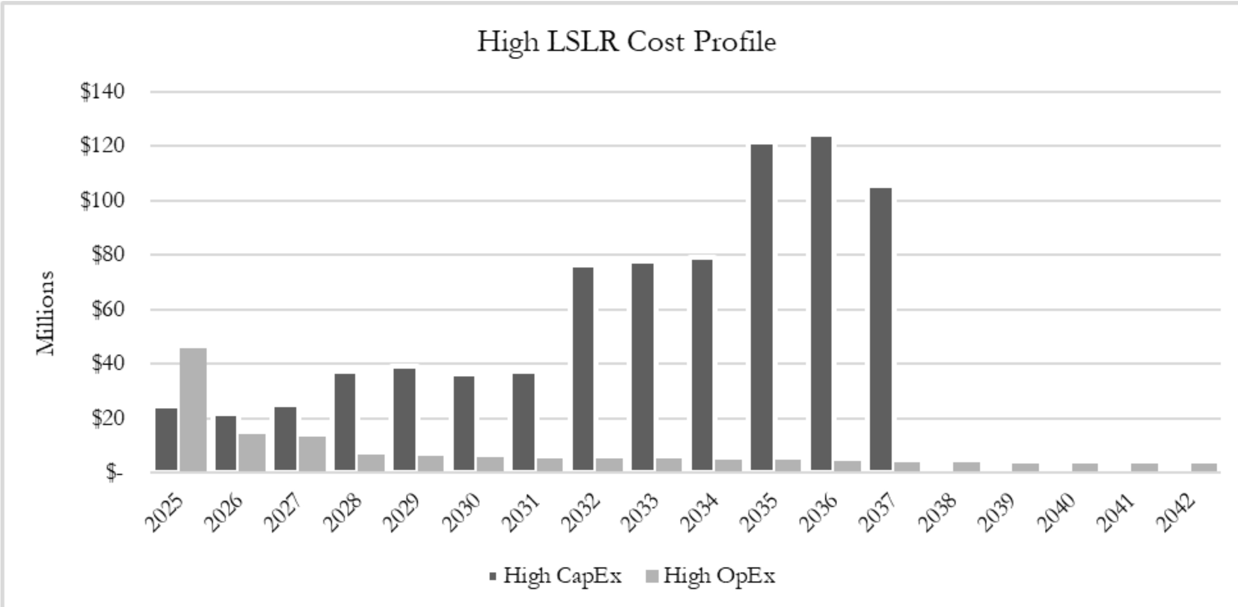


Figure 2: Time Profile of "High" Estimated LSL Costs

For the waterworks representing approximately 99% of inventory reported LSLs and 90% of reported GRR service lines, customer-owned lead and GRR service lines represent 49% of reported lines requiring replacement and an additional 28% require replacement on both the customer-owned and system-owned side. Based on inventory reported values, it is expected that greater than half the CapEx for LSL replacement will be incurred on the customer-owned side. Waterworks will take different approaches to funding on the customer-owned side and may be restricted from using rate payer funds on private property. Therefore, waterworks will likely pursue other funding streams such as the Drinking Water State Revolving Fund (DWSRF) to pay for or subsidize replacement costs on the customer-side.

LSL CASE STUDIES

VERY LARGE WATERWORKS

As part of the analysis, the Study Team engaged directly with a "Very Large" waterworks serving a population of approximately 230,000 that has an existing LSL replacement program in place. Through their LSL inventory provided to VDH, this waterworks identified approximately 1,900 LSLs (the majority of which were system-owned) and approximately 30 GRR. In their inventory, the waterworks reported approximately 67,000 unknown service lines with a total number of service lines of approximately 83,000. As part of the waterwork's LSL replacement program, they are committed to ensuring that 40% of LSL replacement funding is allocated to properties in Justice 40 areas, a process which has included direct outreach to properties to encourage participation in the program.

Based on information provided directly from the waterworks, the analysis assumes that a high estimate of service lines that will need to be replaced is approximately 40,000. The corresponding high CapEx cost associated with LSL replacement is $390M, using LSL replacement costs provided by the waterworks. The analysis assumes that as a "Very Large" system with approximately 40,000 service lines to replace, the waterworks will require until 2037 to replace all service lines. The waterworks also reported anticipated costs of $5.2M related to developing and maintaining a service line inventory, creating an LSL replacement plan, public outreach, and proactive corrosion control treatment testing / pilot testing to be incurred in future years.

MEDIUM WATERWORKS

An example of a "Medium" waterworks from the cost analysis that will require LSL replacement is a waterworks serving a population of approximately 9,500 that reported approximately 41 lead and GRR service lines and 3,400 unknown service lines. The analysis assumes that a high estimate of service lines that will need to be replaced for this waterwork is approximately 216. The corresponding high CapEx cost associated with LSL replacement is $1.9M, calculated using an average per service line replacement cost provided by other Virginia waterworks. The analysis assumes that as a "Medium" waterworks with approximately 216 service lines to replace will require until 2037 to replace all service lines. The corresponding OpEx from 2025 through 2042 associated with additional compliance costs, including continuously updating the LSL inventory and public outreach among other activities, and sampling costs is approximately $0.5M.

VERY SMALL WATERWORKS

An example of a "Very Small" waterworks from the cost analysis that will require LSL replacement is a waterworks serving a population of approximately 500 that reported 9 lead and GRR service lines and around 70 unknown service lines. The analysis assumes that a high estimate of service lines that will need to be replaced for this waterwork is approximately 15. The corresponding high CapEx cost associated with LSL replacement is $0.12M, calculated using an average per service line replacement cost provided by other Virginia waterworks. The analysis assumes that as a "Very Small" waterworks with approximately 15 service lines to replace will require until 2027 to replace all service lines. The corresponding high OpEx from 2025 through 2042 associated with additional compliance costs, including continuously updating the LSL inventory and public outreach among other activities, and sampling costs is approximately $0.02M.

TOTAL PFAS AND LSL COST RESULTS

In order to estimate the total potential expenditure across the Commonwealth in response to the PFAS and lead regulations the Study Team combined the totals for PFAS and LSL CapEx and OpEx results into a single stream, as shown in Table 6 and Figure 3 below.

Table 1: Total Commonwealth CapEx and OpEx Through 2042

Year	CapEx		OpEx[9]	
	Low	High	Low	High
2024	$20M	$33M	$ -	$ -
2025	$53M	$80M	$45M	$46M
2026	$77M	$117M	$14M	$15M
2027	$125M	$193M	$14M	$14M
2028	$243M	$351M	$17M	$16M
2029	$244M	$356M	$76M	$63M
2030	$40M	$72M	$93M	$75M
2031	$32M	$76M	$103M	$83M
2032	$32M	$78M	$109M	$87M
2033	$33M	$79M	$111M	$89M
2034	$51M	$122M	$113M	$90M
2035	$52M	$124M	$115M	$92M
2036	$44M	$106M	$117M	$94M
2037	$ -	$ -	$119M	$95M
2038	$ -	$ -	$121M	$97M
2039	$ -	$ -	$123M	$98M
2040	$ -	$ -	$126M	$101M
2041	$ -	$ -	$129M	$103M
2042	$ -	$ -	$131M	$105M
Total	**$1.05B**	**$1.8B**	**$1.7B**	**$1.4B**

[9] For the PFAS costs feeding into Table 6, CapEx and OpEx were calculated for each waterworks impacted by PFAS. CapEx was identified for multiple treatment techniques and the treatment technique chosen for each waterworks corresponds to the low and high CapEx values. Treatment assignment for each system was based on the relative CapEx costs across treatment technologies. Treatment type was assigned based on two different scenarios: which treatment for each system delivered the lowest CapEx cost and which treatment delivered the highest CapEx cost. The low and high OpEx for each system was tied to the OpEx associated with the treatment type that delivered the lowest and highest CapEx costs, respectively. This approach to arriving at OpEx values explains why the “Low” OpEx value in Table 6. Table 6 may result in a higher value than the “High” OpEx value.

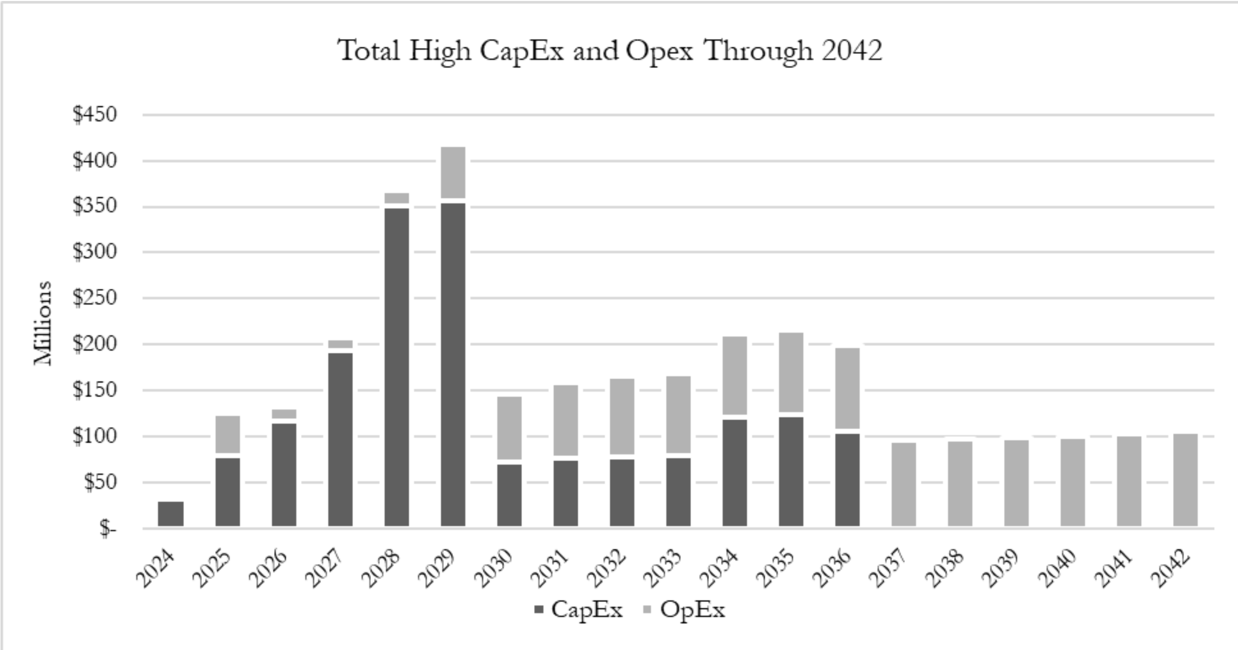


Figure 3: Time Profile of Total "High" CapEx and OpEx (Lead and PFAS)

FUNDING AND FINANCING

Considering the overall CapEx cost range of $1.1B and $1.8B that is estimated to achieve statewide compliance for PFAS and lead NPDWRs, the Study Team considered potential funding and financing opportunities that could be pursued in order to decrease the financial burden on the waterworks and limit the extent of rate increases that would be passed onto the customers, especially for smaller waterworks.

To deliver these capital projects and provide the ongoing operations and maintenance required, most waterworks are expected to utilize a funding model comprised of a combination of low interest loans through programs such as the Virginia DWSRF, state and federal grants when available, bonds obtained through the Virginia Resources Authority (VRA), rate increases, and in certain circumstances, funds from litigation claims. Waterworks will take different approaches to distributing the costs across their customer base. For example, considering that the waterworks and the customer each have responsibility and ultimate ownership over a portion of a water service line, one “Very Large” waterworks reported they have been paying a maximum value of up to $6,000 to replace the LSLs on the private (customer-owned) side using funds from a VDH funding package. Customers are then responsible for paying any remaining balance beyond $6,000 for the customer-side LSL replacement. The amount of funding provided to customers from the waterworks for customer-side LSL replacements will vary from system to system, and certain waterworks may operate in areas that restrict the use of ratepayer funds to pay for customer-side replacements.

Limited details regarding Virginia waterworks’ specific funding and financing plans for PFAS and lead compliance were received during the direct engagement portion of the study. Additionally, publicly available Capital Improvement Plans (CIPs) for the largest 15 waterworks by population were reviewed for relevant funding and financing details. In order to supplement existing plans and suggest options, the Study Team reviewed and compiled details of federal grant and other funding programs that could be utilized by waterworks throughout the Commonwealth to support both PFAS and lead compliance projects.

In addition to federal programs, the Virginia DWSRF program provides technical and financial assistance to waterworks using set-asides and construction project funds. The Virginia DWSRF is administered by VDH and the VRA through two programs that focus on funds for construction and funds for non-construction uses. Waterworks can apply to financial and construction assistant programs (FCAP) to receive financial support to replace aging infrastructure and critical assets, correct public health issues to ensure regulatory compliance, and for new construction and replacement projects. Waterworks can apply to the capacity development program for support to enhance the long-term production safe drinking water, or to provide program administration, direct technical assistance, and other support.

FEDERAL FUNDING OPPORTUNITIES

Funding opportunities at the federal level are primarily driven by the following:

- The Bipartisan Infrastructure Law (BIL) delivers over $50B to the U.S. EPA to improve the nation's drinking water infrastructure (among other infrastructure)
- Additional federal funding support is available through a variety of programs. One such program is committed to investing $500M (including funds from the BIL) through the U.S. EPA to provide technical assistance to help communities invest in water infrastructure to close America's water equity gap. This program intersects with additional opportunities provided through the U.S. Department of Agriculture, the U.S. Department of Housing and Urban Development, and the U.S. EPA.
- The DWSRF, through the U.S. EPA, is a financial assistance program to support states and water systems in achieving the health protection objectives of the Safe Drinking Water Act (SDWA).

Table 7 shows estimated DWSRF and BIL funding received and projected by the Commonwealth of Virginia. Many programs, such as the DWSRF and the Clean Water State Revolving Fund (CWSRF), are ongoing with annual disbursements from the federal government. Although VDH can award available funding to applicant waterworks for PFAS and lead-related projects, the programs are not solely for PFAS or lead. For example, the General Supplemental portion of the DWSRF can be used for many other types of water infrastructure improvements.

Table 7: Estimated DWSRF and BIL Funding

Virginia	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
DWSRF Supplemental	$29,357,000	$29,732,000	$31,767,300	$34,566,150	$34,566,150
Lead Service Lines	$46,256,000	$48,717,000	$48,717,000	$48,717,000	$48,717,000
Emerging Contaminants	$12,327,000	$10,789,000	$10,789,000	$10,789,000	$10,789,000
Emerging Contaminants in Small or Disadvantaged Communities Grant	$27,239,000[10]		$13,519,000	TBD	TBD
Total	**$101,559,500**	**$102,857,500**	**$104,792,300**	**$94,072,150**	**$94,072,150**

As shown in Table 7, the Commonwealth of Virginia will receive DWSRF and BIL funding of approximately $94M to $105M annually between FY22 and FY26, with the stipulation that DWSRF Supplemental funding can also be deployed on other drinking water system improvements beyond PFAS and lead. Virginia's federal allotments specifically for LSLs and

[10] The totals reported for FY 2022 and 2023 each account for half of the combined FY 2022 and 2023 award for Emerging Contaminants in Small or Disadvantaged Communities Grant

emerging contaminants is around $73M annually (assuming that Virginia receives similar allotments in FY 2025 and 2026 for the Emerging Contaminants in Small or Disadvantaged Communities Grant). These funding amounts are consistently less than estimated annual CapEx required (as shown in Table 6), which exceed $350M in certain years.

Table 8: Funding for lead and PFAS projects applied for and awarded from 2022 through 2025 [11]

Year	Lead			PFAS		
	Project Count	Applied For	Received	Project Count	Applied For	Received
2022	50	$46,047,135.00	$45,922,135.00	3	$12,327,000.00	$12,327,000.00
2023	52	$48,045,134.57	$48,045,134.57	3	$10,789,000.00	$10,789,000.00
2024[12]	5	$9,871,122.00	$9,871,122.00	2	$33,478,824.00[13]	$10,789,000.00
2025	0 YTD	0 YTD	N/A	3	$10,789,000.00	$10,789,000.00

Table 8 shows the amount of LSL and PFAS funding applied for and received by Virginia waterworks from 2022 through 2025. Notably in some years, the amount of funding applied for has exceeded the amount of funding available to receive.

FINANCING THROUGH MUNICIPAL BONDS

Municipal bonds are debt securities issued by local government entities such as states, municipalities, or counties to raise funds for public projects, which may include upgrades to drinking water treatment and distribution systems. By purchasing the bonds, investors are lending money to the issuer which is repaid over time with taxes or the project's specific revenue streams, such as water service charges. After assessing infrastructure needs and gaining approval from local authorities, the public entity issues the bonds to raise required funds, which are then deployed on drinking water system upgrades. Municipal bonds offer waterworks with long-term financing, making costly infrastructure projects more manageable by spreading the expense over many years. By leveraging municipal bonds, waterworks can secure the funds needed for critical infrastructure improvements while managing the financial impact on their budgets and customers.

In July 2024, Fairfax Water raised $60M in municipal bond sales for infrastructure renewal projects. Between the high bid and winning bid, Fairfax Water's cost of debt service decreased by $3.2M, which demonstrates the strong financial outcomes that can result from competing banks bidding on bonds. Fairfax Water's AAA credit rating by all three major rating agencies would have contributed to the attractiveness of the municipal bond for the bidders. However, not all waterworks in Virginia will have high credit ratings and therefore may not achieve as competitive of an interest rate as Fairfax was able to attain.

[11] Excludes funding received through the Emerging Contaminants in Small or Disadvantaged Communities Grant.
[12] VDH reported that an additional $671,865.50 will be awarded to waterworks to replace LSLs found during the LSL inventory process as part of 2023 funding received from the U.S. EPA.
[13] The needs in 2024 are greater than what the application may indicate. In this case, this is a result of a waterworks choosing to take the principal forgiveness and not loan funding.

The City of Newport News has raised project funding through the issuance of Water Revenue Bonds. Currently, there are two relevant distribution system improvement projects being funded through these bonds, including the Lead Services Gooseneck Removal Program and the Neighborhood Pipeline/Lead Services Removal projects.

VRA also raises bonds through Virginia's DWSRF, the proceeds of which are then provided as loans to waterworks and local governments to fund drinking water projects. Therefore, Virginia waterworks that are interested in bonds but do not have strong credit ratings themselves can benefit from the Commonwealth's current ratings by applying for loans through the DWSRF.

FINANCING THROUGH BLUE BONDS

Blue Bonds are a versatile tool to finance sustainable water projects. By committing to a sustainability objective and appealing to likeminded investors, borrowers may broaden their access to new capital providers, secure greater funding from existing relationships, and/or realize a lower cost of capital. Although Blue Bonds can be used to finance programs that support vibrant marine ecosystems and biodiversity (including through more sustainable fishing, shipping, and tourism industries), they can also be used to support investments in cleaner and more efficient drinking and wastewater infrastructure, either through new investments or through the rehabilitations of existing assets (i.e., removing lead from municipal water systems).

Investors expect Blue Bond issuers to align their program with industry leading Blue Bond frameworks and best practices. These are typically grounded in the International Capital Markets Association's Green Bond Principles (ICMA GBP). Sustainable water and wastewater management is its own category and guidance issued by the ICMA and International Finance Corporation provides additional clarity on the types of projects which may be financed or refinanced using Blue Bond proceeds.

The VRA supports community investments by providing financing solutions and assistance to localities in connection with their public projects. While the VRA does not currently offer Blue Bonds, pursuing Blue Bonds in the future could offer a funding avenue that could potentially support the efforts of multiple waterworks to achieve compliance with PFAS and lead regulations.

FUNDING WITH LITIGATION PROCEEDS

Recent nationwide settlements are currently an additional mechanism for waterworks to receive funding to perform PFAS compliance activities from corporations who have been identified as contributors to widespread PFAS contamination. The largest drinking water contamination settlement in U.S. history was reached in March 2024 when 3M Company agreed to pay up to $12.5B in a class action settlement with public water systems. In February 2024, The Chemours Company, DuPont de Nemours, Inc., and Corteva, Inc. agreed to pay $1.185B to public water systems. The funds from these settlements will pay public water systems that have already detected PFAS in their water, pay for the costs of testing for those that have not yet tested, and will provide funds to those that identify PFAS as a result of testing.

Through the Study Team's direct engagement with select waterworks, it is understood that waterworks in the Commonwealth are actively pursuing claims through these settlements to receive funding to address PFAS exceedances; however, the funds that waterworks have received do not cover the entire CapEx required for improvements, and cover OpEx for a limited duration of time. One waterworks reported receiving $6M through the 3M settlement to cover improvements to their GAC system and OpEx at one treatment plant, and submitted a Special Needs[14] additional application for $10.5M, for which it is awaiting further details. Another waterworks is expecting to receive $3-4M through the 3M settlement and approximately $1M through the DuPont settlement, noting that the anticipated funds (which have not been finalized) are not sufficient to avoid the need for rate increases to cover the costs for necessary treatment upgrades and OpEx. Funds allocated through these settlements are determined through the consideration of different factors such as the volume of contaminated water, the degree of contamination, flow rates, and proxies for CapEx and OpEx.

In addition to corporate litigation settlements, funding opportunities may arise through the U.S. Department of Defense (DOD). During the Study Team's direct engagement with Virginia waterworks, one waterworks reported their consideration to apply for the Defense Community Infrastructure Project grant offered through the U.S. DOD, noting that these grants typically have small application windows with project design requirements that may present challenges to applicants' abilities to meet the application timing requirements.

The Study Team recognizes that applying for funds through settled class action litigation requires several resources that may not be readily available to or reasonably expected from all waterworks. To apply to receive funds, waterworks staff must first be aware of the litigation, its key deadlines, and have an understanding of how and if their system may be impacted. At a minimum, this requires an understanding of complex legal text that may warrant professional legal assistance to determine applicability. Time and staffing resources are needed to identify and collect relevant supporting documentation and sampling data, and sufficient funds are required to support these efforts and those that may be required as follow-up. Many small and medium waterworks did not have the necessary PFAS sample results to support application for class action funding. It is likely that due to their larger departments, budgets, and staffing resources, larger waterworks will have a greater capacity to investigate funding opportunities through litigation. For the same reasons, smaller waterworks are expected to experience challenges in having the appropriate resource capacity to apply for these funds.

USING RATE INCREASES TO FUND PFAS AND LEAD COMPLIANCE PROJECTS

Regardless of the size of a waterworks, if it lacks adequate capacity to secure funding support (i.e., through federal grants or class action litigation), a portion of the costs needed by the waterworks for PFAS and lead compliance is expected to be passed on to customers through rate increases. Through direct engagement with a number of waterworks, it is understood that anticipated rate increases vary throughout the Commonwealth and many waterworks are still working to understand what may be required. Overall, larger waterworks will be more adaptable to using rate increases to cover costs because of larger customer bases, while smaller waterworks will be more likely to increase rates given the high CapEx and OpEx costs.

[14] Special Needs Funds are established and considered by the Claims Administrator for certain settlement class members that have expended monetary resources on extraordinary efforts to address PFAS contamination in their impacted water sources. Phase One Special Needs Claims Forms were due on August 26, 2024. Phase Two Special Needs Claims Forms are due on August 1, 2026.

One "Very Large" waterworks is taking a phased approach to rate increases, projecting a retail rate increase of 5% in 2025, followed by an increase of at least 9% per year for the years 2026-2028, and an increase of 6% for the years beyond 2028 (2029-2034) to finance a full-scale water treatment plant upgrade for PFAS. Another "Very Large" waterworks reported an expected rate increase of a minimum of 1.5% for every $10M of capital expenditures over the next 13 years, which is intended to cover increased spending needed to meet the requirements of the lead regulations. One "Medium" waterworks is anticipating a 3% annual rate increase over the next five years, totaling 15%, intended to cover water plant upgrades for emerging contaminants and LSL replacements. Another "Medium" waterworks reported applying a 24% increase beginning in 2024 to account for increased spending needed to meet the requirements of the lead regulations. For some waterworks, rate increases are not expected to be necessary to fund PFAS and lead compliance efforts, as reported by one "Very Large" waterworks that has identified both PFAS exceedances and LSLs and will therefore need to implement measures to achieve compliance with PFAS and lead regulations.

ADDITIONAL CONSIDERATIONS

There are several other factors that should be considered which may influence a waterworks' approach to PFAS compliance.

- **Unanticipated costs:** Finding the right treatment method may take various pilot studies and rounds of treatment adjustments that could lead to unintended costs not originally budgeted for. For example, in October 2024 in Grafton, Massachusetts, efforts by the Grafton Water District to treat for PFAS to comply with the U.S. EPA regulations resulted in dissolved iron and manganese in the water system, turning customers' water brown. In response, the system is planning to construct new treatment facilities for iron and manganese, in conjunction with their efforts to address PFAS contamination. The system is limiting the use of impacted wells and offering a quarterly bottled water rebate of $60 to certain customers.

- **Collaboration with sources of PFAS contamination:** As the science behind PFAS improves with time, the relationship between waterworks and other users or off takers will become an important nexus for solutions to track, mitigate, and treat PFAS contamination. For example, some waterworks are actively working to identify potential hotspots or sources of PFAS contamination such as military bases and industrial facilities, all in an effort to evaluate and monitor any changes in their source water. Rather than just monitoring, waterworks will benefit from more direct collaboration with the relevant parties. These relationships can provide opportunities to work with upstream parties to reduce PFAS and subsequently reduce the treatment needed for downstream PFAS treatment by the waterworks. In addition, by working together, the waterworks and other users can leverage their combined influence to advocate for funding support and resources for PFAS remediation efforts or enhanced oversight of contamination sources, ultimately leading to less PFAS contamination in a waterworks' source water.

- **Workforce:** As evidenced by the findings in this study, to meet the U.S. EPA's contamination thresholds for PFAS, waterworks will have to update or build new facilities to treat PFAS contamination. These upgrades will have trickle-down effects, including the training of operators for PFAS treatment facilities. In the Commonwealth, a Class 4 License is the minimum requirement for operating a facility equipped with PFAS-capable treatment technologies such as activated carbon contactors, ion exchange, and membranes. Consequently, operators of impacted systems, with Class 5 and 6 licenses, will need to acquire additional skills and obtain new licenses to operate the upgraded waterworks. This will primarily impact groundwater systems, which are typically classified as Class 5 or 6. Based on 2024 data, this could potentially impact up to 21% of operators[15]. While this represents the maximum potential impact, as not all systems will require upgrades to meet PFAS requirements, it does indicate the available pool of operators who would require upskilling with a minimal learning curve to implement the upgrades in the affected

[15] Represents the total possible Class 5-6 operators that may need upskilling and examination for increased licensure to a minimum of Class 4 per the Office of Drinking Water's 2024, Commonwealth of Virginia, Annual Operator Certification Report

waterworks. Considering the ongoing struggle with low licensure pass rates across all Classes, this potential skills gap is a concern and the Commonwealth should consider providing increased support for operators of PFAS-impacted waterworks, as well as those interested in obtaining at least a Class 4 license.

- **Technology advancements and regulatory changes:** The measurement of PFAS levels in drinking water presents challenges due to current method limitations. For waterworks that employ PFAS treatment, PFAS testing must be completed by a laboratory set up to specifically test PFAS to the levels specified in the PFAS Rule. Currently, PFAS testing turnaround time is 2 to 4 weeks from sample receipt at the laboratory. Most waterworks will not have the capacity to set up their own PFAS laboratory or conduct their own PFAS testing. Further, there is no commercially available PFAS test or surrogate test that could be employed for process control testing, which is necessary to measure the ongoing performance of a PFAS treatment system. The consequence is that waterworks that employ PFAS treatment will be dependent on an outside laboratory to conduct both compliance testing and process. Further, process control test results are available 2 to 4 weeks after the sample is collected, which means that waterworks operators will need to anticipate the need to make process changes, such as media replacement, and will not have real-time feedback on the treatment process. In the future, the laboratory industry anticipates implementing shortcut methods for PFAS analysis that could cut the turnaround time from weeks to a few days, dependent upon laboratory capacity. It is imperative for waterworks to stay informed about technological developments in PFAS detection and treatment to anticipate and prepare for potential future stricter standards, ensuring that current plants are future-proofed against evolving regulatory requirements.

- **Consolidation/Regionalization:** Some waterworks with PFAS contamination may conclude that the costs required to upgrade their treatment plants, add new treatment plants, or find new, uncontaminated water sources are too high. A waterworks in this scenario may consider the consolidation or regionalization of its system with another nearby waterworks. This scenario usually involves a smaller waterworks joining or connecting to a larger waterworks with more technical, managerial, and financial capacity. Benefits to the smaller waterworks consolidation/regionalization may include enhanced drinking water quality, more equitable rate structures, and proactive compliance with drinking water regulations, with greater access to administrative support for necessary activities such as funding applications, community outreach, and administrative reporting. Municipalities and waterworks must consider the tradeoffs to consolidation/ regionalization as disadvantages and barriers may include loss of local control and impacts to municipal taxes and financing, geography and the distance between systems, reluctance to take on deteriorated systems, and infrastructure and bureaucratic transition challenges.

APPENDIX A – VA ACTS OF THE ASSEMBLY – 2024 SESSION BUDGET AMENDMENT HB30 ITEM 280 #1C

VIRGINIA STATE BUDGET

2024 Session

Budget Amendments - HB30 (Conference Report)

Bill Order » Item 280 #1c

Cost Analysis of PFAS and Copper EPA Rules

Item 280 #1c	First Year - FY2025	Second Year - FY2026	
Health and Human Resources			
Department of Health	$500,000	$0	GF

Language

Page 314, line 36, strike "$138,936,004" and insert "$139,436,004".

Page 315, after line 15, insert:
"G. Out of this appropriation, $500,000 the first year from the general fund shall be provided for the Virginia Department of Health to conduct a cost analysis of implementing pending federal Per- and Polyfluorinated Substances (PFAS) regulations for Virginia local water systems and to implement pending federal Environmental Protection Agency Copper Rules for water system lead service lines. The report shall include the results of the cost analysis, possible funding models, and identify federal funding that may be available. The department shall submit the report to the Chairs of the House Appropriations and Senate Finance and Appropriations Committees by December 1, 2024."

Explanation

(This amendment directs the Department of Health to conduct a cost analysis of implementing pending federal Per- and Polyfluorinated Substances (PFAS) regulations for Virginia local water systems and directs the Virginia Department of Health to conduct an analysis of the cost to Virginia localities that will be incurred to implement pending Environmental Protection Agency Copper Rules for water system lead service lines. The report must include a cost analysis, possible funding models, and identify federal funding that may be available.)

APPENDIX B – ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ALE	Action Level Exceedance
AWWA	American Water Works Association
BIL	Bipartisan Infrastructure Law
CapEx	Capital Expenditures
CIP	Capital Improvement Plan
CPI	Consumer Price Index
CWSRF	Clean Water State Revolving Fund
DEQ	Department of Environmental Quality
DOD	Department of Defense
DWSRF	Drinking Water State Revolving Fund
ECHO	Enforcement and Compliance History Online
FY	Fiscal Year
GAC	Granular Activated Carbon
GBP	Green Bond Principles
GenX	HFPO-DA
GRR	Galvanized Requiring Replacement
HFPO-DA	Hexafluoropropylene oxide dimer acid
HUC	Hydrologic Unit Code
ICMA	International Capital Markets Association
IX	Ion Exchange
LCR	Lead and Copper Rule
LCRR	Lead and Copper Rule Revisions
LCRI	Lead and Copper Rule Improvements
LSL	Lead Service Lines
MCL	Maximum Contaminant Levels
NAICS	North American Industry Classification System
NPDWR	National Primary Drinking Water Regulations
NTNC	Non-Transient Non-Community
OpEx	Operational Expenditures
PAC	Powdered Activated Carbon
PFAS	Per- and polyfluoroalkyl substances
PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
POE	Point-of-Entry

POU	Point-of-Use
ppt	Parts per trillion
PWS	Public Water System
RO	Reverse Osmosis
SDWA	Safe Drinking Water Act
U.S. EPA	United States Environmental Protection Agency
UCMR	Unregulated Contaminant Monitoring Rule
VDH	Virginia Department of Health
VRA	Virginia Resources Authority
WBS	Work Breakdown Structure
μg/L	Microgram per Liter

APPENDIX C – ASSUMPTIONS

To ensure the accuracy, completeness, and consistency of this report, certain assumptions were used to guide the analysis and findings of the Study Team. These assumptions are based on publicly available data, information collected by the Virginia Department of Health, and the Study Team's expertise in the subject matter. It is important to note that these assumptions might not reflect the exact reality in every case, as the specific circumstances and context can vary. However, they provide a foundation for this analysis and enable the Study Team to present meaningful insights. These assumptions are subject to change and should be reassessed as new information becomes available. Detailed assumptions regarding data cleaning and cost calculations have been provided and are held by the Virginia Department of Health. With these considerations in mind, the Study Team presents the following assumptions that informed the findings.

1. The Virginia Department of Health has leveraged available historical PFAS sampling results that it has access to inform the findings of this report. This includes the collection of Phase 3 sampling results currently ongoing by the Virginia Department of Health, as of October 25th, 2024.

2. Historical PFAS sampling results were acquired from other state agencies, such as DEQ.

3. The findings and recommendations discussed are based on the final NPDWR released on April 10, 2024.

4. Public water system (PWS) participation in PFAS and LCR surveys is voluntary and the Study Team will use data to the extent it is available and deemed suitable. Survey data will only be utilized if demonstrated to be statistically valid; the sample size of respondents from both the PFAS and lead surveys was identified to be statistically significant. The Study Team used best judgment to refine survey data where necessary and documented updates internally.

5. The treatment techniques identified and discussed herein are for cost estimating purposes only and do not constitute a treatment recommendation for any specific PWS.

6. All survey respondents provided honest and accurate responses.

7. Data collected to support this report accurately represents the larger population in terms of relevant characteristics, such as demographics, behavior, or preferences.

8. External factors, such as regulatory and market trends, will remain relatively consistent during the forecasted period.

9. The EPA cost curves leveraged as part of this analysis are accurate and reasonable for the study period.

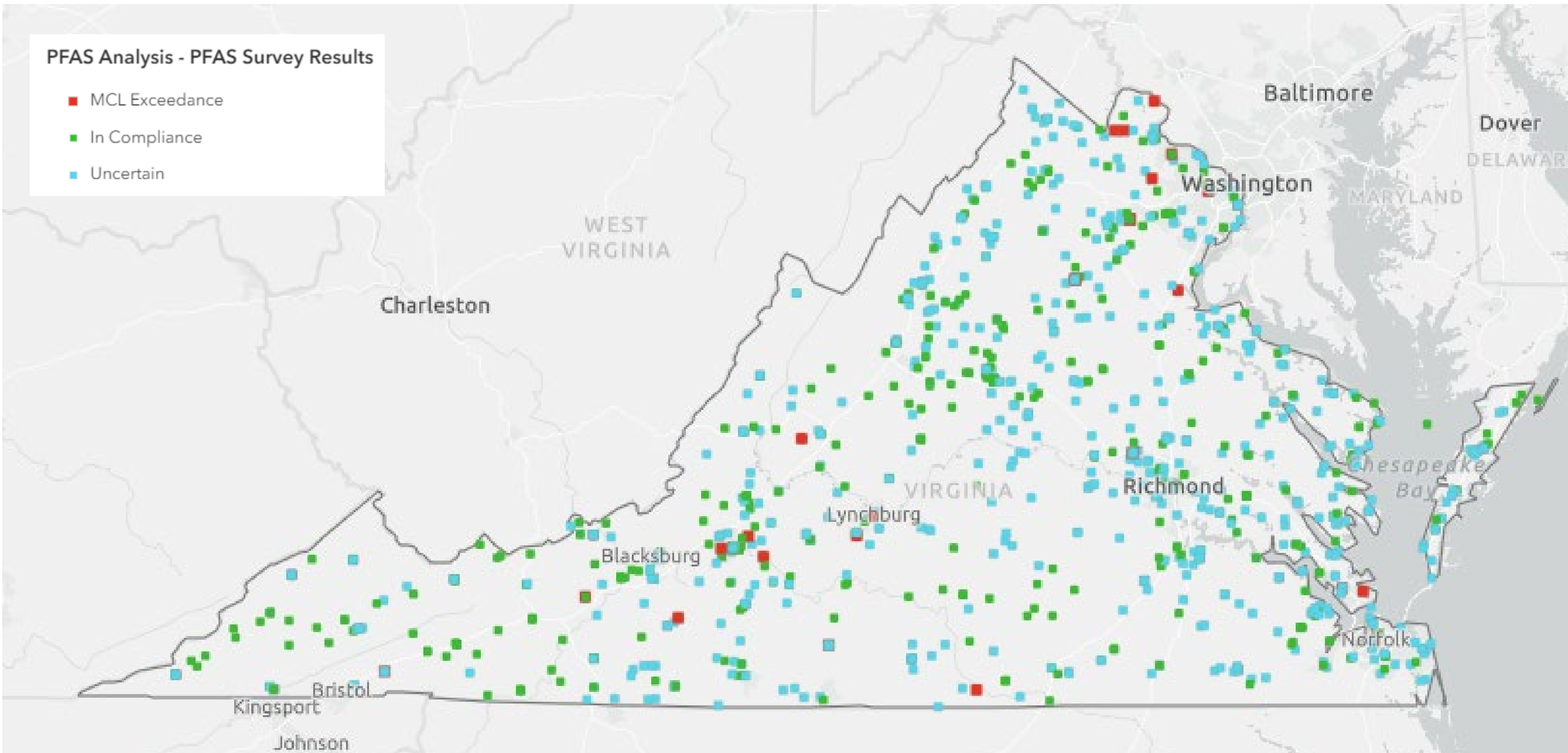
10. Whenever possible, the Study Team has leveraged the cost data provided by waterworks in lieu of estimated values.

11. When not provided by the waterworks directly, the Study Team used best judgment to extrapolate values based on trends observed with other data points collected.

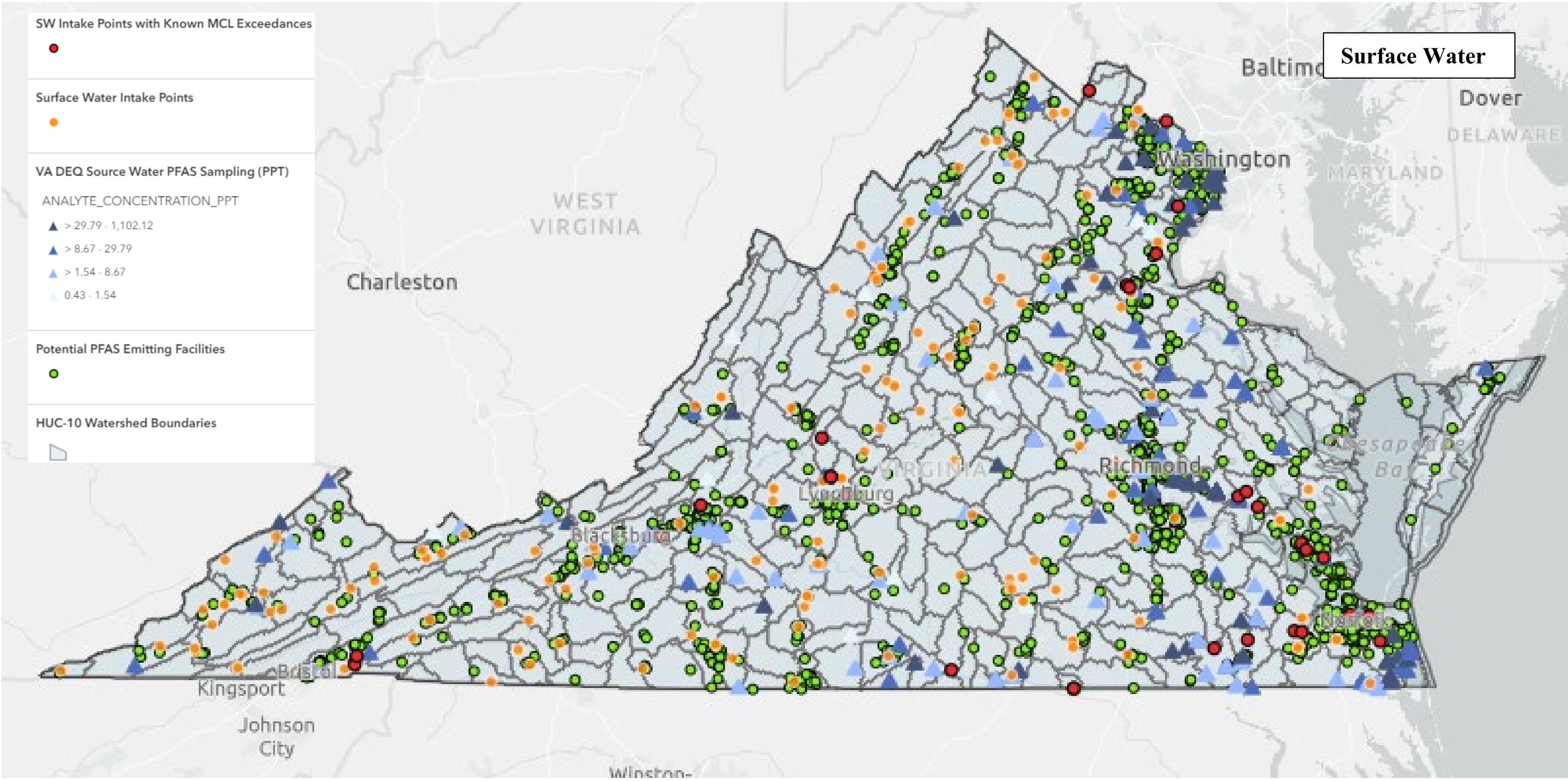
12. Approximately 18% of the population of Virginia uses private water sources and as such, the suggested treatment options for PFAS contamination do not apply to that segment of the population.

APPENDIX D – MAPS

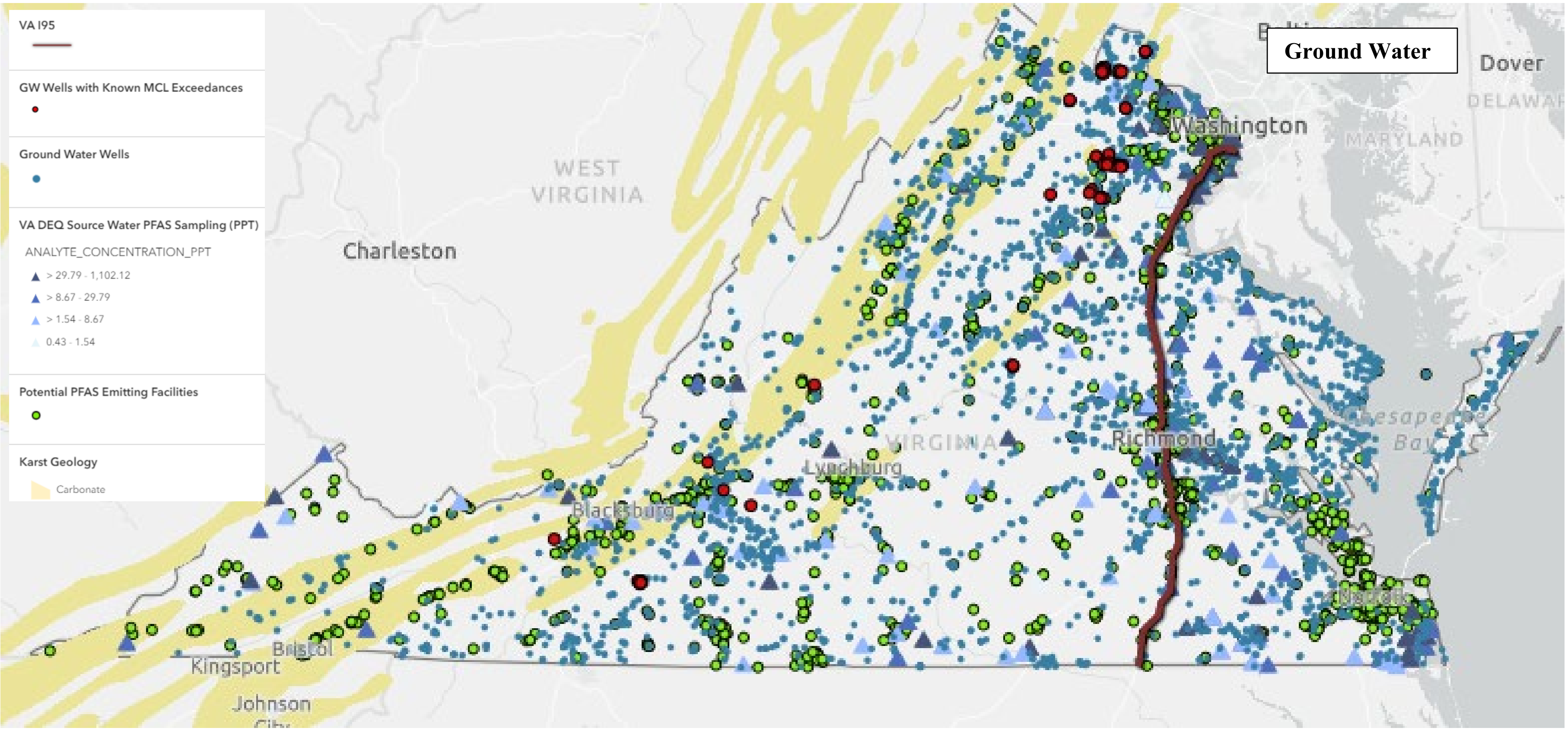
Map 1: Waterworks with reported PFAS MCL exceedances ("MCL Exceedance"), PFAS MCL compliance ("In Compliance"), and waterworks that reported through the survey that they were uncertain on the status of PFAS compliance or where additional extrapolation was needed ("Uncertain").



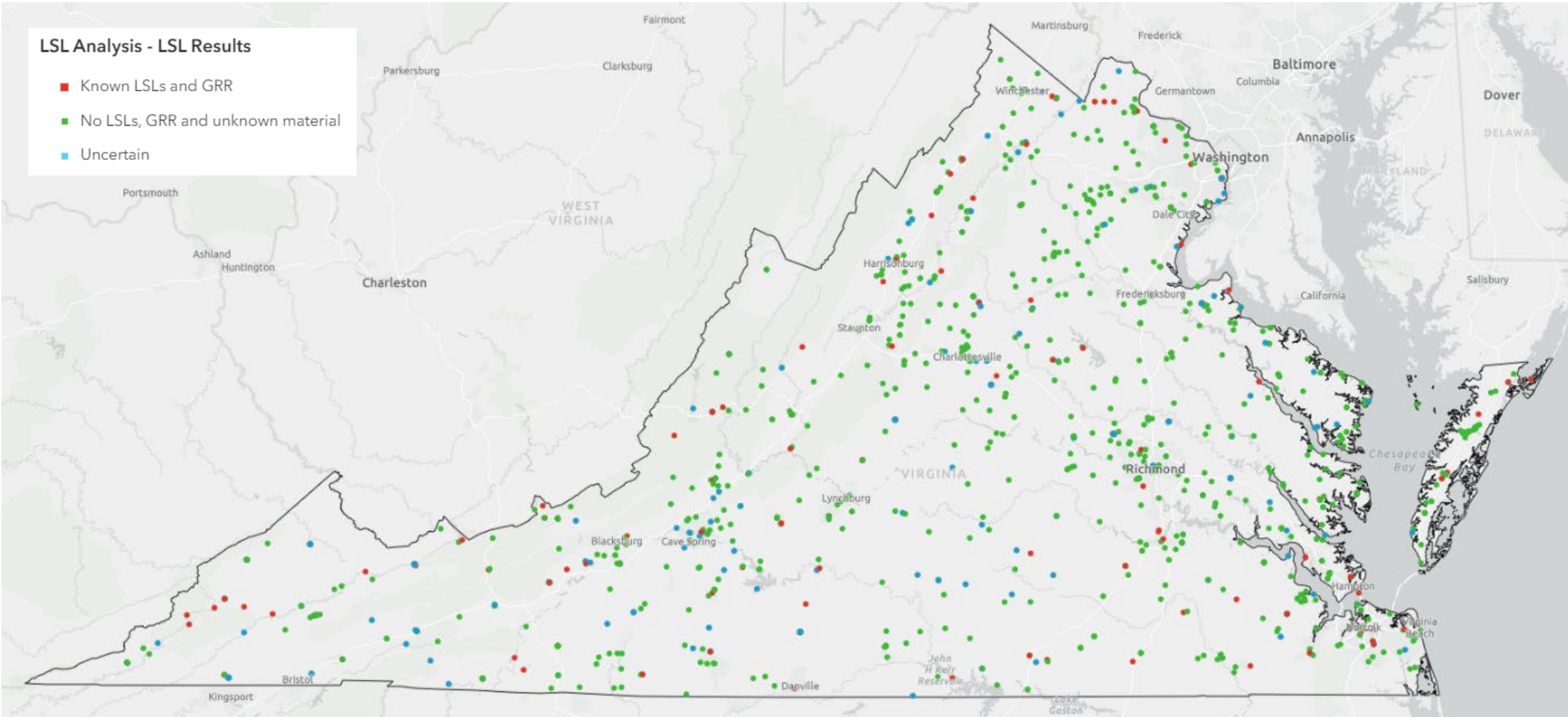
Map 2: Considering potential PFAS MCL exceedances for waterworks without sampling data by including proximity PFAS sampling results, geology, surface water intake points, groundwater wells, and facilities classified by the U.S. EPA as known to have contributed or have the potential to contribute to PFAS contamination.



Map 3: Considering potential PFAS MCL exceedances for waterworks without sampling data by including proximity PFAS sampling results, geology, surface water intake points, groundwater wells, and facilities classified by the U.S. EPA as known to have contributed or have the potential to contribute to PFAS contamination.



Map 4: Waterworks with known lead service lines ("Known LSLs and GRR"), waterworks that have no LSLs, GRRs and unknown material services ("No LSLs, GRR and unknown material"), and waterworks that require lead service line extrapolation exercise to estimate the potential presence of LSLs ("Uncertain").



Map 5: Using the comparison of waterworks with known lead 90th percentiles above the lead Action Level of 15 ppb and the future Action level of 10 ppb to blood lead count by county to extrapolate systems that are likely to have LSLs.