

Appendix A: Technical Evaluation of the Denver Water Lead Reduction Program Plan

The Safe Drinking Water Act (SDWA) Section 1415(a)(3) gives the United States Environmental Protection Agency (EPA) the authority to issue a variance from a treatment technique requirement upon showing that an alternative is “at least as efficient in lowering the level of the contaminant with respect to which such requirement was prescribed [in this case, optimal corrosion control treatment (OCCT)].” In March 2018, the Colorado Department of Public Health and Environment (CDPHE) designated orthophosphate as the optimal corrosion control treatment for Denver Water in accordance with the requirements of the Lead and Copper Rule (LCR), the effective rule at the time. In 2019, Denver Water requested a variance in lieu of implementing orthophosphate treatment and proposed that its Lead Reduction Program Plan (LRPP) is at least as efficient at lowering tap lead levels as orthophosphate. EPA issued an initial three-year variance effective January 1, 2020, to allow Denver Water to demonstrate that the LRPP meets the variance criteria based on its initial few years of implementation. CDPHE issued a modification order on November 15, 2019, that incorporated by reference, EPA’s variance approval. Now in 2022, Denver Water is requesting a variance from the OCCT definition at 40 C.F.R. § 141.2 as that term is used in Section 141.82(e) of the Lead and Copper Rule Revisions (LCRR). This is not a variance from any of the LCRR requirements that apply after an exceedance of the trigger level or the action level based on compliance tap sampling conducted under Section 141.86 of the LCRR, or from any other provisions of the LCRR.

Denver Water has demonstrated that the LRPP is “at least as efficient” in lowering lead levels as compared to the LCRR requirement for optimal corrosion control treatment, which CDPHE had determined to be orthophosphate treatment under its March 2018 designation. This Appendix describes EPA’s considerations in its evaluation of Denver Water’s variance request and EPA’s basis for issuance. EPA’s analysis was based off the September 2019 version of the LRPP as well as all information that Denver Water has reported to EPA under the 2019 variance. Denver Water will update the LRPP to align with the LCRR and the requirements of the 2022 variance; those changes are not expected to impact EPA’s analysis.

Why is the Denver Water variance at least as efficient in lowering lead levels as the LCR and LCRR?

EPA has considered performance of Denver Water’s LRPP comprehensively from January 1, 2020, through June 30, 2022, in making the determination that it is at least as efficient in lowering lead levels as compared to the optimal corrosion control treatment technique requirement. OCCT is defined as “the corrosion control treatment that minimizes the lead and copper concentrations at users’ taps while ensuring that the treatment does not cause the water system to violate any national primary drinking water regulations.” 40 C.F.R. Section 141.2. Consideration of other factors such as cost and watershed impacts, including nutrient levels, are not explicitly mentioned in the OCCT definition. In the January 15, 2021, *Federal Register* notice for the LCRR, EPA reiterated its interpretation of the definition of “OCCT” and whether

impacts of the designated OCCT on wastewater can be used to require a water system to install the less than optimal CCT. 86 Fed. Reg. 4198, 4210 (Jan. 15, 2021) and 56 FR at 26487.¹ In its March 2018 OCCT designation letter, CDPHE states that while acknowledging the impacts of orthophosphate on receiving waters and wastewater utilities, orthophosphate was identified as OCCT to protect public health and to minimize lead concentrations at all consumer's taps while ensuring that the treatment does not cause the water system to violate any provision of the Colorado Primary Drinking Water Regulations, consistent with 5 CCR 1002-11.26 (Colorado Lead and Copper Rule).

The "at least as efficient" language in the SDWA means that, on a system-specific basis, the alternative to be required under the variance is equally effective in achieving the public health protection objective of the rule while addressing system-specific issues. EPA evaluates this statutory standard in light of the objectives achieved as a whole under the LCRR (both prior to and after the compliance date of October 16, 2024) and variance combined, not just considering the component of the rule which is the subject of the variance (i.e., the definition of OCCT).

Denver Water's LRPP includes:

1. Development and maintenance of a Lead Service Line (LSL) Inventory.
2. Distribution of drinking water filters certified for lead removal to homes with LSLs and to certain homes with lead solder.
3. Conducting a Lead Service Line Replacement (LSLR) program that will fully replace all LSLs within 15 years at a cumulative average rate of 7 percent of the lead service lines each year.
4. Operating and maintaining pH and alkalinity adjustment corrosion control treatment (CCT).
5. Implementing communication, outreach, and education actions.

Lead Service Line Inventory

The LCRR requires all systems to develop an initial inventory by October 16, 2024, to identify the materials of service lines. The system must review certain information to develop the inventory, and must categorize service lines as lead, galvanized requiring replacement (GRR), non-lead, or lead status unknown. Systems must update the inventory annually and make it publicly accessible and available online.

Denver Water has expanded upon the materials evaluation previously conducted and undertaken a targeted investigative effort to more precisely determine the locations of all LSLs in its distribution system. Denver Water's inventory assigns each site with a service line of unknown material a probability being a LSL. This probability is based on known construction practices, historical records, and data interpretation. This approach has informed the LSLR program as well as the filter distribution program, which provides a water filter to all homes served by a confirmed or likely LSL or GRR.

Under the variance, Denver Water will annually investigate a cumulative average of 1.4% of the total lead status unknown service lines. In combination with the lead service line replacement efforts described below, by the variance end date Denver Water will have no remaining lead, galvanized requiring replacement, or lead status unknown service lines. These investigations go beyond the requirements of the LCRR.

In the first two and a half years of implementation, Denver Water completed an initial LSL inventory and investigated 9,082 unknown service lines to determine the material type, exceeding the minimum requirement of 1,168 investigations calculated as 1.4% per year.

Denver Water will also be required to meet the inventory requirements of the LCRR by October 16, 2024.

Lead Service Line Replacement Program

Removing the source of lead is an effective way of reducing lead in drinking water, and LSLs are the largest contributor of lead in drinking water. Under the LCR, large water systems are required to conduct LSLR after exceeding the lead action level and are required to replace the system-owned LSLs. In addition, under the LCR, public water systems (PWSs) can cease LSL replacement once the 90th percentile tap lead levels are below the action level in two consecutive rounds of monitoring. Under the LCRR, beginning October 2024, large water systems are required to conduct goal-based LSLR at a rate approved by the state after exceeding the lead trigger level, and are required to fully replace 3% of LSLs per year based on a two year rolling average after exceeding the lead action level.

Denver Water's most recent 90th percentile lead level in the first half of 2022 was 3.9 ppb, and 90th percentile lead levels have been consistently below 5 ppb since CCT treatment reached equilibrium. Denver Water is not currently exceeding the lead action level and thus is not required to replace LSLs under the LCR at this time. Denver Water is also not exceeding the lead trigger level that will be effective in October 2024 under the LCRR so at this time is not expected to be required to conduct triggered LSLR under LCRR.

Given the benefits of LSLR, EPA supports Denver Water's proactive removal of LSLs from its distribution system. Denver Water has been implementing a plan to fully replace all LSLs from its distribution system, currently estimated at 64,000 LSLs, over a timeframe of 15 years, and at a cumulative average rate of 7% per year. Denver Water conducts the replacements at no direct cost to the individual customer. Costs of the replacement program are recuperated through water rates paid by all customers, as well as loans, grants, donations, and a commitment of \$22.5 million in funding from the Metro Wastewater Reclamation District. These efforts are expected to substantially reduce lead levels in drinking water within 15 years.

In the first two and a half years of implementation, Denver Water replaced 12,381 LSLs, exceeding the minimum requirement of 8,954 LSLRs calculated as 7% per year.

pH and Alkalinity Adjustment Corrosion Control Treatment

Both the LCR and the LCRR require water systems to install and operate OCCT, which as described above CDPHE designated as orthophosphate treatment for Denver Water. Under the initial three-year variance effective January 1, 2020, Denver Water began enhanced pH corrosion control treatment on March 3, 2020. On June 9, 2021, CDPHE established a pH range of 8.6 to 9.0 and a minimum alkalinity of 20 mg/L as CaCO₃, at the entry points to the distribution system and a pH range of 8.5 to 9.1 and a minimum alkalinity of 20 mg/L as CaCO₃ in the distribution system.

Actual 90th percentile lead levels achieved through pH and alkalinity corrosion control treatment are a critical component to the overall success of the LRPP in meeting the “at least as efficient as” standard. Beginning in March 2020, Denver Water increased pH with the goal of consistently achieving a pH of 8.8. CDPHE established the OWQP ranges of 8.6 to 9.0 at entry points and 8.5 to 9.1 in the distribution systems, and alkalinity to be at or above 20 mg/L as CaCO₃. Denver Water’s pH rarely varies more than 0.1 from their pH goal of 8.8 at the entry points and in the distribution system. Denver Water is well above the 20 mg/L alkalinity OWQP. Since that time, lead levels have decreased both at homes with LSLs and at homes with copper pipes and lead solder. As shown in Figure 1, from 2019 to the end of 2021, lead levels were reduced by 60%. From the most recent semiannual report received from Denver Water, the overall 90th percentile lead level for the first half of 2022 was 3.9 ppb, respectively. At properties with LSLs, the 90th percentile lead level was 4.0 ppb and at properties with copper plumbing and lead solder the 90th percentile lead level was 1.2 ppb for this same compliance period. Table 1 shows 90th percentile lead levels once pH and alkalinity treatment stabilized in the distribution system in 2021 and 2022.

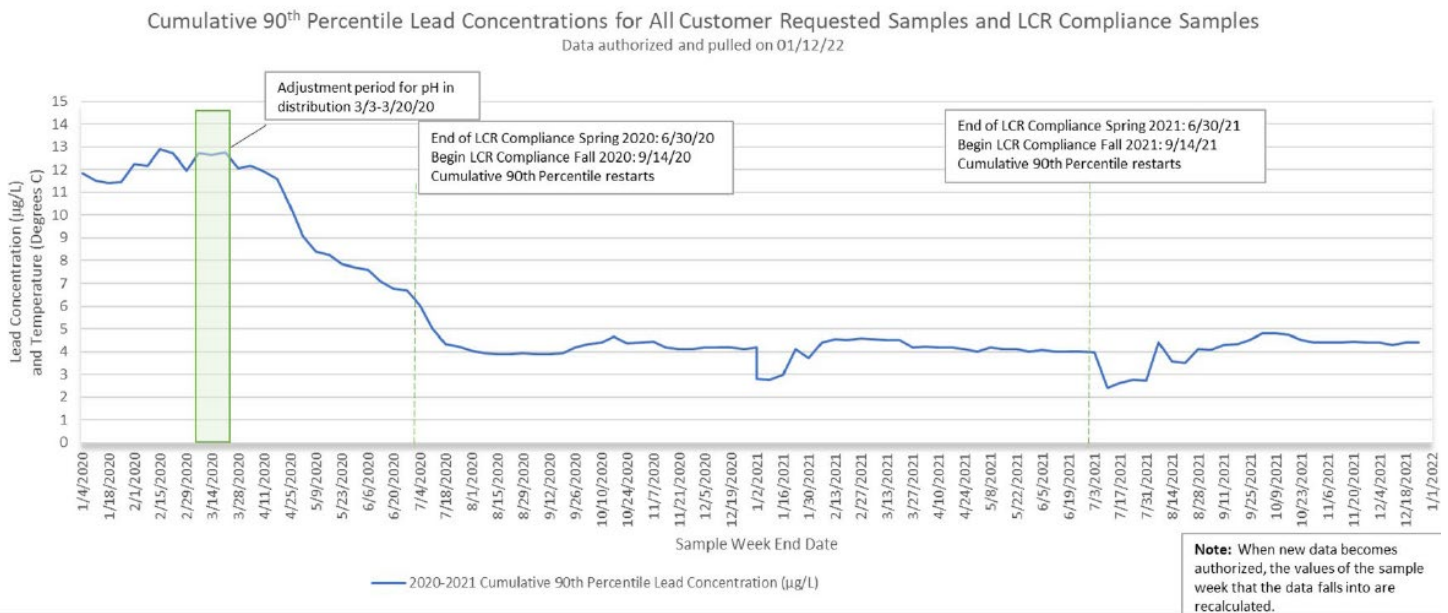
Beginning October 2024, the LCRR requires that all compliance sites be LSL sites. Current lead data for Denver Water shows that the 90th percentile lead levels will increase slightly when calculated solely for LSL sites but are still expected to be below the action level. For the most recent compliance period, this increase was 4.4 ppb to 4.5 ppb lead when 90th percentile lead levels are calculated solely for LSL sites.

Although lead concentrations at sites served by a LSL are expected to be reduced with pH and alkalinity adjustment CCT, they are expected to be higher than sites without a LSL. To account for this difference, Denver Water’s plan includes a provision to distribute filters certified to remove lead to all homes with a confirmed or likely LSL or GRR (see next section) until the service line is removed under the variance.

For homes without LSLs, including homes with other potential sources of lead (e.g., lead solder), performance of pH and alkalinity adjustment is also important since these homes are not provided a filter and do not benefit from a LSLR under the LRPP. Denver Water’s sampling data demonstrates that lead levels have been reduced under the LRPP at these sites as well. The most recent data from fall 2021 shows the 90th percentile lead level for sites with copper plumbing and lead solder was 2.3 ppb (Denver Water December Monthly Report). In 2019, Denver Water conducted a lead coupon study to evaluate the effectiveness of different corrosion inhibitors for copper plumbing with lead solder. Based on that study, the lead levels from copper plumbing with lead solder after treatment with orthophosphate were estimated to range between 2.2 to 2.3 ppb (Denver Water’s Lead Reduction Program Plan, September 2019). Denver Water has demonstrated that pH and alkalinity treatment has achieved equivalent lead reductions as orthophosphate for these sites.

Under the LCRR, a large system such as Denver is required to conduct another CCT study and re-optimize CCT following a trigger level or action level exceedance. This variance does not alter those requirements in the event of a trigger level exceedance or action level exceedance. This variance is from the definition of OCCT as the term is used in 40 C.F.R. Section 141.82(e) and as it relates to CDPHE’s March 2018 orthophosphate designation as OCCT for Denver Water. Based on the present conditions (90th percentile sampling that does not exceed either the trigger level or the action level); all other requirements of the LCRR apply.

Figure 1: Cumulative 90th Percentile Lead Concentrations



Source: Denver Water’s 2021 Annual Variance Report to EPA, Page 14.

Table 1: Denver Water’s 90th Percentile Lead Levels

	Spring 2021	Fall 2021	Spring 2022
Overall 90 th percentile lead Level	4.1 ppb	4.4 ppb	3.9 ppb
90 th percentile lead level for LSL sites	4.1 ppb	4.5 ppb	4.0 ppb
90 th percentile lead level for copper plumbing and lead solder sites	3.4 ppb	2.3 ppb	1.2 ppb

Source: Denver Water’s Monthly and Semiannual Reports to EPA.

Filter Distribution Program

Until all LSLs are replaced, Denver Water provides water filters certified to remove lead to all homes with confirmed and likely LSLs and GRR. Under the LRPP, customers are provided filters until either the service line is confirmed to be non-lead or six months after the lead service line is replaced. Customers that properly use filters should experience decreased lead exposure when using the filter for drinking and cooking purposes, as compared to the absence of a filter. Denver Water tested the performance of multiple filters NSF/ANSI (53)-certified for lead removal and distributed a filter model that meets the NSF/ANSI certification requirements.

In the first two years of implementation, Denver Water distributed filters and provided replacement cartridges on an ongoing basis to over 100,000 people with confirmed and likely lead service lines, achieving an increasing customer filter adoption rate for drinking, cooking, and infant formula of 80%, 81%, and 83% for 2020, 2021, 2022, respectively.

Denver Water performed field testing of filters in use by customers enrolled in Denver Water’s filter program (who are also enrolled in Denver Water’s compliance tap sampling program) at the same frequency as compliance tap sampling. At least fifty filter performance samples have been conducted each six-month period. Over the first two and a half years of the variance, 218 of 269 filter field tests (81%) were below the lead detection limit of 1 ppb. Most of the samples above 1 ppb are between 1 ppb and 2 ppb. The 90th percentile lead level of filter samples was less than 2 ppb. When any filter has not performed sufficiently, Denver Water has replaced the filter in the household immediately and has done additional testing of the filters in its laboratory. Actual lead reductions achieved by the filters are integral to Denver Water’s modeled demonstration that the LRPP is “at least as efficient as” orthophosphate OCCT in reducing lead levels.

Filters are not required under the current LCR. Under the LCRR, beginning in 2024 systems must provide a filter and replacement cartridges to customers for 6 months following a LSLR. The LCRR also identifies galvanized service lines requiring replacement (GRRs). Under the variance, Denver Water will now also provide filters to homes with GRRs.

Communication, Education, and Outreach Program

The efficacy of the filter program to reduce lead exposure is contingent on customers' willingness to adopt filters and ability to use filters correctly. Denver Water's LRPP includes a campaign to ensure all customers with a confirmed or likely LSL or GRR are informed about the filter program. Denver Water's goal is 100% filter adoption. Under the variance, Denver Water documented that it has provided public education materials on the proper use of filters (including filter cartridge replacement) to at least 95% of households enrolled in the filter program.

Communications channels may include "door-to-door" communications, a customer tracking system, how-to videos, and local opportunities to engage residents. Through a biannual survey sent to customers, Denver Water has demonstrated the percent of customers properly using their filter to ensure the communication program is effective in shaping customer behavior to adopt filters and use them correctly. Based on survey responses, overall filter use for drinking is 94%, cooking is 71%, and combined use for drinking and cooking averaged 81% over the two years of LRPP implementation. The percent of customers that properly use the filters for drinking, cooking, and, if applicable, mixing infant formula, each year is a critical component to the overall success of the LRPP in meeting the "at least as efficient as" standard.

The variance also contains public notice requirements that are triggered should Denver Water fail to meet various metrics, including the accelerated lead service line replacement and filter compliance metrics. For example, Denver Water must provide public notice within 30 days to all customers enrolled in the filter program should Denver Water fail to meet the LSL metric. Additionally, public notice requirements are triggered should Denver Water fail to meet the filter compliance metric which includes the requirement to: complete a customer survey to assess filter adoption and use; test filter performance and usage in the field; make direct contact with lead outreach and education materials to at least 95% of all customers enrolled in the filter program every year.

The LCR has public education and outreach requirements that are triggered should there be an action level exceedance. The LCRR has additional outreach requirements for all systems. These regulatory requirements are unchanged by the variance.

Evaluation of Comprehensive Actions of the Lead Reduction Program Plan

Based on the information provided by Denver Water, EPA believes that the combined actions under the LRRP implemented over the last two and a half years under the variance have been at least as efficient as the orthophosphate OCCT. EPA believes that the lead levels from compliance and customer requested samples following implementation of pH and alkalinity adjustment provide a component of the best available information on which to judge whether the LRPP has been at least as efficient. Denver Water's tap samples show that the corrosion control treatment under the variance has further reduced tap lead levels compared to lead levels in 2019 and prior and, coupled with the use of filters and removal of LSLs, have provided equivalent or greater lead reductions than installation of orthophosphate OCCT alone.

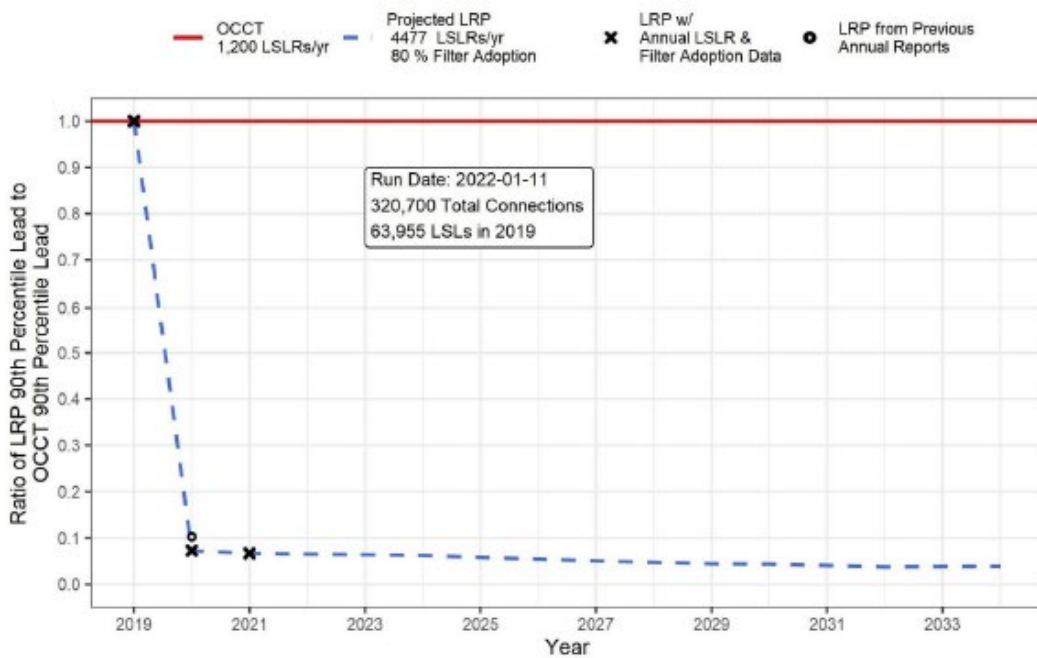
As described above, Denver Water's inventory predictive model will establish the universe for the LSLR program as well as the filter distribution program, which provides a water filter to all homes served by a confirmed or likely LSL or GRR. EPA reviewed the historical records and judgments that form the basis of the inventory predictive model and found them to be reasonable. As part of the variance requirements, Denver Water must continue to update the LSL inventory, investigating an average of 1.4% of the total estimated number of lead status unknown service lines in the inventory each year. Denver Water has found that a cumulative average minimum investigative rate of 1.4% of the total estimated number of unknown service lines each Program Year is adequate for these purposes as a statistically representative sample to verify and support the assumptions made to build the inventory. EPA expects that Denver Water's inventory will improve over time as targeted service line investigations and LSLR inform the logic-based predictive model and reduce the number of service lines of unknown material. By the variance end date, Denver Water must have no remaining sites in the lead, GRR, or lead status unknown categories, as defined in Paragraph 1 of the Order. By the variance end date Denver Water must have replaced all LSLs and GRRs and determined, by direct investigation or statistical inference in accordance with its predictive inventory model, that no remaining service lines are unknown.

Denver Water also developed an equivalency model to compare lead exposure from drinking water to all Denver Water customers resulting from using orthophosphate as OCCT and the variance alternative of implementing the LRPP. The model estimated lead concentrations using data from compliance and customer requested sampling and the lead service line pipe rack study, actual 90th percentile lead levels and LSL and copper with lead solder sites, and actual filter adoption and filter performance rates each year to predict lead concentrations at all connections in the Denver Water service area every year. EPA reviewed the inputs, assumptions, and statistical methodology that Denver Water used for its exposure model. Overall, EPA concludes this is a reasonable methodology to use to evaluate the LRPP system-wide.

As shown in Figure 2, the LRPP has achieved greater lead reductions than orthophosphate treatment in years 1 and 2 of variance implementation and is expected to continue to achieve greater lead reductions, assuming Denver Water continues to meet the terms of the variance including: 7% of LSLs are removed annually, filters are widely used and remove lead, and Denver Water continues to operate pH and alkalinity CCT within the allowable ranges.

EPA has found that, if continued to be implemented effectively, the variance is expected to continue to assure at least equal efficiency in lowering drinking water lead exposure as orthophosphate OCCT. The variance requires minimum metrics are met each year and that information is reported to EPA to assure the LRPP continues to be effectively implemented, resulting in at least as efficient reductions in drinking water lead exposure as orthophosphate. This includes, but is not limited to, ensuring LSLs are replaced on schedule, pH and alkalinity adjustment is maintained as CCT and achieves additional lead reductions, filters are widely adopted and used in accordance with manufacturer instructions, and filters reduce lead levels.

Figure 2: Actual and Projected Lead Concentrations (90th Percentile) Comparing Orthophosphate to Denver Water’s Proposed Variance Approach



(Source: Denver Water’s 2021 Annual Variance Report to EPA, Page 26.)

Based on the first two years of data, EPA confirms that the LRPP is effective, and the variance conditions have been met and is therefore approving the variance for an additional twelve years to allow for completion of the LRPP.

How does the LRPP compare to the Lead and Copper Rule and Lead and Copper Rule Revisions?

Table 2 compares the LCRR requirements in effect until October 16, 2024 (or the LCR), and Denver Water’s variance to demonstrate how the LRPP contains within it several components of the LCR, such as LSLR and CCT. Note that EPA determined efficiency under the SDWA Section 1415(a)(3) standard by evaluating the combined effect that the various components of the LRPP would have in reducing lead as compared to orthophosphate (as described above), rather than by comparing each component of the LRPP with the entire LCR.

Table 2: Summary of the Comparison of pre-2024 Lead and Copper Rule (LCR as incorporated into the LCRR) to Denver Water’s Variance

Element	LCR	Equivalence Comparison
Lead Service Line Inventory	All systems subject to the LCR OCCT requirements were required to create a materials evaluation of their distribution system. The LCR does not require a comprehensive inventory.	Denver Water will continue its program to locate LSLs and update the inventory to be used in the LSL replacement program. Denver Water will complete investigations so that no lead, GRR, or lead status unknown service lines remain in the inventory by the variance end date.
Filters	The LCR does not require water systems to provide filters to homes with LSLs or GRRs.	Denver Water will continue to provide pitcher filters to all homes with LSLs or GRRs until 6 months after the service line is replaced or until the service line is confirmed to be non-lead. Pitcher filters, if used appropriately for drinking and cooking and perform effectively, are predicted to reduce lead levels at homes with LSLs or GRRs.
Lead Service Line Replacement (LSLR)	Conduct 7% LSLR per year after lead action level exceedance, allowing for partial LSLR and test-outs. Discontinue LSLR after two consecutive 6-month monitoring periods below the lead action level.	Variance as proposed will continue to reduce the number of LSLs over the period of the variance, removing the major source of lead in the distribution system. Under the LCR, Denver Water is not required to conduct any LSLRs as it owns no portion of the LSLs within its system.
Corrosion Control Treatment (CCT)	Water systems serving greater than 50,000 persons must install and maintain OCCT.	Denver Water’s variance is from the definition of OCCT in 40 C.F.R. Section 141.2 as that term is used in 40 C.F.R Section 141.82(e) and as it relates to CDPHE’s March 2018 designation of OCCT as orthophosphate treatment. It therefore does not meet LCR requirements to install and maintain OCCT. Instead, Denver Water operates pH and alkalinity adjustment as CCT. Over the first two years of implementation, Denver Water has consistently achieved 90 th percentile tap lead levels below 5 ppb, which is significantly lower than the LCR action level of 15 ppb following the sampling site criteria and protocol in the LCR.
Tap Sampling	Collect samples twice a year at Tier 1 sites.	Equivalent. All tap sampling requirements under LCR will be met.
Water Quality Parameters set by the primacy agency	Meet all LCR requirements for monitoring and compliance.	Equivalent (but WQPs are set for pH and alkalinity adjustment as CCT instead of orthophosphate).
Find and Fix	Not required	Denver Water follows an elevated lead response plan to follow-up on any individual site with elevated lead levels.
LSL-related Outreach	Water systems must offer to replace customer-owned portions of LSLs when conducting LSLR and must provide notice and offer testing to customers if conducting partial LSLRs.	Denver Water conducts outreach to all customers in the filter program regarding proper use and maintenance of the filter, offers to replace full LSLs at no cost to the customer, offers free lead testing at any time, and conducts lead testing following LSLRs.

Table 3 compares the LCRR requirements which have a compliance date of October 16, 2024, with Denver Water’s variance to demonstrate how the LRPP contains within it several components within the updated LCRR, such as an inventory, LSLR, and CCT. Similar to the comparison table above, EPA determined efficiency under the SDWA Section 1415(a)(3) standard by evaluating the combined effect that the various components of the LRPP would have in reducing lead as compared to orthophosphate (as described above), rather than by comparing each component of the LRPP with the entire LCRR.

Table 3: Summary of the Comparison Lead and Copper Rule (LCRR) requirements effective October 16, 2024, to Denver Water’s Variance

Element	LCRR beginning October 16, 2024	Equivalence Comparison
Lead Service Line Inventory	Systems must develop an LSL inventory by the compliance deadline by using specific terms and source of information, make it publicly available online, update it annually, and notify persons served by LSLs, GRRs, and unknown lines within 30 days of completion of the initial inventory and repeat the notification annually until the entire service line is no longer lead. For new customers, notice shall be provided at the time of service initiation.	In addition to meeting the requirements of the LCRR, Denver Water will complete investigations so that no lead, GRR, or lead status unknown service lines remain in the inventory by the variance end date.
Filters	The LCRR requires pitcher filters be distributed to customers for 6 months following LSLR. The LCRR does not require water systems to provide filters to homes with LSLs or GRRs.	Denver Water will continue to provide pitcher filters to all homes with known LSLs or GRRs and lead status unknown service lines until 6 months after the service line is replaced or until the service line is confirmed to be non-lead. Pitcher filters, if used appropriately for drinking and cooking and perform effectively, are predicted to reduce lead levels at homes with LSLs or GRRs.
Lead Service Line Replacement (LSLR)	If the trigger level is exceeded, systems implement goal-based LSLR approved by the state for at least two years. If the action level is exceeded, systems conduct 3% LSLR per year for at least two years. Systems pay to replace portion of service line they own.	Denver Water will continue to reduce the number of LSLs over the period of the variance at a cumulative average rate of 7% per year until all LSLs and GRRs are replaced, removing the major source of lead in the distribution system. Denver Water pays for the entire cost of LSLR. Denver Water is not expected to exceed the trigger level or the action level so would not be required to conduct LSLR. If the action level or trigger level were exceeded, LSLR would be equivalent to what is required under LCRR assuming the State does not determine that a shorter schedule is feasible, in which case a higher rate would be required.
Corrosion Control Treatment (CCT)	Water systems serving greater than 50,000 persons must install and maintain OCCT. Systems with a trigger level or action level exceedance must follow the steps for re-optimizing CCT, as specified in the rule.	Denver Water’s variance is from the definition of OCCT in 40 C.F.R. Section 141.2 as that term is used in 40 C.F.R Section 141.82(e) and as it relates to CDPHE’s March 2018 designation of OCCT as orthophosphate treatment . Therefore, it does not meet LCRR requirements to install and maintain OCCT. Instead, Denver Water operates pH and alkalinity adjustment as CCT. Over the first two years of implementation, Denver Water has consistently achieved 90 th percentile tap lead levels below 5 ppb, significantly lower than the action level of 15 ppb. Denver Water is not expected to exceed the trigger level or the action level. If the action level or trigger level were exceeded, Denver Water would be required to follow the steps to re-optimize CCT under the LCRR; the variance does not change that requirement.
Tap Sampling	Collect samples twice a year at Tier 1 sites.	Equivalent. All tap sampling requirements under LCRR will be applicable.

Element	LCRR beginning October 16, 2024	Equivalence Comparison
Water Quality Parameters set by the primacy agency	Meet all LCRR requirements for monitoring and compliance.	Equivalent (but WQPs are set for pH and alkalinity adjustment as CCT instead of orthophosphate.) If the action level or trigger level were exceeded, Denver Water would be required to follow the steps to re-optimize CCT under the LCRR and WQPs would change; the variance does not change that requirement
Find and Fix	If individual tap samples > 15 ppb, water systems must collect a tap sample at the same site within 30 days and WQP samples near the site. Systems must perform needed corrective actions, customer outreach, and inform local public health officials.	Equivalent. All find-and-fix requirements under LCRR will be applicable. Denver Water also follows an elevated lead response plan to follow-up on any individual site with elevated lead levels.
LSL-related Outreach	Water systems must inform customers annual that they are served by LSL or GRR lead status unknown service lines. Systems required to conduct LSLR must conduct additional outreach.	Equivalent. All outreach requirements under LCRR will be met. Denver Water also conducts outreach to all customers in the filter program regarding proper use and maintenance of the filter, offers to replace full LSLs at no cost to the customer, offers free lead testing at any time, and conducts lead testing following LSLRs.

What actions does Denver Water need to complete before the end of the variance period?

In order to demonstrate continued compliance with the variance, Denver Water must regularly submit information to EPA regarding implementation of the variance. EPA requires this information to independently verify that the variance conditions are being met. Using this information, EPA will confirm whether the LRPP, as implemented, continues to meet the “as least as efficient in lowering the level of” lead standard as compared to orthophosphate. EPA has the sole discretion to revoke the variance if Denver Water does not comply with the terms and conditions, if new regulations impact the terms and conditions or equivalency of the variance, or if EPA believes there is a risk to public health. This section highlights some of the critical information EPA will require from Denver Water and why. The full list of submission requirements is listed in Paragraph 7 of the Order.

Lead Service Line Inventory

Denver Water’s variance requires the water system to create a comprehensive LSL inventory. Until October 16, 2024, to allow EPA to verify Denver Water’s LSLR targets are being met and that its filter program meets or exceeds the minimum adoption rate expressed in the variance, Denver Water must annually submit to EPA the following components of its inventory:

- Total number of service lines;
- Total number of replaced LSLs per year;
- Total number of confirmed or likely LSLs;
- Total number of unlikely LSLs; and
- Total number of non-LSLs.

Beginning October 16, 2024, the inventory reporting requirements under LCRR must be met.

Denver Water must also annually provide EPA with an up-to-date map of its LSL inventory.

Denver Water must annually provide EPA with the total number of investigations conducted so EPA can verify that the 1.4% minimum cumulative average verification rate has been met. Where the LSL status of a site has been changed, Denver Water must provide the rationale for the change (for example, investigation, replacement, water quality data, etc.).

Lead Service Line Replacement

Denver Water is pursuing accelerated LSLR to reduce lead levels in drinking water as part of an alternative to installing orthophosphate as OCCT. Denver Water needs to demonstrate that it is maintaining a cumulative 7% average annual LSLR rate. Denver Water will demonstrate compliance by annually reporting to EPA the address and date of all LSLRs as well as the type of replacement (full, partial, GRR, and if the replacement was conducted by Denver Water or a third party). Denver Water must also report the addresses of households that refuse LSLR. In Denver Water's system, the customer owns the entire length of the service line. Although Denver Water is offering to conduct LSLR at no direct charge to the customer, the customer may still refuse the LSLR. Through May 2022, 204 customers have refused to have their LSL replaced. Because this number is low compared to the number of LSLRs to date, EPA expects Denver Water will be able to complete full LSLR by the variance end date. Denver Water must also submit to EPA any lead sampling results associated with the completion of a LSLR to ensure lead levels have been reduced.

Corrosion Control Treatment

In addition to LCRR reporting requirements, Denver Water must report compliance with the pH and alkalinity values at the entry point and distribution system, 90% percentile lead levels overall, for LSLs sites, and for copper with lead solder sites, and the results of all lead tap samples, all customer requested samples, and all investigative samples collected for inventory purposes. Denver Water must also report actions taken under the elevated lead response plan.

Filter Use and Efficacy

A condition of Denver Water's variance is that filters certified to remove lead must be distributed to all customers served by a confirmed or likely LSL or GRR. The variance includes a provision requiring Denver Water to determine the percentage of customers that properly use and maintain their filter and report that information to EPA. EPA is also requiring Denver Water to provide information about filter distribution so EPA can independently verify the proportion customers use their filter.

EPA is also requiring Denver Water to regularly submit to CDPHE and EPA laboratory and field filter testing results to assess the effectiveness of the filters in removing lead. Denver Water shall notify CDPHE and EPA within 30 days if data indicate lead above 5 ppb in filtered drinking water and shall provide the measured levels of lead in all filtered water samples. Denver Water must also report the data on filter maintenance.

Communication, Outreach, and Education

Denver Water's variance includes a requirement for the water system to take increased public education actions. Each year, Denver Water must submit to EPA a summary of activities, updated outreach, and education plan for the new program year. This will allow EPA to determine if the activities and outreach materials are adequate to meet the requirements of the variance. This includes, but is not limited to, a requirement that outreach and education materials be provided to at least 95% of the of households enrolled in the filter program.

Updated Equivalency Model

Denver Water must submit an Annual Program Year Report that includes a comprehensive evaluation of LRPP performance to date using the equivalency model described in the LRPP with updated inputs based on actual LRPP implementation for: 90th percentile lead levels at LSL and copper with lead solder sites after operation of increased pH and alkalinity adjustment as CCT, number of LSLRs conducted, filter adoption rate, and filter performance in the field. The updated equivalency model will allow EPA to consider the actual performance of key components of the LRPP to evaluate whether the overall program meets the efficiency standard as implemented.

Additional considerations of why the proposed variance is acceptable

EPA rarely approves variances under SDWA Section 1415(a)(3). EPA is approving this variance from the definition of OCCT in 40 C.F.R. § 141.2 for Denver Water in light of several important considerations.

First, Denver Water was in compliance with the provisions of the LCR prior to submitting the variance request. Denver Water conducted a corrosion control treatment study in the mid-1990's. Based on that study, CDPHE designated pH and alkalinity treatment as optimal corrosion control treatment for Denver Water and set a minimum pH of 7.5 and alkalinity of 15 mg/L, respectively, as Optimal Water Quality Parameters (OWQPs) on October 18, 1995. Denver Water installed pH and alkalinity adjustment treatment prior to January 1, 1997. Denver Water has consistently monitored, met these OWQPs and has not had any excursions or violations related to OWQPs. Denver Water has been correctly monitoring for lead at properly designated Tier 1 sites, as confirmed by CDPHE. Following an action level exceedance in 2012, Denver Water re-evaluated its corrosion control treatment.

- Denver Water's 2017 corrosion control treatment study found that the use of orthophosphate as a corrosion inhibitor provided optimal corrosion control treatment (as defined in 40 C.F.R. Section 141.2).
- Denver Water examined potential SDWA simultaneous compliance issues associated with the future use of orthophosphate as a corrosion inhibitor and found that the use of orthophosphate is anticipated to minimize lead and copper concentrations at users' taps without causing Denver Water to violate any national primary drinking water regulations.
- CDPHE designated the use of orthophosphate as optimal corrosion control.

The 90th percentile lead levels in tap samples in the Denver Water distribution system have consistently been below the lead action level since 1997 with the exception of an exceedance in 2012, as shown in Figure 3 below. The first two years of data have also shown that lead levels were further reduced by pH and alkalinity adjustment as CCT. Denver Water's most recent 90th percentile lead level at the end of 2021 was 4.4 ppb. At properties with LSLs, the 90th percentile level was 4.5 ppb and at properties with copper plumbing and lead solder the 90th percentile was 2.3 ppb for this same compliance period.

The LCRR requires that, beginning in October 2024, all compliance samples be collected at LSL sites. EPA expects Denver Water's 90th percentile lead level will increase slightly as a result of the change to sampling locations. The LCRR also requires that fifth liter samples be used for compliance instead of first liter samples. Denver Water completed limited testing in spring 2022 that compares the first liter sample to the fifth liter sample. The results of this testing were varied; at some sites the first liter sample had higher lead levels and at other sites the fifth liter sample had higher lead levels. From this testing, the highest lead level in a fifth liter sample was 7 ppb. Based on the first two years of implementation and Denver Water's limited testing of fifth liter samples, EPA anticipates that continued implementation of the variance will result in Denver Water continuing to have 90th percentile lead levels below the lead action level as well as below the lead trigger level that goes into effect in October of 2024. In the variance, filters are used as a means to lower lead levels by an additional increment while customers await their LSLR, and not as a means to avoid an exceedance of the lead action level.

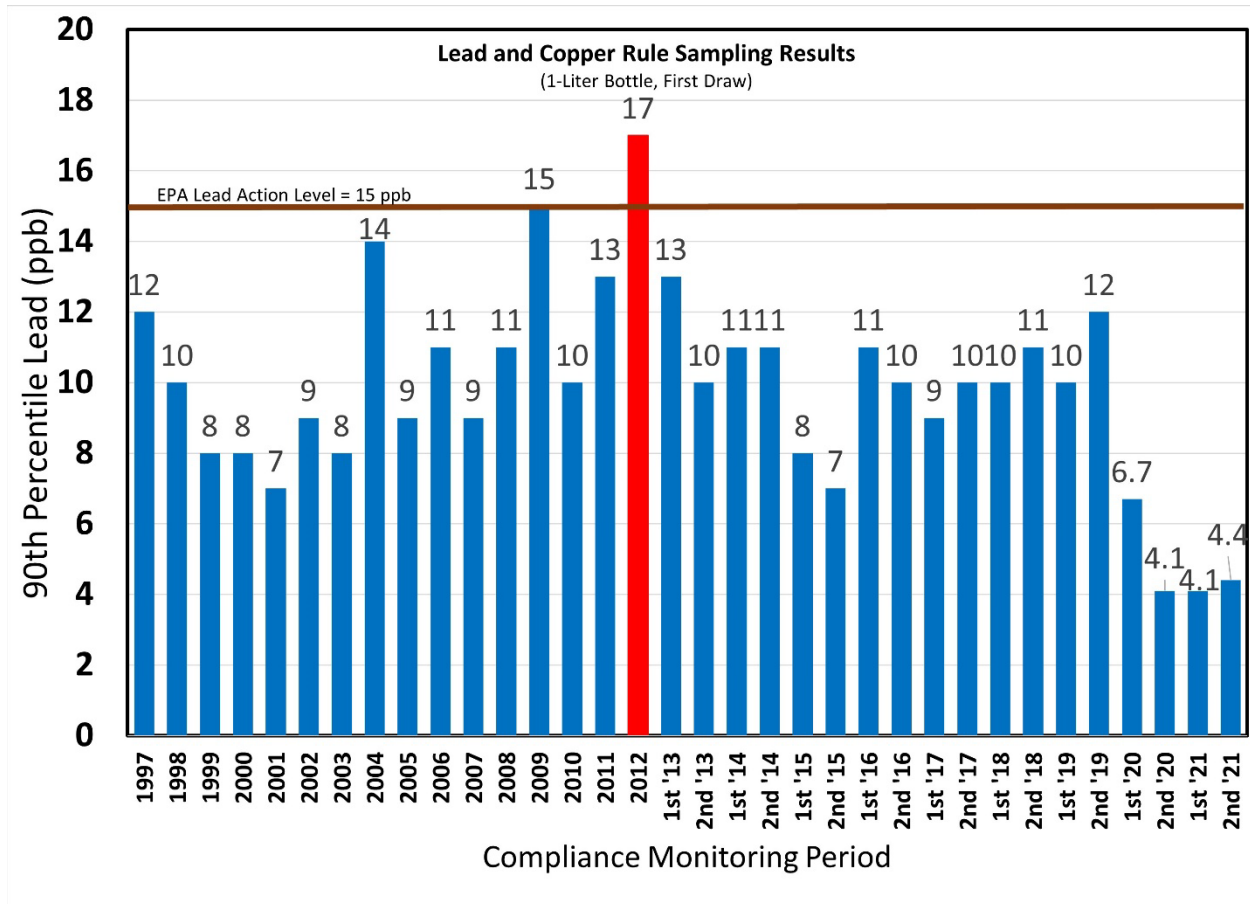
Second, conditions are in place to quickly identify potential failure of the variance or Denver Water's ability to meet the conditions of the variance and to quickly respond to such failures.

- The variance requires frequent reporting of key information, including lead and water quality parameter sampling results. EPA and CDPHE are alerted if any parameters are outside of established ranges. .
- If Denver Water does not meet conditions of the variance at any time, or is unsuccessful in meeting a performance metric, the variance can be terminated.
- In the case of the variance being revoked, commencement of a corrosion control study can begin quickly following the requirements of the LCRR. Should the study indicate orthophosphate is required as OCCT, that treatment can begin relatively quickly because the necessary equipment and facilities are in place.

Third, Denver Water has committed to and has the capacity to replace the full lead service lines. Denver Water will have the capacity and resources to replace all lead service lines within 15 years at a minimum rate of 7% per year based on a cumulative average.

Fourth, Denver Water has the technical, organizational, and financial capacity to continue to implement all the elements of the program for consumers served by their integrated PWSs in addition to customers served directly by Denver Water.

Figure 3: 90th percentile lead levels in tap samples in the Denver Water distribution system since 1997



(Source: Email Submission from Denver Water on June 1, 2022.)

Fifth, Denver Water has the technical, organizational, and financial capacity to continue to implement and maintain the LRPP including:

- the public outreach and education program;
- corrosion control treatment;
- the filter program including distribution and routine replacement for affected consumers until six months after the LSL replacement is completed and continuous measurement of success of the program; and
- compliance with all provisions of the LCRR (other than the definition of OCCT in 40 C.F.R. Section 141.2 as the term is used in 40 C.F.R. Section 141.82(e) and as it relates to CDPHE’s March 2018 designation of orthophosphate as OCCT) including for consumer notice and public education.

EPA also recognizes that Denver Water is concerned about the potential impacts of increased levels of phosphate in discharges from the Denver Water service area and increased nutrient levels in receiving waters. Although Denver Water explored alternatives to compliance with the State's designated optimal corrosion control treatment of orthophosphate, under the LCRR, the regulations do not allow the State to designate a form of CCT that does not meet the definition of OCCT in 40 C.F.R. Section 141.2, or to include actions such as LSLR or pitcher filter distribution into a designation of OCCT.² In the case of Denver Water, the definition of OCCT in 40 C.F.R. Section 141.2 precludes implementation of an alternative approach to address the potential watershed impacts due to increased nutrient levels in receiving waters that may result from Denver Water's use of the designated optimal corrosion control treatment of orthophosphate. EPA's approval of the variance is based on an assessment of the "at least as efficient as" standard and the strength of Denver Water's LRPP in protecting public health from sources of lead in drinking water. But EPA does recognize that additional ecological and public health benefits can accrue from limiting new sources of nutrients into surface water, particularly when the surface water – the South Platte River – is a wastewater effluent dominated stream with limited options to effectively control nutrient levels.

Appendix B: List of PWSs Integrated to Denver Water as of July 1, 2022

Water System Name	PWSID
Alameda	NULL
Alameda	CO0130116
Bancroft-Clover	CO0130133
Bear Creek	CO0130138
Bennett Bear Creek Farm	CO0139139
Berkeley	CO0116140
Bonvue	CO0130152
Bow-Mar	CO0103153
Castlewood	CO0103166
Cherry Creek Valley	CO0103175
Cherry Creek Village	CO0103176
Cherry Hills Heights	NULL
Cherry Hills North	NULL
Cherry Hills Village	CO0103176
Colorado Academy	NULL
Colorado DNR	NULL
Columbine	NULL
Con Mutual	CO0130145
Country Homes Metro	CO0103186
Crestview	CO0101040
Devonshire	NULL
East Cherry Hills Village	CO0103176
Edgewater	CO0130237
Fehlmann	NULL
Galleria Metro	NULL
Glendale	CO0103055
Grant	NULL
Green Mountain	CO0130321
Greenwood Village	NULL
Havana	NULL
High View	CO0130344
HI-LIN	NULL
Hillcrest	NULL
Holly Hills	NULL
Holly Mutual	NULL
Ken-Caryl Ranch	CO0103075
Lakehurst	CO0130466
Lakewood	CO0130467
Littleton	NULL
Lloyd King	NULL
Lochmoor	NULL
Lockheed Martin	NULL
Loretto Heights	NULL
Mansfield Heights	NULL
Meadowbrook	CO0130500
North Lincoln	CO0116552
North Pecos	CO0116553
North Washington	CO0101110
Panorama Park	NULL
Phillips Petroleum	CO0201060
Platte Canyon	CO0103614
Sheridan	NULL
South Adams County	CO0101140
South Sheridan	CO0130718
South University Place	NULL
Southeast Englewood	NULL
Southgate	CO0103721
Southwest Metro	CO0103723
Southwest Plaza Metro	NULL
Southwest Suburban Denver	NULL
Suncor	
Valley	CO0130800
Wheat Ridge	CO0130842
Willowbrook	CO0130843
Willows	CO0103100
Willows	CO0103100

¹ “Many commenters had concerns with orthophosphate impacts on wastewater treatment. The use of orthophosphate for corrosion control can increase the phosphorus loading to wastewater treatment facilities. However, water systems conducting corrosion control studies cannot rule out orthophosphate simply based on the increase in loading to wastewater treatment facilities. The definition of optimal corrosion control treatment means the corrosion control treatment that minimizes lead and copper concentrations at users’ taps while ensuring that the system does not violate any national primary drinking water regulations. SDWA Section 1412(b)(7)(A) requires that a treatment technique prevent known or anticipated adverse effects on the health of persons to the extent feasible. EPA has determined that orthophosphate treatment is a feasible corrosion control technology in accordance with SDWA Section 1412(b)(4)(E). Therefore, eliminating orthophosphate as an option because of concerns unrelated to compliance with national primary drinking water regulations may prevent a system from installing the treatment technique that reduces to the extent feasible the risks of adverse health effects from lead in drinking water.” 86 Fed. Reg. at 4210.

² The order is a variance from the definition of “optimal corrosion control treatment” in 40 C.F.R. § 141.2 as that term is used in 40 C.F.R § 141.82(e) and as it relates to CDPHE’s March 2018 designation of OCCT as orthophosphate treatment for Denver Water. 40 C.F.R. § 141.82(e) of the LCRR requires that “each system must properly install and operate throughout its distribution system the optimal corrosion control treatment designated by the State under paragraph (d) of this section.” 40 C.F.R. § 141.2 defines “optimal corrosion control treatment” as “the corrosion control treatment that minimizes the lead and copper concentrations at users’ taps while insuring that the treatment does not cause the water system to violate any national primary drinking water regulations.” This order is not a variance from any of the LCRR requirements that apply after an exceedance of the trigger level or the action level based on compliance tap sampling conducted under Section 141.86 of the LCRR, or from any other provisions of the LCRR.

When Denver conducted the 2017 CCT study pursuant to 40 C.F.R § 141.82(c) (of the LCR) and CDPHE modified its determination of OCCT, as authorized under 40 C.F.R. § 141.82(h) (of the LCR), the utility and State they were bound by 40 C.F.R. §§ 141.82(c) and (d) (of the LCR), respectively, and the definition of OCCT in 40 C.F.R. § 141.2 (of the LCR). CDPHE designated OCCT as orthophosphate because it “minimizes” the lead concentrations at users’ taps in comparison to pH and alkalinity adjustment. Denver Water, in turn, was required under 40 C.F.R. § 141.82(e) (of the LCR) to “properly install and operate throughout its distribution system the optimal corrosion control treatment designated by the State under paragraph (d) of this section.” This variance is from the definition of “optimal corrosion control treatment” in 40 C.F.R. § 141.2. It will relieve Denver Water from that aspect of the requirement in 40 C.F.R. § 141.82(e) to install the “optimal” corrosion control treatment designated by the State under 40 C.F.R. § 141.82(d) and require Denver Water to comply with the terms and conditions of this variance instead. Accordingly, CDPHE may designate as OCCT alkalinity and pH adjustment even though it does not minimize lead concentrations at users’ tap. CDPHE has modified its OCCT designation under 40 C.F.R. § 141.82(h) to require Denver Water to comply with the terms and conditions of this variance, which includes actions other than installation of CCT.