STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD
INITIAL STATEMENT OF REASONS FOR REGULATORY ACTION
Division 3, Chapter 3.5, Article 1
Title 23, California Code of regulations
30 November, 2020

PROBLEMS ADDRESSED BY REGULATION

Water Code section 10608.34 (Senate Bill (SB) 555 (2015) requires the State Water Resources Control Board (State Water Board) to develop and adopt standards for water loss for urban water suppliers[1] (suppliers). Section 10608.34 requires that the State Water Board incorporate life cycle cost assessment while developing these standards. The State Water Board is authorized to determine a minimum allowable water loss threshold that, if reached and maintained by suppliers, may exempt suppliers from additional water loss reduction. Additionally, section 10608.34 established water loss reporting for suppliers, in which suppliers have been required to report their water loss estimates through annual water loss audits since 2017. Assembly Bill (AB) 1668 and SB 606, passed in 2018, separately require suppliers to calculate their own individual urban water use objectives beginning in 2024. These water use objectives will be calculated based on efficient indoor and outdoor use, commercial, industrial and institutional irrigation, and an allowable water loss volume to be determined by the Board in its section 10608.34 rulemaking.

Prior to SB 555, monitoring of water losses was limited to voluntary efforts by a few suppliers. The volume of water lost from distribution systems due to leakage was largely unmonitored and unregulated. Water loss from leakage is an indicator of efficiency in water use and distribution. Based on data reported till date an average water supplier in California currently loses about 35 gallons per connection per day through leakage,

[1] "Urban water supplier" means a water supplier, either publicly or privately owned, that provides water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. For purposes of this regulation, suppliers functioning solely in a wholesale capacity are not included.

which translates to water losses of approximately 325 thousand acre-feet[2] or 106 billion gallons annually.

Climate change has been adversely affecting water resources due to rising temperatures and changing precipitation patterns, resulting in longer and more frequent droughts. As a result, California has been focusing on greater conservation and water use efficiency. With the advent of the multi-year drought in 2011, several Governor-issued Executive Orders (B-37-16 and B-40-17)[3] directed state agencies to conserve water, reduce loss of water through leakage, and take other direct actions to reduce large leaks that waste large amounts of water. Controlling water loss through leaks is one of the key strategies for improving water use efficiency. The intent of this regulation is to establish requirements that will bring about cost-effective reductions in water losses and maintain low levels of leakage in California to ensure resiliency and efficient water use.

Background and overview of proposed regulation

Water loss control can occur through four approaches: Detecting and locating leaks, prompt and effective responses to reported leaks, reducing operational pressure and pressure variations, and prioritizing infrastructure replacement. These approaches can be implemented through various types of available interventions. The feasibility of implementation and efficiency associated with different interventions depends on a given distribution system's characteristics, including the nature of leakage in the system. Pressure and asset management are dependent on individual water system operations and water quality requirements. The proposed regulation includes a volumetric standard that would be met by suppliers by 2028, with some exceptions, based on the amount of leakage that can be reduced by active leak detection and repair. This standard is calculated using an economic model developed by the State Water Board based on system-specific characteristics and benefit-cost assessment of implementing water loss control.

Pressure and asset management have the advantage of being able to address leaks that are too small to be detected by active leak detection. Additionally, pressure and systematic asset management are also effective in the long-term maintenance of water distribution infrastructure. With a view to developing a comprehensive statewide regulatory approach to water loss control, the proposed regulation includes a volumetric water loss reduction possible through active leak detection and repair, and data

[2] These figures are based on data from water loss auditing in California over 2017-19.

[3] https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/executive_orders.html

submission on data quality, pressure and asset management practices. The proposed regulation has the following pieces:

- Each urban retail water supplier will be required to comply with an individualized volumetric standard for leakage, using the economic model developed by the State Water Board (economic model), by 2028, with some exceptions. Initial compliance will generally require suppliers to demonstrate real loss at or below their standard, as reported in the supplier's water loss audit submitted 2028 or, under certain circumstances, in 2026 or 2027.

- A supplier may exclude one outlier value from their baseline average real loss (average real loss from 2017 to 2020 audit data) that is used to calculate its standard under certain circumstances. An outlier is a reported real loss value for a year varying more than 10 gallons per connection day or 740 gallons per mile per day (depending on whether the supplier reports in gallons per connection per day or gallons per mile per day) from the data reported in each of the remaining years.

- Suppliers may opt to submit updated data for the economic model by July 1, 2023 to the State Water Board to support an adjustment to its standard.

- Suppliers may opt to request a variance to the standard or compliance timeline in the case of unexpected adverse circumstances that may impact compliance.

- Suppliers serving disadvantaged communities with smaller benefit-to-cost ratios for their standard and a significant water loss reduction per the individualized standard, as identified through the economic model, will have additional time before initial compliance is assessed (2031 instead of 2028).

- After 2028, compliance with volumetric standards will be assessed every three years based on the average of the real loss values reported through water loss audits in the preceding three years, with an allowed variation of 5 gallons per connection per day above the standard.

- Suppliers with existing low water loss levels, under 16 gallons per connection per day or 1184 gallons per mile per day, per water loss values reported in water loss audits from 2017 through 2020 (or, in specific circumstances, 2020 and 2021), would not be required to submit responses to water loss-related questionnaires or further reduce water loss, provided they demonstrate meeting specified data quality criteria. These suppliers will be required to maintain losses at or below 16 gallons per capita per day or 1184 gallons per mile per day, depending on how they report water loss.

- By January 1, 2023, suppliers other than those meeting the low loss and high quality data criteria will be required to submit responses to questionnaires on data quality of water loss audits. In addition, suppliers will be required to submit responses to questionnaires on both pressure management and asset management by July 1, 2024 with an updated questionnaire response by July 1, 2027.

SPECIFIC PURPOSE OF PROPOSED REGULATIONS

Section 980 Definitions

The purpose of adding subdivisions (a) through (d) is to address the administrative implementation of the proposed regulation and designate authorities for assessing compliance and adjustment processes. The purpose of adding subdivisions (e) through (yy) is to provide clear definitions for technical terms used in the economic model to calculate volumetric water loss standards. These definitions will ensure that all urban water suppliers implement the proposed regulation consistently, to prevent ambiguity or confusion in the calculation of standards or assessing compliance. These definitions have been aligned with Water Code section 10608.34 for consistency and prevention of conflict or overlap with existing regulations. These definitions also provide default values for the technical parameters based on the best available knowledge from industry practices and literature, which apply unless the supplier has its own adequate data.

Section 981 Volumetric Water Loss Performance Standards

Section 981 explains compliance requirements pursuant to the proposed regulation. Section 981 subdivisions (a), (b) and (c) have been added to provide the timeline and specifics about the volumetric standard as calculated by the economic model for assessing compliance. These subdivisions also outline provisions for using alternate years of data for calculation of these standards or for assessing compliance in specific conditions. Subdivision (d) adds the provision for suppliers to submit data specific to water systems for the economic model to request adjustments to the standard, specifics for which are provided in Section 984. Subdivision (e) describes the provision for suppliers to request a variance to compliance in case of adverse circumstances. Subdivision (f) describes the conditions under which compliance will be assessed for a supplier serving disadvantaged communities with relatively lower benefit-cost ratio and significant real loss reduction in 2031 instead of 2028.

Rationale: Volumetric water loss standards (standards)

In general, each retail water supplier will be required to comply with an individualized volumetric standard for water loss, using the economic model developed by the State Water Board (economic model), by 2028. The water loss standard for each supplier is calculated to reflect the water loss level that can be achieved by that supplier cost-effectively. Each supplier’s standard is individually determined from a cost-benefit analysis. Suppliers will be allowed to provide their own water system-specific data to the

State Water Board to use in the economic model and calculate the standard, and requires supporting documentation. If such data is provided by a supplier, this process is called an adjustment to the standard. The model conducts a benefit-cost analysis for each urban water supplier and assumes 2022 through 2028 to be the implementation period for water loss control, based on the regulatory timeline for adoption of the standards.

Suppliers can opt to comply with the standard initially by demonstrating a real loss value at or below the standard in the water loss audit submitted in 2026 or 2027, as opposed to solely the audit submitted in 2028. This provision allows for a supplier to be in compliance if the supplier has successfully demonstrated an ability to meet the standard, but, due to unforeseen circumstances, has exceeded its standard in its 2028 audit. Circumstances could include changes in water supply and delivery volumes or unanticipated water metering or billing errors. This approach is consistent with the post-2028 compliance approach of the regulation, which averages the preceding three years of audit values, to reflect the fact that water loss can be influenced in a given year by unforeseen circumstanced. The proposed regulation does not provide for averaging for purposes of measuring initial compliance, to ensure that suppliers have met the standard in a single year before compliance is measured by averaging over multiple years.

Additionally, suppliers may include their water loss reduction, as prorated till 2028 by the suppliers, when calculating their urban water use objective pursuant to AB 1668 and SB 606. The standard will be included in the urban water use objective by the compliance date for the supplier as the allowed water loss volume. The water loss audits submitted on January 1 of each year will be the primary method of assessing compliance with standards, to avoid duplicative reporting and to align with existing regulations.

After 2028, compliance with volumetric standards will be assessed every three years based on the average of the real loss values reported through water loss audits for each of those three years, with an allowed variation of 5 gallons per connection per day above the standard. This provision ensures that any variations in real loss due to unforeseen circumstances are the cause for exceedances of the standard, and not any overarching failure to take appropriate and cost-efficient steps to achieve the supplier's water loss standard. The established margin of 5 gallons per connection per day similarly ensures progress while providing an allowance for such circumstances.

Generally, suppliers will be required to meet the water loss standard determined by the State Water Board by 2028. The majority of water loss occurs because of lack of proactive maintenance of water distribution systems, which has led to continued loss of water through leakage (Sedlak, 2015). Distribution systems require regular maintenance in the form of monitoring, detection and repair and replacement activities to maintain leakage at low levels and control newly emerging leakage over time. The model used in the regulation assesses these costs and benefits associated with ongoing water loss control over an assumed 30-year lifecycle of the regulation to determine standards. This section institutes a requirement for ongoing compliance for suppliers, such that leakage does not rise to higher levels in these systems.

Rationale: Requests for adjustments and variances

Adjustments

The proposed regulation will allow suppliers to request for adjustments to their standard between March 1 and July 1, 2023. Supplier’s standards are calculated using best currently available data on leakage or real loss, water system characteristics, associated costs and efficiencies of actions, and valuation of water incorporating avoided cost of water owing to water savings from the proposed regulation. It is anticipated that suppliers would need over a year after adoption of the proposed regulation to select vendors and begin implementing water loss control programs. As suppliers begin to implement water loss control actions to reduce water loss, it is anticipated that suppliers may obtain new information on these parameters. The regulation allows suppliers to provide new information to the State Water Board that is relevant to their standard based on initial implementation of water loss control actions. These adjustments will be evaluated on a case-by-case basis by the State Water Board. Adjustment requests will need to be accompanied by supporting documentation.

Variances

The proposed regulation allows suppliers to request to defer a compliance date, or otherwise modify compliance obligations, in case of severe economic hardship or substantial adverse change due to an unforeseen event, e.g. wildfire. These variances will be evaluated on a case-by-case basis by the State Water Board. Drought will generally not be cause for a variance. Variance requests will need to be accompanied by evidence of conditions warranting the variance.

Suppliers are anticipated to incur upfront costs in an effort to reduce water loss. To prevent undue strain on suppliers serving disadvantaged communities, or spillover impacts on ratepayers within these disadvantaged communities, the proposed regulation provides additional time before initial compliance is assessed for certain suppliers. Suppliers that serve disadvantaged communities and have a calculated standard requiring real loss reduction of over 25% and a benefit-cost ratio over 2 over the assumed implementation period (2022-2028) will be required to comply by January 1, 2031, not January 1, 2028. This provision would allow for additional time for distribution of up-front costs for these suppliers in recognition of the difficulty they may have in making large up-front expenditures and the lower calculated benefit they would accrue. These suppliers are anticipated to still incur a net benefit. Suppliers that are not anticipated to incur a new benefit will not be required to reduce real loss. The provision for variances has been included in the section pursuant to stakeholder input.

Provisions for reliable data quality

A supplier may exclude an outlier value from its baseline average real loss that is used to calculate its standard, by using three out of the four years of audit data reported in water loss audits submitted from 2017 through 2020. A reported real loss value for a year varying more than 10 gallons per connection day or 740 gallons per mile per day from the data reported in each of the remaining years used to calculate the baseline real loss would qualify as an outlier. This allows a supplier to correct for or exclude an inaccurate reported value for real loss and to ensure that the standards are based on verified and reliable data. During the first four years of water loss audit reporting, suppliers have notified the State Water Board that reported audits may require correction of errors or may not realistically reflect the supplier’s water loss due to anomalies in underlying data. This provision has been included per this stakeholder input.

Section 982 Economic Model

Section 982 describes the economic model used to calculate the volumetric water loss performance standards for each supplier. The economic model has been described to ensure consistency in terminology, technical parameters, data inputs and the relationships between these inputs and parameters within the model. The description of the model is crucial to the use of accurate data in the model to calculate standards. This description is also necessary for implementing the adjustment process and ensuring consistency and transparency in decisions reached regarding adjustment requests. If a supplier opts to request an adjustment, the data provided by the supplier will need to correspond appropriately to the definitions used by the State Water Board in the economic model.

Subdivision (a) (1) through (24) provide the underlying equations used to calculate the standard. Each of these technical parameters have been defined in Section 980 and used in this subdivision of section 982 to describe the calculation of the standard and conduct the benefit-cost analysis underlying the calculation of the standard.

Subdivision (b) describes the overarching equation used to calculate each supplier’s water loss standard, using inputs calculated in subdivision (a).

Subdivision (c) describes whether default values identified in section 980 are used in the equations in section 982, subdivision (a), and the process to be followed by the State Water Board in case of insufficient evidence for the adjustment request.

Subdivision (d) provides an alternative compliance pathway for suppliers with existing low levels of real loss that are supported by high quality data. Suppliers meeting the criteria for showing existing low levels of real loss and high quality data will be exempt from having to respond to the questionnaires required by section 983.

Rationale

Water Code 10608.34 requires the State Water Board to consider life cycle cost accounting to develop the standards. The model conducts a benefit-cost analysis for each urban retail supplier and assumes 2022 through 2027 to be the implementation period for water loss control, based on the regulatory timeline for adoption of the standards.

Leakage can manifest in different forms, either visibly above the ground surface, which is typically called “reported leakage” and is reported when observed visually, or under the ground surface, which is typically called “unreported leakage” and generally requires specialized detection equipment to be found (AWWA, 2016, Water Research Foundation, 2014, Sturm et al, 2014). Another form of leakage occurs through leaks that are too small to be detected by leak detection equipment, which is often called “background leakage” and requires operational interventions such as managing distribution pressure or replacing pipelines. Assessing the nature of leakage is crucial for determining a cost-effective water loss control strategy. All available approaches can be used to address unreported leakage, whereas addressing background leakage requires specific approaches (AWWA, 2016, Water Research Foundation 2007). To allow for flexibility in selecting a suitable approach available to suppliers, the volumetric water loss standard is based on the amount of unreported leakage that can be reduced by the supplier, while the supplier is not actually required to use any particular control method.

The model calculates the total cost of leak detection, by multiplying the unit cost of leak detection with the average number of miles surveyed per month. The model calculates the number of unreported leaks to be repaired and the cost of leak repair per month by multiplying the unit cost of repair with the number of unreported leaks and dividing by the leak detection efficiency to account for false positives. These cost estimates were obtained from the Irvine Ranch Water District, a report by Pacific Gas and Electric Company (2015), and engineering consulting firms such as Water Systems Optimization, M.E. Simpson and Kunkel Water Efficiency Consulting. The total associated costs are calculated for each month. A real monthly discount rate of 3.5% is applied to the costs to calculate the present value for 2020. This is in line with the Guidelines for Preparing Economic Analysis (2014)[4] from the US EPA, which suggests that the real discount rate should be in the range of 3%-7% depending on the time horizon. In general, lower discount rate can be adopted if the regulation impact is expected to last longer, especially with consideration of intergenerational equity. The proposed regulation is intended to conserve water and it would have permanent impacts on water resources and environment, with a time horizon of 30 years for economic analysis. Accordingly, the State Water Board has determined that 3.5 percent is an appropriate discount rate for the proposed regulation.

The State Water Board is required to consider life cycle cost accounting to develop these standards. Per inputs from the water loss industry, leak detection equipment and pipe repair material have lifecycle periods that are longer than the initial compliance period for the proposed regulation. Water distribution infrastructure maintenance is conducted to prolong its useful life, and reduce water loss, and damages and outages from main breaks. The State Water Board therefore anticipates that where water loss reduction is cost-effective, suppliers would continue to achieve these benefits beyond the regulatory compliance period. Additionally, the model conservatively quantifies the associated benefits, as the additional benefits of prevention of main breaks, such as reduced water outages, avoided property damage, business and traffic disruptions, are not included in the model. Therefore, the Board considered a time horizon of 30 years for the economic model.

The water saved from water loss control is calculated as the difference between the real loss after active leak detection and repair and the baseline average real loss, which is the supplier's current real loss assuming it would maintain the real loss without water loss intervention. This water saved contributes to the benefits to be realized from the proposed regulation. The water is valued at the avoided cost of water based on the cost of obtaining an alternative source of water (Pacific Institute, 2015). The standards would require all suppliers to at least maintain their real loss if they are not required to reduce real loss based on the benefit-cost analysis.

The model applies the annual real rise in price of water (Metropolitan Water District, 2020 (a) and (b)) to calculate the price of water at the beginning of 2022, after which a monthly rise is applied to the price of water. The price of water is multiplied by the water saved from water loss control. This constitutes the benefits. The monthly discount rate is applied to each month of benefits after 2022 to calculate the present value for 2020.

[4] https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses

The present value of benefits and costs are calculated over a period of 30 years from 2022 through 2051. The net benefit is calculated as the difference between the present value of benefits and the present value of costs associated with active leak detection and repair. If the net benefit over 30 years is positive, the model calculates the unreported real loss over the year 2027, by summing the unreported leakage occurring over the 12 months of 2027. The standard is calculated by adding the annual reported and background leakage to the unreported real loss over 2027, as the model assumes that only unreported leakage can be reduced by all standard industry approaches. If the net benefit is zero or negative, the standard is equal to the current average baseline real loss.

Exemption for suppliers with low real loss

Suppliers with low water loss, under 16 gallons per connection per day or 1184 gallons per mile per day (depending on how the supplier reports water loss) that meet data quality per criteria determined by the State Water Board would not be required to submit responses to questionnaires or reduce water loss. This threshold is at the 20th percentile statewide of the real loss estimated reported through water loss audits from 2017 through 2019. These suppliers will be required to maintain losses at or below this 20th percentile statewide real loss level for the lifetime of the regulation, i.e. 16 gallons per connection per day or 1184 gallons per mile per day, depending on how the supplier reports water loss. This reduces reporting burdens on suppliers that already have a reliably calculated low real loss. This provision has been included in response to stakeholder input.

Section 983 Questionnaires

Section 983 subdivision (a) requires suppliers to submit responses to questionnaires to the State Water Board on data quality of water loss audit reports in 2023 submitted to the Department of Water Resources pursuant to 10608.34, subdivision (b). Subdivision (b) of the proposed regulation requires suppliers to submit responses on pressure management practices in 2024, with an update to these responses in 2027, while subdivision (c) requires responses on asset management practices by 2024, with an update to these responses in 2027.

Rationale

Urban water suppliers will be required to submit responses to three questionnaires, unless they are exempt from this requirement based on existing data quality and low loss levels. Responses to the questionnaires would provide the Board with data from suppliers on their practices to maintain quality checks on data water loss audits and implement pressure management and systematic asset management. Additionally, the responses would provide the public with information on these practices, suppliers' management of water distribution infrastructure and water loss control.

Questionnaire on data quality and apparent loss

"Apparent loss" is defined in the American Water Works Association (AWWA) M36 manual as the non-physical water loss that occurs when water is successfully delivered to a water user, but for various reasons is not measured or recorded accurately. This is not water that is physically lost from the system, but water that is otherwise unaccounted for. Water lost through leaks, defined as real loss, is calculated in water loss audits by estimating the volume of water not accounted for by the supplied volume and apparent loss. Thus, real loss estimation is dependent on apparent loss estimation and data quality.

Per stakeholder input, there are three primary reasons for apparent water loss requirements: 1) to prevent reporting of unreasonably low real loss volumes due to overestimated apparent loss estimates; 2) to improve apparent and real loss data accuracy; and 3) to support supplier efforts to reduce apparent losses and improve data quality. The State Water Board is therefore proposing this data submission by 2023 which would provide suppliers sufficient time to compile these responses.

The accuracy of audits primarily relies on the accuracy of measured supply and delivery volumes, with some influence from accuracy in measuring unmetered uses (e.g., fire flow and public buildings) and unauthorized consumption (e.g., due to theft or meter tampering). Practices to improve underlying data include regularly testing water meters, regular measurement of unmetered flows, and streamlining billing data. The questionnaires address supplier practices on these aspects.

Questionnaire on pressure management practices by urban water suppliers

High operational pressure and variation can increase the amount of leakage from distribution systems (Walski, Bezts, Posluszny, Weir, & Whitman, 2006) (Vicente, Garrote, Sanchez, & Santillan, 2015) (Boulos, Karney, Wood, & Lingireddy, 2005) (LeChevallier, Yang, Xu, Hughes, & Kunkel, 2014). Higher operational pressure can cause higher loss of water through defects in infrastructure, while sharp variations in pressure can strain infrastructure. Pressure reduction and management of variations are established interventions recommended by industry experts to reduce leakage and main breaks in such distribution systems.

A distribution system is typically divided into pressure zones based on operational needs of different parts of the supply area (National Research Council (US), Safe Drinking Water Committee, 1982). Effectively monitoring the operational pressure and identifying leaky or high-pressure portions of the distribution system are the first steps to determining the potential benefits of pressure management in a distribution system before implementation. Lack of basic pressure monitoring and optimized pressure management restricts options available to suppliers for cost-effective water loss reduction. Historically, suppliers have been implementing pressure management for operating distribution systems smoothly, especially in hilly terrain, to reduce energy consumption, especially during periods of low water demand. But some suppliers have also taken steps towards implementing pressure management to reduce water loss and pipe failures (Los Angeles Department of Water and Power and Water Systems Optimization Inc., 2015).

Through prior stakeholder input, suppliers emphasized the need to strike a balance between maintaining water quality, meeting fire flow requirements and reducing excessive pressure. The State Water Board conducted a study on pressure management, constraints in implementation, and associated benefits (Alex, 2015). The study highlighted the need to provide water suppliers and fire departments a guide to costs and benefits to facilitate implementation of pressure management. For example, pressure management implemented in the El Dorado Irrigation District (California), Philadelphia Water Department (Pennsylvania), Halifax Regional Water Commission (Canada) and the City of Ontario (Canada) demonstrate an annual water savings from reducing water loss ranging from 10 - 30% (California Urban Water Conservation Council, 2010). Additionally, pressure management is known to reduce bursts and leakage in the system that cause outages and possible contamination of drinking water.

But, owing to supplier-specific constraints, staff excluded water loss reduction resulting from pressure management from the scope of the economic model used to calculate the volumetric standards. The economic model does not include the additional benefit of pressure management in terms of water loss control. Hence, to comprehensively consider all aspects of water loss control, the proposed regulation instead requires suppliers to submit responses on the feasibility and implementation of pressure management.

Responses to the questionnaire would provide the State Water Board with data on current practices to maintain existing pressure management devices and the feasibility of implementing pressure reduction for reducing strain on water distribution infrastructure and, consequently, water loss from leakage. The questionnaire would also obtain information on the potential amount of water loss that would be reduced using pressure management. This has a two-fold benefit: If suppliers have a large amount of leakage that is too small to detect, this ensures monitoring and control of this type of leakage; and this will ensure that suppliers regularly monitor their water distribution system for pressure-related events that could cause unforeseen pipe failures or increase the water loss through existing leaks.

Suppliers will be required to submit an update to responses by July 1, 2027 to provide updated information.

Questionnaire on asset management

Suppliers will be required to submit responses to questionnaires on asset management by July 1, 2024 with an update to responses by July 1, 2027.

Asset management is one of the four industry-established approaches for water loss control. Systematic, priority-based pipe replacement and other forms of asset management contribute significantly to leakage reduction. Suppliers may approach asset management in different ways, but it is a part of water distribution infrastructure maintenance for all suppliers. For example, East Bay Municipal Utility District uses data on various parameters such as material, age, traffic density and operational pressure, across its distribution system to predict pipe failures and to prioritize pipe replacement based on likelihood and consequence of failure (East Bay Municipal Utility District, 2018), while other suppliers plan pipe replacement based on material of pipe that has the history of highest number failures (Los Angeles Department of Water and Power, 2017).

Through the stakeholder process, water suppliers highlighted that multiple factors affect the prioritization of pipes replaced, and mitigating water loss control is not the only motivation behind asset management. As a result, the associated capital investment is determined based on other potential benefits and factors, although several suppliers directly rely on asset management for their system to reduce water loss. Incorporating water loss reduction from implementing asset management in the model to calculate volumetric standards for all suppliers involves a high degree of uncertainty. But, to have a comprehensive regulation on water loss control and improve transparency on water distribution infrastructure maintenance the proposed regulation needs to address asset management.

The proposed regulation would require suppliers to submit data on their asset management practices. Responses to the questionnaire would provide the State Water Board with information on record-keeping for systematic asset management (e.g. history of leaks, pipe inventory, factors causing leaks, and repair response time) to prevent large leaks and future occurrence of unexpected leaks, and prioritization of asset management based on pipe failures.

Section 984 Adjustments

This section adds specifics on the timeline and process for suppliers requesting adjustments and the process for providing a decision on requested adjustments. Subdivision (a) describes the timeline for requesting an adjustment to the standard. Subdivision (b) describes what is required for requesting an adjustment, including identification of the specific parameters or inputs to the economic model that the supplier requests to adjust and supporting documentation demonstrating the need for the adjustment. Subdivision (c) describes the process for the Board to make decisions on adjustment requests. The rationale for including this section has been provided in the rationale for section 981, as that section adds this provision to the scope of the Volumetric Water Loss Performance Standards.

Section 985 Variances

This section adds specifics on the process and conditions under which a supplier may request variances in response to unforeseen adverse circumstances that affect compliance with the supplier’s water loss standard. Subdivision (a) describes the conditions under which a supplier may request a variance. Subdivision (b) specifies the effect of an approved variance request. Subdivision (c) delegates the decision-making on and specifies that the State Water Board will provide prompt decisions on requests for variances. The rationale behind including a provision for variances is explained in the rationale for section 981, as that section adds this provision to the scope of the Volumetric Water Loss Performance Standards.

Section 986 Additional Conservation Tools

This section describes the enforcement actions that the State Water Board may regarding compliance with the proposed regulation. Subdivision (a) describes a possible enforcement tool that the State Water Board may opt to exercise that would require the supplier to implement additional actions that would assist the supplier to come into compliance, and specifies the process for a supplier seeking reconsideration of Board decisions. Subdivision (b) describes an enforcement tool that the State Water Board may opt to exercise which would require a supplier to provide the State Water Board information on water loss and describes potential liability if the supplier fails to provide the requested information. Subdivision (c) describes potential liability if the supplier proves false information.

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ANTICIPATED BENEFITS

Reduced unknown losses

Smaller and unidentified leaks often remain undetected unless efforts are made to locate them with specialized equipment or other specific methods. Small undetected leaks may lose volumes of water over a large period of time comparable to or higher than visible breaks, which are typically repaired quickly. Overall, the proposed regulation is anticipated to reduce statewide water loss by approximately 40 percent. For a typical utility per the Standardized Regulatory Impact Analysis and the economic model results, the proposed regulation would result in 15,042 acre-feet of water loss reduction and therefore generate total benefits of $18.9 million dollars in present value over the identified lifecycle. Among the 253 water utilities or suppliers impacted by the proposed regulation (i.e. expected, based on current data, to be required to reduce water loss), 43 are privately owned water companies. 9 of them are identified as small businesses. On average, the regulation would generate 4,226 acre-feet water loss reduction in the 30-year assumed lifetime for small businesses, with total benefits amounting to 5.2 million dollars. These are much lower than the assumed benefits to a typical utility since smaller utilities have a smaller water system, with a lower volume of total leakage that could occur. The total amount of water saved at the state level is approximately 3.8 million acre-feet, and the associated total benefit approximately 4.8 billion dollars.

Avoided costs - additional water resources

Impacts of climate change are evident with multi-year droughts (Diffenbaugh, Swain, & Touma, 2015) and changing precipitation patterns (Sun, Berg, & Hall, 2018). With increasing urban population and impacts of climate change, water resources are anticipated to experience increasing strain (Vicuna, Maurer, Joyce, Dracup, & Purkey, 2007). As a result of warming temperatures coinciding with reduced precipitation, stream flows and groundwater levels are shrinking (Mann & Gleick, 2015), impacting fish populations and causing a permanent loss of groundwater storage[5], which impacts domestic supplies and agricultural production. A reduction in demand on water resources contributes to the protection of watersheds. Reducing leakage is an effective approach for prolonging the use of existing water resources, thus delaying the need for suppliers to identify and secure additional scarce sources of water supply.

Globally, utilities already implement leak reduction measures, motivated by a need for conservation, improving energy-efficiency and asset management. For example, Halifax Regional Water Commission in Canada has been monitoring water loss and implementing a proactive leak detection program since 2000. Halifax Regional Water Commission was able to save 10.5 million gallons per day by reducing its leakage (Center for Neighborhood Technology, 2014). This strategy enabled Halifax Water to defer treatment plant expansion and repair in the long-term. The Philadelphia Water Department instituted an ongoing water loss control program in 2000 which achieved a water loss reduction of 30 million gallons per day (Center for Neighborhood Technology, 2014). UnityWater, a water distribution utility in Australia, has been implementing a system-wide leakage management plan since 2013 to offset the cost of expensive water. Unitywater decreased its real losses[6] to 13 gallons per connection per day, which is significantly lower than other water utilities globally (Goraya & Lukin, 2018). A joint initiative between the local government of New South Wales, water sector organizations

[5] United States Geological Survey, Central Valley: Drought Indicators (https://ca.water.usgs.gov/land_subsidence/central-valley-subsidence-data.html)
[6] “Real losses” are water losses through physical leaks in the system, as opposed to “apparent losses” which are revenue losses due to billing, systematic or metering errors, or theft of water.

and the Australian Government implemented a regional effort with 75 local water utilities over a five year period to reduce leakage to achieve ongoing savings of approximately 25 gallons per connection per day (Local Government Association New South Wales, 2012). Aarhus Water in Denmark reduced its leakage by 260 million gallons per year over a period of 13 years by monitoring its leaks closely, which informed its prioritized asset management program.

Avoided costs - additional energy consumption

Water supply in California is associated with high embedded energy usage and costs; at least 7% of the state's overall electricity is used to treat, convey and distribute water to end users (California Public Utilities Commission, 2011). Water savings from water loss reduction result in a reduction in the embedded energy use associated with treating and supplying potable water. The energy savings vary with factors such as source of water, sizes of leaks and operating pressure (California Rural Water Association, 2015; California Public Utilities Commission, 2011).

High operating pressure and large variations increase leakage and breaks in distribution systems (European Union, 2015). Pressure management techniques such as mitigating pressure transients[7] (Boulos, Karney, Wood, & Lingireddy, 2005) and avoiding excessive operational pressure are key approaches for reducing loss of water from leaks and breaks. Improving pressure management in a distribution system can lead to energy savings from reduced operational energy consumption. Additionally, decreasing embedded energy usage in water supply translates to reduced greenhouse gas emissions (Stokes, Horvath, & Sturm, 2013). The joint initiative in New South Wales, Australia for a regional water loss control effort involving 75 water utilities saved a total of 1 million kilowatt-hour or 1.2 million kilograms of carbon dioxide (Local Government Association New South Wales, 2012).

Reduction in distribution system breaks

Breaks or large failures in distribution system infrastructure, such as pipelines or hydrants and valves, have adverse impacts such as damage to property and disruptions to water supply, traffic and essential services. Typically, smaller leaks develop into larger breaks if not detected early (American Water Works Association, 2016). Regular leak detection provides the ability to implement preventive measures prior to the occurrence of large breaks. Similarly, managing pressure to reduce leakage also protects distribution infrastructure and can reduce the occurrence of breaks.

[7] A pressure transient is an extremely high variation in pressure over a short time period (typically one-hundredth of a second).

Prolonged asset life

Key approaches to water loss control are managing pressure and transients, proactively identifying unknown leakage, expediting response to repairs, and prioritizing asset management by using information on break histories, age and material of pipes, and consequence of failure (Kleiner & Rajani, 2000). These practices improve maintenance of distribution infrastructure, which contributes to prolonging water infrastructure life. For example, reducing pressure transients decreases the occurrence of shocks in the distribution infrastructure. Active leak detection preempts the occurrence of large breaks, thus decreasing damage to the distribution system. With a proactive leak detection program, the Birmingham Water Works Board (Alabama, U.S.A) detected about 240 leaks and identified 14 miles of pipeline requiring immediate replacement (Center for Neighborhood Technology, 2013).

Water quality protection

Defects in distribution infrastructure may result in both leaks and intrusion, if operational pressure in a pipeline varies greatly (Mora-Rodriguez, Delgado-Galvan, Ramos, & Lopez-Jimenez, 2013). Pipeline breaks may cause intrusion of external contaminants into the pipeline, thus compromising water quality. Proactive water loss control reduces the risk associated with contamination of water in distribution infrastructure through breaks.

Accessibility to safe and affordable drinking water

The regulatory requirements would follow a progressive approach for improved monitoring, operations, detection and repair programs, and asset management. The proposed regulation is based on long-term cost-effectiveness. The proposed regulation will encourage prioritization of infrastructure monitoring and maintenance to reduce leakage. As described above, water loss control provides several direct benefits including reliable water supply. This approach will enable water suppliers with fewer resources to plan and implement water loss control in a cost-effective manner over a long compliance period. It is anticipated that water suppliers distributing water to disadvantaged communities would be able to prioritize and incorporate improvements in infrastructure maintenance for regulatory compliance and in turn reduce water outages and risks of contaminant intrusion from breaks.

Suppliers are anticipated to reduce lost revenue due to more efficient water distribution, which they could use to fund conservation or more water loss reduction programs or low-income affordability programs to improve accessibility to safe and affordable water. Despite upfront costs, these lower water supply costs could delay a rise in rates on a long-term basis, leading to improvement in the quality of life of California residents.

Increase in transparency and ratepayer trust

Large breaks may lose large amounts of potable water and cause damage and outages, which could appear contradictory to conservation efforts and negatively impact ratepayer trust. Conversely, leak detection activities and spreading awareness on efforts towards water loss control can boost ratepayer trust. Additionally, reducing water losses improves water use efficiency, which could shift reliance from high-cost water supplies and support higher drought-resilience and stability (Center for Neighborhood Technology, 2013). Proactive water loss control reduces interruptions in commercial activities, thus mitigating negative economic impacts from water outages. Additionally, the public availability of data from questionnaire responses on data quality, pressure management and asset management will improve transparency in practices suppliers conduct to monitor and maintain their water distribution systems.

Boost to economic activity

Methods to control water losses include possible use of different types of leak detection equipment, pressure monitoring and modulating devices, related software, repair and replacement technologies and suitable pipe material. Improving estimates of real losses may result in more accurate measurement of volumes of water flowing in the distribution system. Such efforts include meter testing, calibration and replacement and improving billing practices. These actions may generate additional economic activity in distribution infrastructure manufacturing, leak detection, pressure monitoring and modulation devices, water-efficiency and consulting sectors. Reduced unexpected infrastructure failures and avoided water outages and property damage will improve economic conditions for households, commercial establishments and businesses.

ALTERNATIVES INFORMATION

The State Water Board considered two alternatives to the water loss performance standards based on stakeholder comments and internal staff discussions. The two alternatives are evaluated for costs and benefits, economic impacts and cost-effectiveness, relative to the proposed standards.

Alternative 1

The first alternative proposes using a more stringent leak detection survey frequency to calculate the standards which would lead to quicker reduction in leakage as compared to the proposed regulation. The assumed leak detection survey rates to calculate the standards was half of those of the proposed regulation.

Under Alternative 1, 257 suppliers would be required to conduct leak detection and repair in order to maintain the corresponding water loss control level, slightly more than the number under the proposed regulation (253). This is as expected since Alternative 1 considers more stringent leak control implementation with relatively more stringent standards.

Costs and Benefits

For a typical utility, the total cost to comply with Alternative 1 is 3.09 million dollars in present value. The statewide total cost is about 792 million dollars. As compared to the proposed regulation, Alternative 1 would lead to approximately 54.49% higher costs. This is consistent with the fact that Alternative 1 would require more frequent leak surveying, which is associated with higher costs. The lifetime benefit from water loss reduction for a typical utility is about 20.5 million dollars in present value, which results in a total of 5.3 billion dollars statewide benefit. This is about 10.85% higher than the proposed regulation. As more frequent leak detection surveying would be able to identify and repair leaks in less time, it would reduce the total water loss further and lead to a higher total benefit. The net benefit would be approximately 10.66% higher than the proposed regulation. It should be noted that even though Alternative 1 would generate a larger net benefit, the percentage increase in cost, 54.49%, is much higher than the percentage increase in benefit, which is 10.85%. This implies that the extra benefit is associated with a much larger cost increase.

Economic Impacts

Macroeconomic impacts are also evaluated for Alternative 1. The RIMS-II model was used for this analysis, which is described in detail in the SRIA. Both the lifetime impacts and annual impacts are about 54% higher than the proposed regulation, which is consistent with the fact that the direct cost is about 54% higher and the same RIMSII multipliers are adopted.

Reason for Rejection

This Alternative 1 is rejected because the assumed leak detection frequency would not be a realistic representation of the anticipated leak detection frequencies that can be implemented by suppliers. Though it could lead to a rapid reduction in leakage, Alternative 1 would increase the annual costs to approximately 26 million per year. The initial costs per utility would increase by about 80% as compared to the proposed regulation. The higher initial costs would a impose larger burden on the suppliers. Even though the long-run benefits are relatively higher than the proposed regulation, the increased leak detection would be an unrealistic representation of implementation timelines. In addition, the cost effectiveness analysis shows that even though the total water loss reduction is higher for this Alternative 1, the average cost of reducing water loss is higher than the proposed regulation by approximately 39.6%.

Alternative 2

Alternative 2 is based on a proposal provided by the California Municipal Utilities Association (CMUA), which is an association representing urban water suppliers. This proposal would require a decrease in leakage to a volume equal to the 85th percentile of overall leakage for California averaged over three years instead of individual standards.

Under Alternative 2, only 61 urban water suppliers would be required to reduce their leakage, which accounts for less than one fourth of the suppliers affected by the proposed regulation and a total of only 15% of the larger urban water suppliers. This is as expected since Alternative 2 would require suppliers to only reduce their leakage to the 85th percentile of average losses in California.

Costs and Benefits

For a typical utility, the total cost to comply with Alternative 2 would be approximately136 thousand dollars in present value. The total cost on a statewide basis would be approximately 34.8 million dollars. Costs incurred under this alternative would 93.2% lower than those for the proposed regulation. This is consistent with the fact that Alternative 2 would result in less frequent leak surveying and repair, which would result in lower costs.

The lifetime benefit from water loss reduction for a typical utility would be approximately 21 million dollars in present value, which results in a total of 1.3 billion dollars in statewide benefit. The total benefit is 73.12% lower than that for the proposed regulation. Less frequent leak detection surveying would mean fewer leaks are identified and repaired, and would reduce the total water loss reduction and lead to a lower total benefit. The net benefit is about 70.33% lower than that the proposed regulation as well.

Economic Impacts

Macroeconomic impacts have been evaluated for Alternative 2 using the RIMSII model similar to the proposed regulation and Alternative 1. Both the lifetime impacts and annual impacts are approximately one tenth of those for the proposed regulation, which is consistent with the fact that the direct cost for Alternative 2 is about 93% lower than that for the proposed regulation with the same RIMSII multipliers.

Reason for Rejection

Alternative 2 is rejected because it would not reduce statewide water loss effectively, which is the key goal of Water Code section 10608.34. The current median leakage for the state is 27 gallons per connection per day, while the average is 35 gallons per connection per day. The proposed threshold per Alternative 2, i.e. the 85th percentile of the statewide leakage, would result in a standard of 54 gallons per connection per for all suppliers regardless of their system-specific characteristics. The proposed threshold would be twice that of the current median, which is not progressive for improving statewide water loss control, reduction of potential leakage, and improved maintenance of water infrastructure, and could in contrast result in a lapse in ongoing or future water loss control efforts.

Alternative 2 would impose lower costs on suppliers, but the amount of total water loss reduction would be 73% lower than the proposed regulation. Additionally, with inadequate water loss monitoring and maintenance of water supply infrastructure if Alternative 2 were to be adopted, suppliers and businesses would likely face higher costs in terms of unexpected leaks, water outages and property damage without regular monitoring and maintenance. Water supply infrastructure has been inadequately maintained and rehabilitated historically, which has led to its deterioration and overall higher long-term operational costs, demanding long overdue efforts towards water loss control (Sedlak, 2015). Thus, Alternative 2 would not achieve the goals of water loss control and water efficiency as effectively as the proposed regulation. Therefore, Alternative 2 is rejected.

Thus, the State Water Board determines that no other alternative currently identified is less burdensome and equally effective in achieving the purposes of the regulation in a manner that achieves the purposes of the statute being implemented. Interested persons may propose alternatives during a written comment period for the proposed regulation.

MANDATED USE OF SPECIFIC TECHNOLOGIES OR EQUIPMENT

The regulation does not mandate the use of any specific technologies and equipment.

EFFORTS TO AVOID DUPLICATION OR CONFLICT WITH THE CODE OF FEDERAL REGULATIONS

The State Water Board has determined that there are no conflicts with the Code of Federal Regulations, as there are no similar, equivalent or overlapping Federal regulations. Thus, the proposed regulation will not duplicate any parts of the Code of Federal Regulations.

STANDARDIZED REGULATORY IMPACT ASSESSMENT (SRIA)

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Abbreviations

AWWA – American Water Works Association

BEA – Bureau of Economic Analysis

CPI – Consumer Price Index

DWR – Department of Water Resources

EBMUD – East Bay Municipal Utility District

EPA – Environmental Protection Agency

LADWP – Los Angeles Department of Water and Power

MWD – Metropolitan Water District

NAICS – North American Industry Classification System

RIMS – Regional Input-Output Modeling System

SRIA – Standardized Regulatory Impact Assessment

SWRCB – State Water Resources Control Board

TAP – Technical Assistance Program

UWS – Urban Retail Water Suppliers

UWMP – Urban Water Management Plan

WLPS – Water Loss Performance Standards

PFAS – Per- and Polyfluoroalkyl substances

PFOA – Perfluorooctanoic acid

A. Introduction

Water has always been a scarce resource in California. Since the severe drought in 2015, conservation of water, especially drinking water, has become one of the most urgent and efficient ways to alleviate water crisis.

Urban population accounts for more than 90% of total population in California. Urban water use accounts for approximately 10-12% of total water use. Although urban water use is a relatively small part of total water used in the state, the production cost of drinking water is far higher, since urban water is mostly high quality water for drinking and other household uses. With the advent of the multi-year drought in 2011, several Governor-issued Executive Orders (B-37-16 and B-40-17)[8] directed state agencies to conserve water, reduce waste of water through leakage, and direct actions to reduce large leaks that waste large amounts of water. Additionally, Senate Bill 555 (2015) required the State Water Resources Control Board (State Water Board) to develop performance standards for water loss for urban water suppliers[9] (UWS), while considering life cycle cost accounting. The proposed Water Loss Performance Standards (WLPS) aim to reduce water loss, reduce the extra energy and emission from supplying and treating water that is lost to leakage, and meet the sustainability objectives of efficient water use in California.

Prior to passage of the Water Code section 10608.34, monitoring of water losses was limited to voluntary efforts by suppliers. There was no statewide standard or obligation regarding for the volume of water lost from distribution systems due to leakage. Water loss from leakage is an indicator of efficiency in water use and distribution. An average water supplier in California loses about 33 gallons per connection per day through leakage, which translates to water losses of about 300,000 acre-feet or 98 million gallons on an annual basis, as per data reported by urban retail water suppliers from 2017 to 2019[10].

Existing water resources are facing increasing demand due to rising population. This has resulted in efforts to augment water supplies through approaches such as recycling water and desalination, which increase the cost of produced water. The proposed regulation is designed to provide a long-term regulatory mechanism to bring water losses to levels that

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[8] https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/executive_orders.html

[9] "Urban retail water supplier" means a water supplier, either publicly or privately owned, that directly provides potable municipal water to more than 3,000 end users or that supplies more than 3,000 acre-feet of potable water annually at retail for municipal purposes.

[10] These figures are based on data from water loss auditing in California over 2016-17 and 2017-18.

are cost-effectively feasible for UWS. The water savings from reducing distribution losses on a long-term basis can delay the need for additional supplies.

Climate change has been adversely affecting water resources due to rising temperatures and changing precipitation patterns, resulting in multi-year droughts. As a result, California has been progressing towards greater conservation and water use efficiency. Controlling water loss through leaks is one of the key strategies for improving water use efficiency. The intent of this regulation is to establish requirement that will bring about a reduction in water losses and maintain low levels of leakage in California while using water resources efficiently in the face of climate change.

California has a high energy consumption associated with water supply (7%). Water loss control can avoid other costs associated with additional supply or pumping requirements and reduce the energy consumption associated with water distribution, which would contribute to a reduction in greenhouse gas emissions.

Lack of existing monitoring for leaks in distribution systems can lead to breaks that surface and cause property damage. High distribution pressure and variations also lead to breaks. Breaks can compromise water quality in the distribution system. The regulation will require each UWS to comply with a maximum allowable water loss volume that is cost-effectively achievable. This will encourage improved monitoring through increased leak detection and repair and pressure and asset management. These measures will result in a reduction in breaks and associated damages, including leaked water collecting contaminants and flowing into water bodies. An additional advantage is prolonged asset life due to improved maintenance of the distribution system.

The proposed regulation will encourage prioritization of infrastructure monitoring and maintenance to reduce leakage. The State Water Board intends to enable UWS to plan and implement water loss control in a cost-effective manner over the implementation timeline from 2020 through 2028 for water loss reduction, with ongoing compliance beyond 2028. It is anticipated that UWS supplying water to disadvantaged communities would be able to prioritize and incorporate improvements in infrastructure maintenance for regulatory compliance and in turn reduce water outages and risks of contaminant intrusion from breaks, however the upfront costs may prove burdensome for some disadvantaged communities, so the proposed regulation defers the initial compliance date, while still ensuring appropriate motivation remains to spur the intended benefits.

Methods to control water losses include possible use of different types of leak detection equipment, pressure monitoring and modulating devices, repair and replacement technologies, and suitable pipe material. Improving estimates of real losses may result in efforts to accurately measure volumes of water flowing in the distribution system. These actions may generate additional economic activity in distribution infrastructure manufacturing, leak detection, pressure monitoring and modulation devices and consulting sectors. Additionally, proactive water loss control reduces interruptions in commercial activities, thus mitigating negative economic impacts from water outages.

The Proposed WLPS has the following elements:

- Urban water suppliers would be required to comply with individual numeric volumetric standard for water loss by 2028 (or 2031 for suppliers meeting certain criteria relating to serving disadvantaged communities/residents). These standards would be calculated using a model developed by the State Water Board that assesses the additional benefits and costs associated with reducing the leakage to the volumetric standard. The standard would involve leakage reduction only if the net benefit is positive for the supplier given the system and water resource conditions.
- Except for certain UWS that have existing low leakage levels and high quality data, suppliers would be required to comply with three data submission requirements in 2023, and 2024 and 2027. The data submission would provide the State Water Board information on the following:
    - Improving data quality of water loss estimates during the early implementation period (2023)
    - Determining the operational and economic feasibility of reducing water loss requiring larger capital investment such as pressure management and asset management for individual water distribution systems (2024 and updates in 2027)
- The proposed regulation has the following provisions for urban water suppliers:
    - Adjustments: The supplier can provide the State Water Board with individualized data as the supplier improves its data accuracy and begins field implementation of water loss control approaches. This updated data can lead to an adjustment in the supplier's standard. These adjustments can be requested until 2023.
    - Variances: In case of natural disasters or other unexpected adverse circumstances, suppliers can request variances on an ongoing basis, which would provide the supplier with temporary relief regarding compliance.
    - UWS with existing low losses: Suppliers with existing water losses lower than the threshold determined by the State Water Board (16 gallons per service connection per day or the equivalent amount in gallons per mile per day) that can meet data quality criteria developed by the State Water Board, would not be required to reduce their water loss further or respond to the

questionnaires. Suppliers can qualify for this alternative compliance pathway until 2023.

1. Background of the Proposed Regulation

Water Code section 10608.34 (Senate Bill 555, 2015) sets statutory requirements for monitoring and reducing water losses through leaks in distribution systems. The State Water Board is required to develop performance standards for water loss by 2020 for urban water suppliers (UWS). Per statute, the State Water Board is required to evaluate a life cycle cost accounting in the development of the performance standards[11].

Urban water suppliers have been required to submit water loss audits since October 2017 pursuant to Water Code section 10608.34, subdivision (b) and regulations developed by Department of Water Resources. The water loss audits are required to be conducted per the M36 manual by the American Water Works Association (AWWA, 2016). The accuracy of the water loss estimates from these audits depends on the quality of entered data. The process of assessing the quality of data entered in the audit is called validation. Water Code section 638.3, subdivision (a) requires the submitted audits be validated.

Assembly Bill 1668 and Senate Bill 606, passed in 2018, require UWS to calculate their own individual urban water use objective beginning in 2024. The objectives are to be calculated based on efficient indoor, outdoor and commercial, industrial and institutional irrigation, and an allowable water loss volume, based on standards adopted by the State Water Board (except that the standard for indoor water use was set by the legislature, see Wat. Code, § 10609.4). The volumetric water loss standards would be used as the allowable water loss volume to calculate the urban water use objectives.

The formal rulemaking process is expected to begin in early 2021 and is expected to conclude by July 2021.

2. Background on water loss reporting and control in California

Suppliers are currently required to report their water loss using water loss audits. These audits are spreadsheets which calculate the amount of leakage or real loss, based on the

[11] The lifecycle cost accounting will consider costs, and benefits, projected to accrue while implementing interventions over their lifetime, including planning, installation, implementation, and operation of interventions that may be used to meet the performance standards.

reported volumes of water that flow into the system and that are supplied. The accuracy of estimated leakage is tied to the these reported volumes. These reported volumes are subject to the supplier's water metering, meter testing and data handling practices. Lack of metering and regular testing of meters to determine errors can introduce significant error in these audits, particularly due to potential inaccuracies in these volumes.

The goal of the regulatory proposal is to establish individual standards for each supplier built on these industry-established concepts, based on economic analysis of the benefits and costs associated with reducing leakage. The standard calculation depends on the accuracy of reported data. The data submission requirement on practices to improve data quality is intended to improve reliability of reported data, and to encourage data quality improvement during implementation and prior to compliance. The proposed regulation does not prescribe data improvement practices.

Intervention strategies to reduce leakage, also known as real loss, can vary depending on distribution system characteristics and the nature of real loss. Real loss can occur in several forms describe as follows:

- Visible failures that are large and occur above the ground.
- Hidden leakage that is not visible above ground but detectable by surveying the distribution system through specialized equipment.
- Background leakage that is too small to be detected with specialized equipment, but that can be reduced by replacing or rehabilitating infrastructure or managing pressure.

Real loss reduction has four key approaches as per industry practices that are suited for each form of leakage (Figure 1):

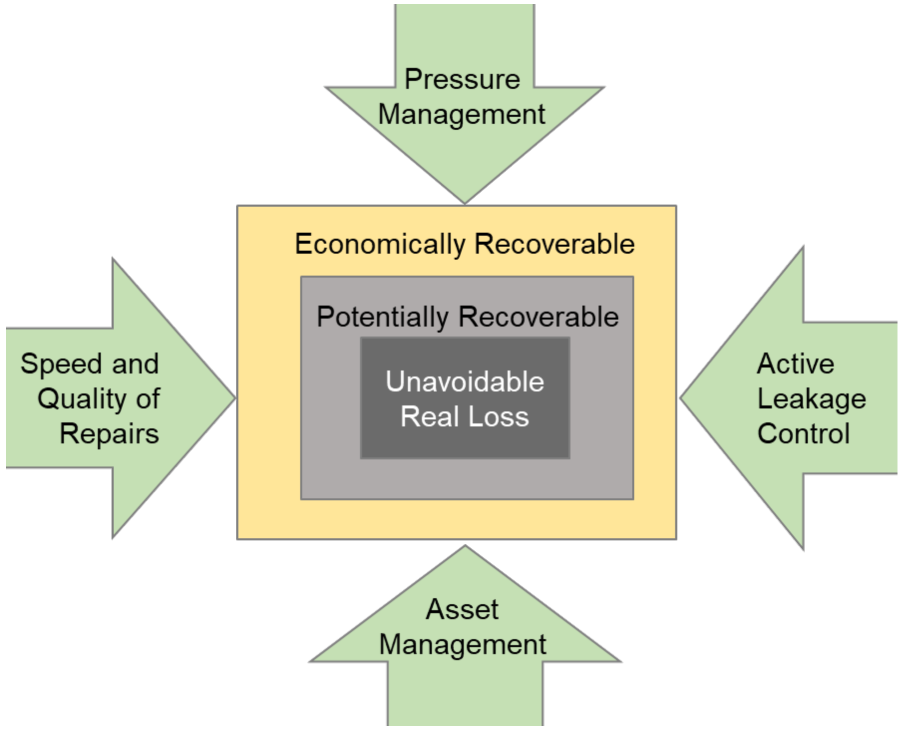

Figure 1 Foundational Approaches to Leak Detection

- Active leak detection and repair involves surveying the distribution system for leaks with specialized equipment, and repairing those leaks. This method is typically used to reduce hidden detectable leakage.
- Reducing time between locating and repairing a leak minimizes the amount of water lost through visible or detectable leaks.
- Pressure management reduces strain on the distribution system infrastructure due to high water pressure or variations in water pressure (water hammer effect), and reduces the water leaking through cracks and defects in the system.
- Systematic asset management reduces leakage by prioritizing replacement of pipes and other appurtenances, usually those that are leakiest and have most failures and those located in areas of high consequence, e.g. hospitals, dense commercial centers.

Pressure and asset management are the only approaches that can be used to reduce background leakage that is too small to be detected through specialized equipment. These approaches, with reducing repair time, can be used to reduce the occurrence of and loss of water through reported leaks. Of these approaches, the feasibility of implementing pressure management and asset management and the estimated volume of leakage reduction depends on operational characteristics for each distribution system. Estimating the amount of leakage that is recoverable through pressure management and asset management for urban water suppliers involves high amount of uncertainty and the supplier's unique characteristics.

On the other hand, due to availability of data, associated costs and benefits of implementing active leak detection and repair for each supplier can be determined to a much greater degree of accuracy. The amount of leakage that is recoverable can be determined from data on length of pipeline, number of service connections and operational water pressure, as reported by suppliers.

Unreported or hidden leakage can be reduced by either of the standard approaches, in contrast to background or reported leakage. The intent of this regulation is to provide each supplier the flexibility to choose any effective approach best suited for its system and budget to reduce the leakage to the volumetric standard. The economic model developed by the State Water Board to calculate the individual volumetric standards focuses on unreported, hidden leakage, to ensure flexibility in choice of approach.

3. Overview of proposed framework for performance standards

The State Water Board is required to adopt performance standards for all urban water suppliers. Compliance with the regulation will be in the form of volumetric water loss reduction based on economic and engineering feasibility, and submission of data on practices influencing reported water loss data, and efforts towards water loss control. The regulations for performance standards would require compliance with four requirements:

- Data submission on underlying data quality of water loss audits (2023)
- Data submission on feasibility of pressure management and asset management (2024, and updated 2027)
- Leakage (real loss) reduction to comply with individual volumetric standard in gallons per connection or mile per day (by 2028) if assessed as economically feasible.
- Maintain leakage at volumetric standard on three-year average basis with an allowed variation of 5 gallons per connection per day (beyond 2028)

Additional details on each requirement are provided in the next section. The performance standards adopted in 2021 will require compliance with a volumetric performance standard by 2028. The calculation of the volumetric standard would be based on an economic assessment of costs and benefits associated with actions required to reduce real loss. A supplier's individual standard would require the supplier to reduce real loss, if the net benefit of reducing the real loss is positive. If the net benefit of reducing real loss for the supplier is not positive, the individual standard for the supplier would only require the supplier to maintain its system at its current level of real loss.

The proposed approach will provide opportunities for adjustments to the volumetric standard in 2023 based on additional data. The proposed regulation would have a process for UWS's to request adjustments of their allowable water loss volume owing to improvements in data accuracy, and hence the reported real loss. Additionally, the framework includes a process to request for a variance in case of natural disasters or economically adverse circumstances.

The regulatory framework provides suppliers with low losses and high data quality an alternative compliance pathway where the suppliers would not be required to further reduce their real loss or submit additional data on data quality, pressure and asset management. Suppliers with losses lower than 16 gallons per connection per day, or the equivalent real loss in gallons per mile per day, that can demonstrate high underlying data quality by meeting data quality criteria developed by the State Water Board will qualify for this alternative compliance pathway.

a. Data submission on underlying data quality of water loss audits (2023)

The State Water Board provided $3.2 million in funding to the California-Nevada section of AWWA (CA-NV AWWA) to develop and execute a Technical Assistance Program (TAP) over a period of two years to facilitate the reporting of water loss volumes through AWWA audits. The report on TAP (Water Systems Optimization and Cavanaugh, 2017) outlined gaps in collected data and monitoring practices that could impact the reliability of data from water loss audits. The gaps identified were uncertainty in estimating source and customer meter inaccuracy and average operating pressure and negative or technically implausible estimates for water loss.

To address these data gaps, the regulation would require suppliers to submit data as responses to questionnaires on their metering and meter testing practices by January 1, 2023. The questions are aimed to gauge suppliers' current practices to assess the quality of underlying data for audits. The data submission does not require additional analysis or field work, but only reporting of current practices.

b. Data submission on feasibility of pressure and asset management (2024/2027)

Pressure management and asset management are crucial approaches to reducing water loss control. These approaches are known to be highly effective in reducing real losses through small undetectable leak and large visible leaks. Water loss control may require multiple approaches to be effective, in addition to active detection and repair. Due to supplier-specific needs and constraints that need to be considered for implementing these two approaches, it is proposed that suppliers submit data as responses to questionnaires by July 2024, and update those response in 2027. The questions will assess suppliers' efforts towards systematic asset management and pressure management to reduce leakage in portions of the water distribution system that are highly prone to leakage. The data submission does not require additional analysis or field work, but only reporting of current practices.

c. Allowable water loss volume to be included in urban water use objective by 2028

The calculation of standards incorporates various unique characteristics of each water distribution system. The economic assessment to calculate the standards evaluates the type of real loss occurring in each system and calculates the reduction of real loss that is economically feasible. The standard is based on the volume of leakage reduction possible through standard approaches available to the suppliers. The proposed regulation aims to provide the supplier the flexibility to select the appropriate approach for their system to reduce real losses to the volumetric standard. The economic model that calculates the individual volumetric standards focuses on unreported, hidden leakage which can be reduced by all standard approaches, to ensure flexibility in choice of approach. The economic model bases the economic feasibility on costs and benefits associated with implementing active leak detection and repair, due to the availability of reliable data on costs and benefits associated with using this approach. The regulation does not require suppliers to use specific technologies, and bases the standard only on the amount of reduction feasible during this period. It is anticipated that suppliers would need additional time in the initial period of implementation to select vendors and finalize contracts prior to implementation and achieving any real loss reduction. To accommodate this need, the model assumes that the period of actual reduction of real loss is 2022 through 2027, while compliance is assessed based on the annual audits submitted January 1, 2028, reporting water loss for 2027.

d. Ongoing Water Loss Control (2028 onwards)

Maintaining an appropriately low level of leakage efficiently requires continued infrastructure maintenance to control newly emerging leakage over time. These maintenance efforts involve regular monitoring of the distribution system, prioritizing infrastructure replacement and continued repair (and replacement as suitable) for system components. From 2028 onwards, UWS's would be required to comply with their water loss standard on a three-year average basis with an allowed deviation of 5 gallons per connection per day.

Per statute, the State Water Board is required to consider life-cycle costs accounting in its development of water loss performance standards. Once the supplier meets its individual standard in 2028, the economic model incorporates the costs and benefits associated with maintaining the real loss for the supplier for ongoing compliance. To incorporate the lifecycle of intervention strategies and the anticipated time for which suppliers may incur additional costs and benefits, the model considers a time horizon of 30 years.

The model is based on real loss reduction achievable through active leak detection and repair. The equipment used for active leak detection and repair has a typical lifecycle of 10 to 15 years. The duration between adoption and compliance is 7 years, with ongoing compliance beyond these 7 years. A lifecycle of 30 years accounts for the longer implementation, useful lifecycle of pipe material and compliance period, for the purpose of lifecycle cost accounting, as required by the statute.

4. Economic model to calculate performance standards

Water Code section 10608.34 requires the State Water Board to consider life-cycle costs accounting in its development of water loss performance standards. For UWS's, cost-effective water loss reduction requires a balance between the potential benefits and costs associated with reducing and maintaining losses at a lower level. For example, eliminating leakage completely from a water distribution system may not be economical, with the costs incurred being higher than the benefits achieved. The objective of the regulation is to determine the water loss volume that each supplier can cost-effectively achieve, with costs and benefits estimated over the life cycle of intervention strategies and compliance.

The effects of climate change are expected to be extended and severe droughts, warmer temperatures, and changed precipitation patterns. At the same time, California faces an increasing demand for water. Water loss control from distribution systems is an effective way of conserving water and strengthening drought resilience and potentially avoiding the need for additional water resources. Additionally, water lost through leakage from UWS infrastructure is usually treated to potable quality, conveyed from treatment facilities to the end user, and at times imported from distant sources of water before being lost as leakage. Accordingly, the water lost can also have a high energy and carbon footprint for the UWS and the state.

Costs and benefits associated with real loss reduction[12]

The economic model uses data reported by suppliers through water loss audits, costs associated with active leak detection and repair based on quotes from vendors, literature review and estimates from water suppliers. The benefits associated with water loss reductions are calculated based on the higher of variable production cost of water or the avoided cost of water. The reduction of embedded energy is included in the production or avoided cost of water. The economic model assumes that all located leaks are repaired.

The volume of real loss reduced is calculated by assuming that all detected leaks are repaired. The model calculates the volume of real loss reduced through active leak detection and repair based on the volume and number of leaks typically detected and repaired for each distribution system as established by the American Water Works Association (American Water Works Association, 2016). The model assesses the present value of the net benefit associated with real loss reduction over the time horizon. The model calculates a volumetric standard for the water distribution system based on the volume of real loss over the year prior to compliance, if the net benefit is positive over 30 years.

The model is in the process of being peer reviewed by an independent expert panel, especially to review all underlying assumptions, findings and default values for the model. The model structure would also be peer reviewed by this panel.

Table 1 Costs and Benefits associated with Real Loss Reduction

Associated Costs over time horizon of 30 years	Associated Benefits over time horizon of 30 years

[12] Please refer to the Appendix for detailed information on the costs and benefits.

Cost of surveying water distribution systems to detect and locate leaks Cost of repairing leaks found while surveying Costs associated with additional excavations, where equipment shows false positives while detecting leaks. Costs are discounted at the rate of 3.5%.	Marginal value of lost water valued at the avoided cost of water saved by reducing real loss or the variable production cost of water, whichever is higher Real rise in price of water projected from the average annual increase at 5.6% Benefits are discounted at the rate of 3.5%.

e. Innovation in technology

Real loss reduction and leak detection and repair is an emerging field. It is assumed that the proposed regulation would not have a significant impact on leak detection and repair costs since the regulation could have two potential opposite impacts on these costs. On the one hand, due to increase in the demand for leak detection and repair services, leak detection and repair service vendors or businesses might charge higher prices if no new businesses enter this sector. This is likely to be the case in the short run. Conversely, higher demand might generate more competition among existing businesses and new firms may have incentive to enter the market as well, which could further increase competition. Competition would incentivize suppliers to innovate existing technology to decrease marginal cost and benefit from the economy of scale. This would drive down the price of leak detection and repair. This would be more likely in the long run. Combining these two forces, it would be challenging to identify either the direction or the magnitude of the potential impact. The most likely outcome is some combination of both.

f. Data used in the model

The model uses data reported on current real losses, the variable production cost of water and other system-specific characteristics such as average operating pressure, length of distribution mains, service connections from the water loss audits submitted by suppliers from 2017 through 2020. The reported data is averaged over a period of four years.

Additionally, the proposed regulation would allow suppliers to provide individual system-specific information for several parameters used to evaluate the type of leakage occurring in the distribution system, and the cost that suppliers incur for detecting and repairing leaks. The suppliers can also provide values appropriate for their distribution systems for the marginal avoided cost of water. For suppliers that are unable to provide values for these parameters, the model provides default values. The default values for these parameters are as follows:

Marginal cost of avoided cost of water

The marginal cost of avoided cost of water is determined from the cost of alternative water sources available to the supplier. The most common alternative water sources are stormwater reuse, recycled water (indirect potable reuse), brackish water desalination and imported water. The Pacific Institute has estimated the cost for each of these sources (Pacific Institute, 2016)

Costs associated with interventions for real loss reduction

Costs for leak detection surveying are in metrics of dollars per mile surveyed. The State Water Board obtained estimates for cost incurred by a supplier both for leak detection programs that were conducted in-house and that were outsourced. A fraction of suppliers have in-house leak detection programs, while it is anticipated that most suppliers could opt for external consultants for leak detection.

The model uses the unit costs on the higher end of the range, both for surveying and pinpointing, to accommodate for the use of external technical consultants by suppliers.

Leak repair costs

Typically, suppliers do not outsource leak repairs, and instead use their own staff to repair leaks. The cost of repairing leaks varies significantly with pipe size, type of pipe, extent and size of leak, and depth of pipe. The State Water Board obtained a large range of leak repair costs from suppliers and from existing literature. Predicting the specifics of a pipe that could be identified to have a leak has high uncertainty associated with it. It was assumed in the model that there is equal probability to detect a leak in any type of pipe, and the average of all these estimates was used to value the cost of repairing each detected leak. The costs were averaged over the two years to accommodate for changes in material vendors and cost of pipe material.

The average cost calculated from all these estimates is $ 5,946 per leak.

The model has three parameters that are fixed in the model and would not be changed by suppliers:

Time horizon

The time horizon is considered to be 30 years to incorporate the costs and benefits associated with ongoing compliance beyond 2028, and lifecycle of intervention strategies.

Discount rate

The associated costs and benefits would be discounted annually at the rate of 3.5% per stakeholder recommendation. This is also in line with the Guidelines for Preparing Economic Analysis (2014) from the US EPA, which suggests that the real discount rate should be in the range of 3%-7%, depending on whether costs and benefits are incurred contingent on consumption flows or capital stocks, and the time horizon. Consumption flows are associated with lower discount rates than capital stocks. In general, a lower discount rate could be adopted if the regulation impact is expected to last longer, especially with consideration of intergenerational equity. The proposed regulation is intended to conserve water and it would have permanent impacts on water resources and the environment, with a time horizon of 30 years for economic analysis. Therefore, a relatively low discount rate is proposed.

Rise in price of water

The Metropolitan Water District (MWD) is the largest water wholesaler in California. It supplies approximately 19 million people, which is almost half the population of California. The rise in price of water is projected from the average annual rise in the cost of treated wholesale water that MWD sells to its member agencies that are urban water suppliers.

Water resources in California are facing impacts of climate change, including early snow melt due to high temperatures and long periods of drought. Groundwater in California has had a lower rise in cost until recently, but this scenario is anticipated to change due to the implementation of the Sustainable Groundwater Management Act (SGMA)[13]. SGMA is likely to require water suppliers and users in many groundwater basins to manage demand and develop approaches to use groundwater sustainably to reduce and prevent groundwater overdraft. These approaches will require investment from water users and suppliers for ensuring sustainable groundwater use. Additionally, water suppliers would be anticipated to invest in treatment systems for emerging contaminants such as per- and

[13] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Groundwater-Sustainability-Plans/Files/GSP/Overview-of-COD-GSPs.pdf?la=en&hash=79DB286C10345CFAE9AEA25EF3084351EDCA6C78

polyfluoroalkyl substances (PFAS)[14]. These issues are expected to increase water costs higher than previously observed for groundwater sources.

Currently projections for the future cost of water for groundwater users has high uncertainty, as plans for sustainable groundwater management and PFAS treatment are still under development. Hence, the State Water Board staff is using the rise in costs that are being observed for imported water, i.e., water sold by MWD, that is 5.9% (Metropolitan Water District, 2020).

It should be emphasized that both the costs and benefits calculated from the model are real values since they have been either adjusted for inflation or using the current prices. Costs are based on current cost information reported by the water suppliers. Benefits are calculated with a 5.9% annual growth in real water prices since all the prices are adjusted by CPI. Therefore, the costs and benefits are real present values after discounting from the future values with a real discount rate.

5. Provision for Requesting Adjustments by UWS's

Suppliers would be able to request adjustments to standards if there are significant changes to data used in the economic model for calculating standards, which could impact their standard. These adjustments will be evaluated on a case-by-case basis, based on documentation supporting the adjustment. Suppliers will be able to request these adjustments by July 1, 2023.

Additionally, suppliers would be able to request a variance regarding compliance with their volumetric standard if they can demonstrate unexpected adverse conditions which prevent it from implementing established measures or strategies to achieve its standard. The request would need to be accompanied by supporting documentation of conditions pertaining to distribution system characteristics or administrative procedures warranting the variance. Thus, the water loss standards for suppliers could change as a result of adjustments, or variances. This could affect the associated benefits and costs. Predicting variations with these costs and benefits due to adjustments and variances involve a high amount of uncertainty, due to which the State Water Board has presented the analysis using default values used in the model.

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[14] https://www.waterboards.ca.gov/publications_forms/publications/factsheets/docs/pfoa_pfos_guidelines_faq_factsheet.pdf

6. Major Regulation Determination

A major regulation is “any proposed rulemaking action adopting, amending or repealing a regulation subject to review by [the Office of Administrative Law (OAL)] that will have an economic impact on California business enterprises and individuals in an amount exceeding $50 million in any 12-month period between the date the major regulation is estimated to be filed with the Secretary of State through 12 months after the major regulation is estimated to be fully implemented (as estimated by the agency) computed without regard to any offsetting benefits or costs that might result directly or indirectly from that adoption, amendment, or repeal.” (Budget letter 13-30, California Department of Finance.)

The proposed WLPS regulation has been determined to be a major regulation because the annual macroeconomic impact would exceed $50 million in a 12-month period, during the period of analysis, 2022 through 2051. As shown in section D.3, the impact on gross output in 2022 is about $53 million, which is higher than the threshold.

7. Baseline

The economic impact of the proposed WLPS regulation is evaluated against a baseline of current business as usual (BAU) climate in water loss control, i.e., in the absence of the proposed WLPS regulation suppliers would conduct the minimum level of leakage detection and repair on their water distribution systems. The baseline assumes that water suppliers would conduct leak detection surveys or repairs only as needed to maintain leakage at current levels. The amount the water loss from the distribution system is evaluated based on the current leakage reported by the water supplier in the audit process.

This baseline represents a constant water loss, which is a conservative estimate. Typically, water distribution systems deteriorate over time and need regular monitoring and maintenance. Thus, it is expected that without regular maintenance the leakage would rise naturally as time passes. But, with the implementation of AB 1668 and SB 606, suppliers would be required to comply with a water use objective that reflects efficient water use and conservation. This objective includes various water uses such as indoor water use, outdoor water use, commercial outdoor use for irrigation and water loss through leaks. Thus, due to this additional regulatory motivation, it is anticipated that, without the proposed regulation, suppliers would at minimum maintain their system so as not to exceed their current leakage to comply with their urban water use objective.

8. Public Outreach and Input

As part of an extensive pre-rulemaking process for the proposed regulation, the State Water Board has been engaging with stakeholders, including, water suppliers, industry experts, and environmental justice groups, through public meetings and workshops, and input received from stakeholders. The stakeholder engagement covered topics such as data accuracy and variability, focus areas, program implementation, costs, feasibility and efficiency of interventions, rulemaking framework and the economic framework and analysis.

Prior stakeholder engagement was conducted on the following topics[15]:

- Data quality and performance indicators: March 2018
- Water loss control actions, June 2018
- Avoided cost of water, Water loss control implementation in California (presented by water suppliers): September 2018
- Staff proposed framework: February 2019
- Assumptions, benefit-cost calculations behind economic framework: June 2019
- First draft of economic model to calculate standards: September 2019, with express comment period
- Data submission requirements: December 2019
- Second draft of economic model to calculate standard, data submission requirements and revised regulatory proposal: May 2020, with express comment period

Additionally, the State Water Board conducted meetings and calls with individual suppliers and regional water supplier associations to address questions and issues related to the regulatory framework. The State Water Board has also participated in several conferences to present the regulatory proposal at various stages, organized by associations such as the American Water Works Association and the Alliance for Water Efficiency.

B. Direct Benefits from Regulation

The proposed regulation is intended to reduce water losses in the distribution systems of urban water suppliers through utility-specific performance standards. The main direct benefits are from the value of water saved due to the proposed regulation. The saved

[15] https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/water_loss_control.html

water includes the cost and energy associated with extracting or importing water, and treating and pumping it for eventual distribution. Direct benefits have been quantified in the economic model, as a function of utility specific variables (e.g. variable production costs) and estimated discounting. In order to evaluate the life cycle benefit, future benefits are converted to present values through appropriate discount rate.

1. Benefits to Typical Utilities

The benefits are calculated using the marginal cost of future water, with the rising price of water incorporated at areal annual rate of 5.9%. The future marginal cost of water is based on an average of alternative sources - such as imported water, recycled water, brackish and sea water desalination - which amounts to $1,093 per acre-feet of water (Pacific Institute, 2016). If a supplier's current variable production cost was higher than this value, their current variable production cost was used. The State Water Board has evaluated the increase in price of water sold by the Metropolitan Water District of California (the largest supplier of imported water in California) over the past decade; that increase has been 5.9%, and the State Water Board proposes to use that value in the economic model to generally reflect the increase in price of water for urban retailer water suppliers., That value is expected to remain reasonable over the lifetime of the regulation while accounting for increased production costs due to the implementation of SGMA and higher water quality requirements addressing emerging contaminants such as PFOA and PFAS.

The baseline discount rate to be used in the economic model is 3.5%, which takes into consideration the potential future impacts of climate change as well as the duration of the regulation and the likely activities to be taken for compliance with the regulation. The real discount rate of 3.5% is based on stakeholder recommendations and recognizes that water scarcity is increasing due to climate change. A discount rate is typically used to predict how the value of an investment or a consumption depreciates with time. A lower discount rate recognizes that investments made today will have more value in the future, given the increasing strain on existing water resources and the need for diversifying water sources. The variable production costs are from the audit data provided by the UWS's.

The calculation of direct benefits is based on the input values for each utility system over a 30-year period, and then aggregated to the state level.[16] A typical utility is a hypothetical utility defined as the average across all the utilities subject to the regulation. For this hypothetical utility, as shown in Table 2, this proposed regulation would result in 15,042

[16] As the regulation is targeting system-level water loss control, the analysis in this SRIA is based on system-level information. For suppliers with multiple systems, the costs and benefits could be summed up into supplier level if needed.

acre-feet of water loss reduction and therefore generate total benefits of $18.9 million dollars in present value.

Table 2 Direct Benefits for Utilities

	Typical Utility	Small Private Businesses
Water loss reduction (acre-foot)	15,042	4,226
Total Benefits ($)	18,930,514	5,181,727

Importantly, the model does not incorporate additional benefits from leak reduction approaches other than leak detection and repair, namely, preventative pipe replacement, and pressure management. Additional benefits include prevention of unexpected main breaks that can cause property damage, water outages and traffic increases; decreasing strain on distribution systems and early deterioration; avoiding potential contamination of water due to defects in the infrastructure; and the long-run benefits to watershed sustainability. Quantifying these benefits involves a high amount of uncertainty, and thus these likely additional benefits are not included in the model.

2. Benefits to Small Businesses

In addition, the costs on small businesses are examined separately. According to Government Code, section 11346.3, subdivision (b)(4)(B), small businesses are businesses that satisfy three criteria: (a) Independently owned and operated.; (b) Not dominant in its field of operation; and (c) Has fewer than 100 employees. Among the 253 water utilities that could be impacted by the proposed regulation, 43 are privately owned water companies. Nine of them meet the criteria that define a small business, with the other two criteria. On average, the regulation would generate 4,226 acre-feet water loss reduction in the 30-year lifetime at utility level for small businesses, with total benefits amounting to 5.2 million dollars. Both are much lower than the benefits to a typical utility because smaller utilities generally have a smaller water system with a lower length of pipe, and a corresponding lower volume of total leakage that could occur.

3. Statewide benefits

Given that the State Water Board’s model is utility-specific, benefits must be aggregated to give an estimate of the direct benefits to the state. There are 409 utilities that have reported data as UWS. The total benefit to the State is composed of the total values of water loss reduction for all these utilities. There are some other benefits that have been excluded from the scope of calculation for the regulation, such as the reduction in carbon emissions from decreased water pumping activities accompanying with the water loss reduction, because this cannot reasonably be calculated based on existing information or projects, but that is anticipated to be significant at the statewide. More discussion will be presented in the later sections. Additional UWS that have not reported data might report or be required to report in future, with standards being set for them. Costs and benefits associated with these UWS have not been quantified due to the lack of reported data.

The benefits are estimated based on the amount of water saved through real loss reduction. The model compares the amount of real loss that a distribution system would have under two scenarios: No intervention (business as usual) while maintaining existing real loss levels; and With intervention (with reduced leakage based on a reasonable average leak detection frequency).

As shown in Table 3, the total amount of water saved at the state level is approximately 3.8 million acre-feet, and the associated total benefit is as high as about 4.8 billion dollars. Annual benefits are reported in Column 3-5 for several critical years: anticipated beginning of implementation (2022), primary year of initial compliance (2028) and the end of the assumed lifecycle period (2051). The water saved in the initial year (2022) would be 21,830 acre-feet, due primarily to new leak detection and repair. This number would increase to 132,972 after 2028 when nearly all the utilities complete their initial survey of the whole water system and continue until the end of the assumed lifetime (2051). The associated benefit would increase from about 26 million dollars in 2022 to about 170 million dollars in 2028 and then decrease to 151 million dollars in 2051.

Table 3 Direct Benefits for the State

	30-year lifetime	2022	2028	2051
Water Saved (AF)	3,805,702	21,830	132,972	132,972
Total Benefit ($)	4,751,559,131	25,620,560	169,972,304	150,848,094

C. Direct Costs from Regulation

The proposed regulation results in direct costs to urban water suppliers, which would have spillover effects to individuals and businesses (indirect costs). No other group of individuals or businesses are anticipated to face direct costs from this regulation. Individuals are not expected to modify any home infrastructure or plumbing, and thus do not face any direct costs of this regulation. Water bills may increase slightly for ratepayers, and thus individual households, due to increased maintenance of supplier-owned water distribution systems; this is discussed in Section D.3.h.

The direct costs calculated are based on costs associated with regular leak detection and repair of detected leaks, for suppliers that can reduce leakage effectively, over the time horizon of 30 years. Direct costs have been quantified in the economic model as a function of current real loss and system characteristics, such as length of mains, number of service connections and operational parameters. The economic model also contains a detailed description of the variables and equations used to calculate direct costs. Please refer to Section A.5 for details.

1. Costs to Typical Utility

The direct costs of conducting leak detection and repair are calculated based on a unit cost for surveying and repairing detected leaks for each mile of the distribution system. The calculation of the direct costs is based on input values for each utility over a 30-year period for the time horizon of the economic assessment, and then aggregated up to the state level. A typical utility is then defined as a utility with the average cost and benefit among all the impacted utilities.

As discussed in Section A.5, three components are considered in the total costs: leakage detection cost, leak repair cost, and monitoring and reporting costs associated with complying the proposed regulation. Table 4 reports the direct costs over the 30-year lifetime. For the hypothetical typical utility, the highest direct cost would be from leak detection, which is approximately 1.4 million dollars. The repair cost is 420,820 dollars. In addition, it is assumed that each impacted utility would need 1/24 personnel-year of an engineer position to monitor the leak detection and repair progress and report to the State Water Board, including preparing data and paperwork. It should be noted that these tasks could be absorbed by the existing employees at water utilities. The cost of this position is assumed to be $200,000 per year in 2020 with an annual real growth rate of 3.5%.[17] This results in a total of monitoring and reporting cost of $250,000 in present value.

Table 4 Direct Costs for Utilities

[17] If an alternative growth rate is adopted, the monitoring and reporting cost could be higher or lower, but would be still in line with the magnitude estimated here.

	Typical Utility	Small Private Utility (Small business)
Leakage Detection ($)	1,356,840	481,546
Repair Costs ($)	420,820	120,682
Monitoring and Reporting Costs ($)	250,000	250,000
Total Costs per Utility ($)	2,027,660	852,228

2. Costs to Small Businesses

In addition, the costs on small businesses are examined separately. Small businesses are defined in Government Code, section 11346.3, subdivision (b)(4)(B), by the following three criteria: (a) Independently owned and operated; (b) Not dominant in its field of operation; and (c) Has fewer than 100 employees. Among the 253 water systems potentially impacted by the proposed regulation, 9 are identified as small businesses with these criteria. On average, the total cost is about $852,228 for small businesses, less than half that of the typical utility. This is mainly because small businesses have smaller water supply systems with shorter pipes and fewer total leaks to repair, which leads to both lower leak detection and repair costs. For simplicity, monitoring and reporting costs are assumed to be independent of utility size since it involves similar amount of paperwork and monitoring efforts regardless of the size.

3. Statewide Costs

Given that the State Water Board's economic model is utility-specific, costs could be aggregated to give an estimate of the direct costs to the state. There are 409 utilities counted as urban water suppliers, among which 253 utilities would potentially be impacted by the proposed regulation. This means that these water systems would need to conduct leak detection and repair to comply with their water loss standard. The total cost to the State is composed of the leak detection cost, leak repair cost, and monitoring/reporting cost.

As shown in Table 5, the total costs for all the impacted utilities at the state level would be about 512 million dollars over the 30-year lifetime. The costs on leak detection is about 343 million dollars for the lifetime considered, which accounts for about 67% of the total cost. Leak repair costs account for another 21% of the total cost, and the rest is monitoring and reporting costs. The average annual cost would be about 17 million dollars, and the actual annual costs vary from year to year. Columns 3-5 report the annual costs in 2022, 2028 and 2051, respectively. In 2022, the total cost is about 30 million dollars. It declines to about 21 million dollars in 2028 and further down to about 10 million dollars in 2051. The savings are mainly due to regular detection in the later years.

Table 5 Direct Costs for the State

	30-year lifetime	2022	2028	2051
Leak detection costs ($)	343,280,575	20,913,102	14,279,132	6,391,512
Repair costs ($)	106,467,436	6,495,944	4,323,040	1,935,045
Monitoring and Reporting costs ($)	62,750,000	2,091,667	2,091,667	2,091,667
Total Costs ($)	512,498,011	29,500,712	20,806,125	10,468,484

D. Macroeconomic Impacts

1. Methodology

Direct costs are translated into inputs of a general equilibrium economic model to assess the macroeconomic, indirect, and spillover effects of the regulation. The statewide impacts of the proposed regulation on the California economy will depend on the results from the general equilibrium model. The State Water Board adopts the regional economic model developed by the US Bureau of Economic Analysis (BEA), Regional Input-Output Modeling System (RIMS II). The RIMS II model provides multipliers that allow the Board to estimate the effect of the regulation on the industries in California.

RIMS II is produced by the U.S. BEA using its 2012 national I-O table, which shows the input and output structure of 372 U.S. industries, which have then been adjusted by their 2017 regional economic accounts to reflect California-specific industrial structure and trading patterns.[18] Each industry is associated with a set of multipliers that represent how

[18] Please see https://apps.bea.gov/regional/rims/rimsii/ for detailed information.

final demand changes would be translated into regional outputs, earnings and employment.

The RIMS II model depends on a few important modeling assumptions that can be considered as limitations to this approach. First, only backward linkages are modeled in RIMS II. In other words, only the impacts on the upstream industries are included in the model. Second, businesses in the affected industries have no supply constraints and can satisfy additional demand with an increase in inputs and labor from within the State. Third, it assumes businesses have fixed patterns of purchases, or no potential technological changes are allowed in the model. Fourth, the model assumes businesses use local inputs if they are available.

Regarding the first assumption, one concern is that water is a key input for various industries. If the water suppliers pass the costs of complying with the WLPS regulation to consumers, which results in a significant consumer price increase, then the downstream industries that use water as an input would be affected. Based on our later analysis on water price, the potential change in water price is negligible (below 0.01% increase in household water bill as a share of disposable income for the first year). This justifies the adoption of RIMS model for this analysis. The second assumption would be violated if there is a capacity limit for detection, repair and pressure management equipment and services. Given that the total demand changes for these industries are not extremely large and the water suppliers would split the changes across time, effects are unlikely to reach any supply capacity.

Regarding the third assumption, the reality is that technology has been developed to be more efficient in leak detection and repairs in the last decades. For example, since 2016, some leak detection companies have started using continuous acoustic monitoring systems, which have decreased the use of equipment and labor efficiently by automating leak detection and location.[19] Additionally, consistent use of leak detection over time increases efficiency of the equipment due to increased training and technical knowledge. This applies not only to the service contractors, but also to the operators who may find more cost-effective solutions to satisfy the requirements of the proposed regulation. Therefore, the results of the assessment represent the impact's upper bound. As for the fourth assumption, since a majority share of the changes in final demand are services which are mostly provided by local firms, this assumption can be reasonably accepted. In the case that some of these services and equipment are not provided by the local companies, the Board's estimates based on RIMS II multipliers tend to overestimate the impacts.

2. Inputs to the Assessment

Translating the direct costs for RIMS II inputs begins with identifying industries that produce water loss control equipment or provide related services, including but not limited to leak detection and leak repair. To generate RIMS II input values, we first categorize all the industries by NAICS name and code that make up the capital costs used in the economic model. Table 5 lists the industries that are directly related to leak detection and repair. Costs reported in Table 5 have been separated into NAICS categories with the matched NAICS codes listed in Table 6.

Table 6 Macroeconomic Inputs by Industry in 30 Years

Direct Cost Category	NAICS	Industry Description	RIMS II Code	Direct Cost ($)
Leak detection service	334519	Other Measuring and Controlling Device Manufacturing	33451A	343,280,575
Leak repairing equipment	334513	Industrial process variable instruments manufacturing	334513	33,004,905
Leak repairing service	541990	All Other Professional, Scientific, and Technical Services	5419A0	73,462,531
Monitoring and reporting	541990	All Other Professional, Scientific, and Technical Services	5419A0	62,750,000

The industries were then matched with the RIMS II industry codes. Column 4 of Table 6 reports the corresponding RIMS II code. The next step is to identify the multipliers for each industry.[20] The industry multipliers are reported in Table 7, which include multipliers for gross outputs, earnings, employment and value added.

Table 7 RIMS II Multipliers (Type II) Associated with the Affected Industries

Direct Cost Category	Type II RIMS II multipliers			
	Gross Output (per dollar)	Earnings (per dollar)	Jobs (per million $)	Value Added (per dollar)
Leak detection service	1.6625	0.4638	7.1558	1.1391
Leak repairing equipment	2.1849	0.9085	13.9868	1.3288
Leak repairing service	1.9837	0.6604	11.2098	1.2524
Monitoring and reporting	1.9837	0.6604	11.2098	1.2524

Data Source: BEA, *California RIMS II multipliers (Type II), 2007/2015,* 2017.

3. Results

a. Overall Impacts by Industries

The resultant macroeconomic impacts are shown in Table 8 for gross output, earnings, jobs, and value added. The total impacts are separated into the contribution from changes in final demand for each direct cost category.[21] As there is no timeline in RIMS II model, all these results should be interpreted as the overall final outcomes to the new equilibrium due to the WLPS regulation in a 30-year lifetime.[22]

Gross output

Gross output represents the total value of goods or services produced in a region within a given time period. It is used as a measure for the overall size of the economy. As

[20] Department of Finance, California, provided the RIMS II type II multipliers.
[21] The industry specific and statewide economic impact depend on the proportion of regulation related spending that remains in the state. Hydraulic models, leak repairs, and leak detection surveys performed by companies located within the state will likely result in positive economic indicators.
[22] In reality, it could take more than a year for the economy to adjust to the new equilibrium. Taking that into consideration, our estimates from RIMS II model could overestimate the impact within a year.

demand increases, output is expected to expand, holding all other factors constant. As discussed in the above sections, the proposed WLPS regulation increases the final demand in leak detection and repair related services and equipment. Thus, it is expected to increase the total output in the whole California economy.

As can be seen from the first column of Table 8, the total impact on gross output is approximately 913 million dollars over the 30 years. The largest contributor is the leak detection, which results in an increase of about 571 million dollars in gross output, about 62.5% of the total impacts. The contribution from extra demand in repair equipment and service to comply with the regulation is approximately 218 million dollars, which accounts for about 24% of the total impacts. The rest is from the monitoring and reporting category. The average annual impact is about 30 million dollars in present value. Overall, the impact is relatively small compared to the size of the California economy, which was about $3 trillion in 2019.[23]

Earnings

The proposed regulation will impose no direct costs on individuals in California. However, the costs incurred by affected businesses and the public sector will cascade through the economy and affect individuals.

One measure of this impact is the change in real personal income. Column 3 of Table 8 shows annual change in real personal income across all individuals in California. Total personal income growth increases by about $279 million as a result of the proposed regulation over the lifetime. The change in personal income estimated here can also be divided by the California population to show the average or per capita impact on personal income. The increase in personal income is estimated to be about 8$ per capita in lifetime.

Table 8 Macroeconomic impacts by industries over 30 years

Direct Cost Category	Gross Output (dollar)	Earnings (dollar)	Jobs (number)	Value Added (dollar)
Leak detection service	570,703,956	159,213,531	2,456	391,030,903

[23] This information is from the U.S .Bureau of Economic Analysis: https://www.bea.gov/sites/default/files/2020-10/qgdpstate1020_0.pdf

Leak repairing equipment	72,112,417	29,984,956	462	43,856,918
Leak repairing service	145,727,623	48,514,655	824	92,004,474
Monitoring and reporting	124,477,175	41,440,100	703	78,588,100
Total Macro Impacts	913,021,171	279,153,243	4,445	605,480,395

Employment

Column 4 in Table 8 presents the impact of the proposed regulation on total employment in California. The employment impacts represent the net change in employment, which consist of positive impacts for some industries and negative impacts for others. The proposed regulation is estimated to result in a slightly positive job impact, 4,445 jobs in total over the lifetime. These changes in employment represent less than 0.03 percent of baseline California employment.

Value added

Value added is considered as an alternative measure of outputs. Value added includes all the extra value contributed by all the factors of production. It excludes the values of direct inputs and intermediate inputs, either domestically produced or imported from other regions/countries. As reported in the last column of Table 8, the total impact on value added is approximately 605 million dollars, less than 0.02 percent of the total Gross Domestic Product (GDP) in California. This is consistent with the result on gross output that the overall impact is relatively small.

In addition, the annual impacts are examined for some critical years and reported in Table 9.[24] The overall impact on gross output is estimated to be approximately $53 million for 2022, which qualifies the regulation as a major regulation. The earning impact varies from about $16.4 million in 2022 to $6.3 million in 2051. The annual impact on jobs varies from 260 jobs in the initial year to 102 jobs in 2051. The impact on value added is about 60% of that on gross output, as expected. There is a decreasing trend in macroeconomic impact over time due to lower leak detection and repair costs, and positive real

[24] Annual impacts for other years are available upon request.

discounting. Overall, the annual economic impacts are relatively small comparing to the size of California economy.

Table 9 Macroeconomic impacts by year

Economic Impact	2022	2028	2035	2040	2051
Gross Output ($)	52,921,696	37,450,294	30,223,422	26,042,971	20,280,422
Earnings ($)	16,405,774	11,639,783	9,413,533	8,125,738	6,350,575
Jobs	260	185	150	130	102
Value Added ($)	35,007,242	24,733,366	19,934,319	17,158,266	13,331,611

b. How many firms are impacted by WLPS?

The proposed regulation directly affects all the urban water suppliers that will be required to conduct water loss control for purposes of complying with the proposed regulation. There are 409 urban water retailers, out of which 253 water suppliers would be affected by the proposed regulation. The rest of the 156 water suppliers already have their water loss controlled at levels that would not subject them to additional obligations under the proposed regulation, and thus would not be affected by the regulation. Among the 253 affected water suppliers, 43 are privately-owned water companies and 210 are public water agencies.

As shown in the analysis above, firms providing services including leak analysis, detection and repair services will be affected indirectly. In addition, manufacturing firms producing leak detection equipment will experience higher demand as well. There are, in total, seven large businesses in California for water distribution system leak detection among urban water suppliers. There are 29 water consulting firms in California, providing consulting services related to water loss control that would be also affected. All of them are counted as small businesses. The numbers of equipment producers are from the US Census.[25] It reports the number of businesses in California at the NAICS six-digit level. According to the data, there were 113 businesses in this industry in California in 2012. Among them,

[25] https://www.census.gov/data/datasets.html

37 are counted as small businesses, with the number of employees below 250.[26] As not all these firms are leak detection or repair equipment producers. This approach tends to overestimate the number of firms affected.

The results are listed in Table 10.[27] The second column reports the share of number of firms for each category. The privately-owned urban water suppliers account for 22.4% of the total impacted firms. Leak-related service and detection equipment businesses account for about 18.75% and 58.85%, respectively. The number of small businesses is reported in the next column. According to the definition of small businesses from the Government Code, 9 out of the 43 privately owned water systems are counted as small businesses. The total number of small businesses impacted is 75, including 9 privately owned water systems, 29 water consulting companies, and 37 leak detection equipment producers.

The State Water Board considers the above numbers as the lower bound of the potential overall impacted firms. As discussed in Section D.2 on the macroeconomic impacts, other industries can be affected indirectly due to production chains and networks. Due to data limitations, it is infeasible to estimate impacts for firms or industries beyond the ones directly tied to water loss control. Also, given that the overall impact of the proposed regulation is not extremely substantial compared to the overall size of manufacturing in California, the potential impacts on those indirectly affected manufacturing firms are anticipated to be negligible.

Table 10 The number of firms impacted

Firm Category	Total firms	Share of firms	Small firms	Share of small firms
Urban water retailers	43	22.40%	9	20.93%
Leak detection and repair service	7	3.65%	0	0%

[26] According to the definition of small businesses from the Government Code for the State of California, a manufacturing enterprise exceeding 250 employees is not “small business”. As we do not have information on firm employment, it is infeasible to adopt this definition.

[27] An alternative approach that was considered involved counting the numbers of firms for leak detection, repair and equipment producers. According to the information from https://www.directindustry.com/, there are 18 and 14 firms producing leak detectors and pressure sensors, respectively. It’s possible that not all the firms list their products there. This approach is likely to underestimate the number of firms affected.

Water consulting service	29	15.10%	29	100%
Leak detection equipment	113	58.85%	37	32.74%
Total number of firms	192	100%	75	-

c. Business creation and elimination

RIMS II model cannot directly estimate the creation or elimination of businesses. The overall increase in jobs represents the net impact, which can be associated with both creation and elimination. The direct increase occur in the form of demand for leak detection, repair and consulting services; this may promote creation of new business to advise water utilities on compliance with regulation. At the same time, new businesses generally promote competition among existing firms, which can result in exiting of less competitive firms.

In addition, water rates are likely to increase in the short term to cover initial capital investment. Although the potential increase in water rates on average is not large based on State Water Board calculations, suppliers in various regions may react differently depending on their ability to finance the initial capital costs. Thus, in certain regions with high water use, there could be a relatively higher increase in water rates than the baseline estimate, which may theoretically lead to a possibility of exit or entry of businesses that use water intensively. However, businesses have absorbed increases in water rates over the years, and are anticipated to do so for future increases as well.

The increase in gross output will not only affect the industries that provide the contracted services, but also all the related equipment manufacturers, maintenance operators, equipment suppliers, and other businesses that provide intermediate services or goods to those leak detection contractors. Therefore, leak detection service contractors and their various suppliers will likely see an increase in demand for their services as a result of the proposed regulation. However, barriers to entry, such as the cost of equipment or innovation needed to provide goods and services for leak detection and repair work, is likely to limit the number of new indirectly impacted service contractor businesses.

For water suppliers, the cost of compliance could be a financial burden on smaller businesses. However, the proposed regulation allows for variances from compliance in case of unexpected adverse economic conditions, which would prevent exiting of such smaller businesses. The proposed regulation also allows for adjustments to the volumetric standard if costs estimated by the urban water suppliers are different from the State's estimates for individual retailers. Additionally, the proposed regulation includes a proposal for provisions to provide flexibility for suppliers serving disadvantaged communities.

d. Job creation and elimination

The proposed regulation is expected to create a demand for services from consultants and utility employees to aid in developing hydraulic models, conducting leak detection surveys and repairs, and assessing/implementing asset management and other approaches for real loss reduction. Table 8 displays the expected job growth from the final demand change, ranging from 102 to 260 jobs per year for the assumed lifetime of the regulation, primarily for work related to leak detection, repair and pressure management. Employment will consist of full- and part-time jobs, though the RIMS II data does not capture the difference.

It should be noted that while the I-O model captures job growth in companies that perform support activities on a contract or fee basis for leak detection and repair, there is a possibility that water suppliers themselves may downsize the number of in-house employees if they shift these activities from in-house to outsourcing. Also, for the leak detection and repair service companies, competition could be tougher due to new firms entering. This could drive some small firms out of markets. All these examples would lead to job losses not captured by the RIMS II model. However, it should be emphasized that these negative impacts would be outweighed by the positive effects on job creation, so that the net impact would be positive.

e. Increase or Decrease in Investment in California

From the results shown in Table 5, the direct impacts on costs mostly consist of leak detection and repair services or equipment to meet the requirements of the proposed regulation. The total increase in purchases from these two directedly affected industries is approximately $512 million over the assumed lifetime. The indirect economic effect of this spending is expected to create about $913 million of gross outputs over the lifetime and $605 million in value added (see Table 8). This increase in outputs would be associated with higher investment spending. However, this impact of the proposed regulation will be relatively insubstantial compared to California's roughly $3 trillion annual economy.[28]

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[28] California Department of Finance, *Gross State Product*.
<http://www.dof.ca.gov/Forecasting/Economics/Indicators/Gross_State_Product/>

f. Incentives for Innovation

Water suppliers in California are constantly trying to increase efficiency, revenue, and profit by innovating. While the proposed regulation will help reduce water loss in the long term, the costs from pressure management, leak detection and repair will increase in the first year and the years following as compared to the baseline.

Increased use of leak detection and repair equipment will promote innovation in this sector. Water saving appliances and technologies have abated the rising demand for water. Urban water suppliers must continue to find ways to produce and transport water cheaply and efficiently to avoid or delay raising rates for consumers, particularly when increasing water prices is subject to regulation or public processes. For urban water users, water price may increase due to costs imposed on suppliers to comply with the regulation, which in turn might be passed on to end users. With the rise in rates, there could be a higher demand for leak detection and repair equipment, promoting innovation in these devices, methods of repair and higher efficiency. There may be an increase in demand for water efficient appliances, in addition to leak detection and repair equipment and material, such as low flow shower heads, toilets and water-efficient dishwashers and washing machines. All these will likely promote better technologies and innovation in the water sector.

g. Competitive Advantage or Disadvantage

In the short-term, if urban water suppliers cannot pass all the increased operating costs to consumers, they may experience cost burdens. Small suppliers are anticipated to incur upfront costs associated with the regulation. However, as the State Water Board proposes a long period until initial compliance is measured, this makes it possible for suppliers to spread the costs of compliance over as long as seven years (until 2028). Accordingly, the potential negative economic impact is expected to be relatively small and distributed over the longer implementation period. At the same time, for leak detection service providers, the proposed regulation would increase the demand for leak detection and repair equipment and services. This will create a competitive advantage for Californian firms in these industries.

In the long-term, State Water Board staff expect that the proposed regulation will reduce water loss in California and promote efficiency in water use. As can be seen from Table 3 and Table 5, the cost of supplying water will slightly decrease in the long term for water suppliers due to effective water loss control. This lower cost of supplying water will likely create a competitive advantage for water suppliers. Suppliers are anticipated to reduce lost revenue due to more efficient water distribution, which they could use to fund conservation, more water loss reduction programs, or low income affordability programs that would improve access to safe and affordable water and improve efficiency of water use in California, with a corresponding which would improve the quality of life, especially for low-income communities. The reductions in water outages and unexpected leaks from increased water loss control would reduce property damage and adverse commercial impacts, and associated liabilities. Additionally, these lower water supply costs could delay a rise in rates, which would provide a competitive advantage to industries that use water intensively. However, it should be noted that the change in water price will be relatively small, which is unlikely to have substantial impact on competitiveness of Californian businesses.

Also, since the regulation will not interfere with other economic investments and activities in the state, such as manufacturing and service industries unrelated to water loss control, the State Water Board does not anticipate a competitive disadvantage resulting from proposed regulations in the long-term.

h. Impacts on Households

In addition to the projected income impacts identified through the RIMS II model, the potential effects of the proposed regulation on household water bills and disposable income are analyzed under a number of assumptions. The impacts of the regulation on the water bill per connection and household disposable income is presented in Table 11. The main finding is that the regulation will have minimal impacts on water bills and disposable income. In the first year of the regulation, water bills would increase slightly by about $0.30 per household. For the three later years presented in the table, the actual water supply costs would decrease by roughly $10-13 per year, i.e. around $1 per month, due to the benefits from saved water, which could delay any rise in water prices for individual households.

These estimated impacts rely on a number of important assumptions. First, it is assumed that all capital costs spread equally across years with a fixed portion of equipment cost in the total repair costs. Second, it is assumed that the leak detection and repair are constantly efficient over the assumed lifetime and, as the suppliers finish the first round of detection, the later costs of leak detection decrease due to positive discounting. In addition, as mentioned in the costs and benefits analysis section, the same technologies would be applied through the assumed regulation lifetime, which tends to overestimate costs, considering that technology development could make leak detection and repair more efficient and thus less costly. Finally, the net costs/benefits that would occur to comply with the regulation will be passed onto all households. Water suppliers might need to absorb these costs if they were unable to increase their water rates.

The proposed regulation will have very small impacts on disposable income. In 2022, the regulation will increase annual household income slightly, by $1.27. In later years, consumers would experience net increase in disposable income due to avoided increases in water prices as water supply costs decrease. The total net impacts on disposable income would be positive each year and up to about $13. It accounts for less than 0.02% of the annual median income in California.[29] The net impact of the regulation on household disposable income would be positive and fluctuate by approximately $1 per month in most years, or less than 0.02% of median income.

Table 11 Household Impacts or Water Loss Reductions

Economic Impact	2022	2028	2035	2040	2051
Earnings per household ($)	1.27	0.90	0.73	0.63	0.49
Water bill change per household ($)	0.30	-11.50	-12.04	-11.93	-10.77
Net Impact per Household ($)	0.97	12.40	12.77	12.55	11.26

i. Other benefits

Other benefits of the regulations include benefits to the state's environment and quality of life, health, safety and welfare of California residents, among many others. First, reduction in water losses can promote energy conservation by saving oil/electricity used in pumping and distributing water. This will reduce associated greenhouse gas emissions and provide environmental benefits. California has a high energy consumption associated with water supply. About 7% of the state's total energy usage was used to pump and deliver water across the state (Natural Resources Defense Council and Pacific Institute, 2004). Water loss control can avoid other costs associated with additional supply or pumping requirements and reduce the energy consumption associated with water

[29] The median income and number of households in California are from https://www.census.gov/quickfacts/CA.

distribution, which would contribute to a reduction in greenhouse gas emissions. There could be a slight increase in carbon emissions to due increased activity to reduce real losses, such as repair trucks, excavations or increased demand in water infrastructure material, however that is expected to be at least offset by reductions in energy used to pump and treat water that is currently lost to leaks.

Lack of distribution system and leak monitoring can lead to breaks that surface and cause property damage. High distribution pressure and variations also lead to breaks. In case of variation in distribution pressure, breaks can compromise water quality in the distribution system. The regulation will require urban water suppliers to comply with a maximum allowable water loss volume that is cost-effectively achievable for each urban water suppliers. This will encourage improved monitoring through increased leak detection and repair and pressure and asset management. These measures will result in a reduction in breaks and associated damages. An additional positive outcome will be prolonged asset life due to improved maintenance of distribution systems. The proposed regular surveys on the water distribution system will improve the monitoring of the condition of water infrastructure, which can effectively reduce the risk of major failures in water infrastructure that could lead to significant costs of emergency repair, disruptions in traffic and transit, property damage, water quality issues and other negative economic impacts. Finally, water loss reduction will help conserve water and improve drought resiliency in California in the long term.

The proposed regulation will encourage prioritization of infrastructure monitoring and maintenance to reduce leakage. It is anticipated that urban water suppliers supplying water to disadvantaged communities would be able to prioritize and incorporate improvements in infrastructure maintenance for regulatory compliance and in turn reduce water outages and risks of contaminant intrusion from breaks. Improving the useful life of infrastructure is anticipated to improve deteriorating water systems, which would contribute to better access to safe and affordable water supply. Water loss control would reduce outages and loss of water in water distribution systems. Proactive leak monitoring and detection reduces breaks that may cause the leaked water to collect contaminants and flow into water bodies.

4. Summary and Interpretation of the Economic Impact Assessment

California urban water suppliers will face higher operating costs during the implementation of the proposed regulation but will see reduced operational spending as water losses are reduced. As suppliers implement these changes, demand for goods and services in supporting industries will benefit across the State.

Overall, the proposed regulation is unlikely to have a significant impact on the California economy. The results show that purchases made by urban water suppliers have a positive impact on many industries, and that the transition from uncontrolled or under-controlled water loss to reduced water loss will bring many indirect and induced economic benefits to California. Additional economic benefits include benefits to the environment and households due to water savings, reduced carbon emissions and improvement in quality of life for individuals supplied by water supply systems which are lacking in maintenance.

E. Alternatives

The State Water Board considers two alternatives to the water loss performance standards based on stakeholder comments. The two alternatives are evaluated for costs and benefits, economic impacts and cost-effectiveness, relative to the proposed regulation.

1. Alternative 1

The first alternative proposes using a more stringent leak detection survey frequency to calculate the standards, which would lead to quicker reduction in leakage as compared to the proposed regulation. The assumed leak detection survey rates to calculate the standards was half of those for the proposed regulation.

Under Alternative 1, 257 urban water suppliers would be required to conduct leak detection and repair in order to achieve the water loss levels, slightly more than the number under the proposed regulation (253). This is as expected since Alternative 1 would provide more stringent leak control.

a. Costs and Benefits

Table 12 reports the costs and benefits for Alternative 1 over the 30-year assumed lifetime of the regulation. For a typical utility, the total cost to comply with Alternative 1 is 3.09 million dollars in present value. The statewide total cost is about 792 million dollars. As compared to the proposed regulation, Alternative 1 would incur about 54.49% higher costs. This is consistent with the fact that Alternative 1 would require more frequent leak surveying, which is associated with higher costs. The lifetime benefit from water loss reduction for a typical utility is about 20.5 million dollars in present value, which results in a total of 5.3 billion dollars statewide benefit. This is about 10.85% higher than the proposed regulation. As more frequent leak detection surveying would be able to identify and repair more leaks in time, it would reduce the total water loss further and lead to a higher total benefit. The net benefit is about 10.66% higher than the proposed regulation as well. It should be noted that even though Alternative 1 would generate a larger net benefit, the percentage increase in cost, 54.49%, is much higher than the percentage increase in benefit, which is 10.85%. This implies that the extra benefit is associated with a much larger cost increase.

Table 12 Direct Costs for Alternative 1

	Typical Utility	Statewide	Comparing to Proposed Regulation, Statewide
Total Cost ($)	3,080,767	791,757,175	54.49%
Total Benefit ($)	20,494,547	5,267,098,481	10.85%
Total Water Loss Reduction (acre-foot)	16,387	4,211,412	10.66%
Net Impact ($)	17,662,807	4,539,341,306	7.08%
Cost-effectiveness ($/acre-foot)	188	188	39.61%

b. Economic Impacts

Macroeconomic impacts are also evaluated for Alternative 1. The same approach is adopted using RIMSII model as for the proposed regulation. The industry multipliers in Table 7 are used to account for the amplified impacts for the whole California economy. Results on gross outputs, earnings, employment and value added are reported in Table 13. In addition to the 30-year assumed lifetime impact, the annual impacts for the critical years are also reported. Both the lifetime impacts and annual impacts are about 54% higher than for the proposed regulation as reported in Table 8, which is consistent with the fact that the direct cost is about 54% higher and the same RIMS-II multipliers are adopted.

Table 13 Macroeconomic Impacts for Alternative 1

Economic Impact	30-year Lifetime	2022	2028	2051
Gross Output ($)	1,408,875,861	91,023,900	58,119,709	28,112,012
Earnings ($)	434,006,593	28,040,066	17,903,875	8,659,953
Jobs	6,840	442	282	136
Value Added ($)	935,572,354	60,444,960	38,594,737	18,667,948

c. Cost-Effectiveness

Cost-effectiveness is measured by the average cost to achieve one acre-foot of water loss reduction. As shown in the last row of Table 12, the cost-effectiveness is approximately $188 per acre feet of water saved. In the case of Alternative 1, it would achieve higher water loss reduction, but the total cost is much higher than the proposed regulation. Alternative 1 is a less cost-effective alternative compared to the proposed regulation.

d. Reason for Rejection

This Alternative 1 is rejected because the assumed leak detection frequency would not be a realistic representation of the anticipated leak detection frequencies that can be implemented by suppliers. Though it could lead to a rapid reduction in leakage, Alternative 1 would increase the annual costs to approximately $26 million per year. The initial costs per utility would increase by about 80% as compared to the proposed regulation. The higher initial costs would impose a larger burden on urban water suppliers. Even though the long-run benefits are also relatively higher than for the proposed regulation, the increased leak detection would be an unrealistic representation of implementation timelines. In addition, the cost effectiveness analysis shows that even though the total water loss reduction is higher for Alternative 1, the average cost of reducing water loss is higher than for the proposed regulation by about 39.6%.

2. Alternative 2

Alternative 2 is based on a proposal provided by the California Municipal Utilities Association (CMUA). This proposal would require a decrease in leakage to a volume equal to the 85th percentile of overall leakage for California averaged over three years instead of individual standards.

Under Alternative 2, only 61 urban water suppliers would be required to reduce their leakage, less than one fourth of the suppliers that would be required to reduce their water loss under the proposed regulation. This is as expected since Alternative 2 would require suppliers to reduce their leakage to a much higher threshold (85^{th} percentile of average losses in California), which would mean that majority of suppliers report leakage that is lower than the threshold proposed through Alternative 2.

a. Costs and Benefits

Table 14 reports the costs and benefits for Alternative 2 over the 30-year assumed lifetime of the regulation. For a typical utility, the total cost to comply with Alternative 2 is 136 thousand dollars in present value. The total cost on a statewide basis is approximately 34.8 million dollars. Costs incurred pursuant to this alternative would be 93.2% lower than those for the proposed regulation. This is consistent with the fact that Alternative 2 would result in less frequent leak surveying and repair, which results in lower costs.

The lifetime benefit from water loss reduction for a typical utility is about 21 million dollars in present value under Alternative 2, which results in a total of 1.3 billion dollars in statewide benefit. The total benefit is 73.12% lower than that for the proposed regulation. As less frequent leak detection surveying would identify and repair fewer leaks in time, Alternative 2 would reduce the total water loss reduction and lead to a lower total benefit. The net benefit is about 70.33% lower than for the proposed regulation.

Table 14 Direct Costs and Benefits for Alternative 2

	Typical Utility	Statewide	Comparing to Proposed Regulation, Statewide
Total Costs ($)	571,227	34,844,876	-93.20%
Total Benefits ($)	20,937,240	1,277,171,623	-73.12%
Total Water Loss Reduction (acre-foot)	17,024	1,038,460	-72.71%
Net Impact ($)	20,616,012	1,257,576,746	-70.33%

Cost-effectiveness ($/acre-foot)	34	34	-75.08%

b. Economic Impacts

Macroeconomic impacts have been evaluated for Alternative 2 using the RIMSII model similar to for the proposed regulation and Alternative 1. The industry multipliers in Table 7 are used to account for the amplified impacts to the statewide economy. Results on gross outputs, earnings, employment and value added are shown in Table 15. In addition to the 30-year assumed lifetime impact, the table also shows the annual impacts for critical years. Both the lifetime impacts and annual impacts are about one tenth of those for the proposed regulation as shown in Table 15. This is consistent with the fact that the direct cost for Alternative 2 is about 93% lower than that for the proposed regulation with the same RIMSII multipliers.

Table 15 Macroeconomic Impacts for Alternative 2

Economic Impact	30-year Lifetime	2022	2028	2051
Gross Output ($)	62,003,991	2,807,456	2,571,244	1,523,477
Earnings ($)	19,100,434	864,842	792,076	469,310
Jobs	301	14	12	7
Value Added ($)	41,174,117	1,864,308	1,707,450	1,011,674

c. Cost-Effectiveness

Cost-effectiveness is measured by the cost to achieve an acre-foot of water loss reduction. For Alternative 2, though the total cost is lower than the proposed regulation, it would achieve significantly lower overall water loss reductions. The cost-effectiveness is lower than for the proposed regulation. This means that the average cost of saving one acre-foot of water loss is lower than that for the proposed regulation.

d. Reason for Rejection

Alternative 2 is rejected because it would not reduce statewide water loss effectively, which is the key goal of Water Code section 10608.34. The current median leakage for the state is 27 gallons per connection per day, while the average is 35 gallons per connection per day. The proposed threshold per Alternative 2 at 85th percentile of the statewide leakage would result in a standard of 54 gallons per connection per for all suppliers regardless of their system-specific characteristics, potential for reducing water loss or water resilience. The proposed threshold would be twice that of the current median, which is not progressive for improving statewide water loss control, reduction of potential leakage, or improved maintenance of water infrastructure, and could in result in a lapse in ongoing or future water loss control efforts.

Alternative 2 would impose lower costs on urban water suppliers, but the amount of total water loss reduction would be 73% lower than under the proposed regulation. Additionally, with inadequate water loss monitoring and maintenance of water supply infrastructure, suppliers and businesses would likely face higher costs in terms of unexpected leaks, water outages and property damage without regular monitoring and maintenance geared towards keeping water loss to a low level. Water supply infrastructure has been inadequately maintained and rehabilitated over past decades, which has led to its deterioration and overall higher long-term operational costs, demanding long overdue efforts towards water loss control (Sedlak, 2015). Thus, Alternative 2 would not achieve the goals of water loss control and water conservation as effectively as the proposed regulation. Therefore, Alternative 2 is rejected.

F. Fiscal Impacts

1. Local Government

The proposed regulation directly impacts urban water suppliers that are public agencies. Among the 253 suppliers potentially impacted by the proposed regulation, 209 are local public water utilities and one is state or federal water agency. The public water utilities are typically operated by cities, or local water authorities. The revenues of water agencies come from different sources, including local grants, local taxes, and operating revenues (e.g., fares).

The overall fiscal impact to local governments is positive. In the short term, expenditure on leakage detection and repair services, capital investments towards replacing old water pipes and infrastructure could lead to increased annual budgets for public water agencies. In the longer term, the total direct costs to water utilities due to the proposed regulation result in annual savings due to water loss reduction and reduced operating costs and increased available resources. The annual total direct costs and benefits of the proposed regulation to public water agencies relative to the baseline are summarized in Table 16.

Table 16 Fiscal Impact on Local Government

Year	Total direct Costs	Total Value of Water Loss Reduction	Net Impact
2022	23,415,285	22,947,074	-468,212
2028	15,935,958	151,507,915	135,571,957
2035	12,477,595	154,108,340	141,630,744
2040	10,477,073	150,680,009	140,202,936
2051	7,133,127	134,461,201	127,328,074

As the change in water price is not expected to be significant, the burden from this on local government is supposed to be minimal. It is likely that local government will experience some fiscal benefits from economic activity induced by the regulatory requirements. They will also benefit from reduced environmental liabilities associated with water loss in their communities.

2. State Government

a. The State Water Board

The proposed regulation would have a minor impact on staffing resources and would require one and half personnel-years assisting urban water suppliers with compliance and modifications to their standards, reviewing supplemental documentation, and enforcement including audits of reported information. The cost of the position is estimated to be $200,000 annually in 2020 dollars. The total estimated annual cost due to additionally required staff hours would be $300,000. Currently, this additional workload is expected to be absorbed by the current staff.

b. Other State Agencies

In addition, there is one unique impacted utility, Santa Fe Irrigation District, which is a state-owned water supplier.[30] Therefore, regulation impacts on this district should be counted as the fiscal impacts for the State government. The lifetime total cost is estimated to be about 917 thousand dollars, and the total benefit from water loss reduction is estimated to be about 10.2 million dollars. Thus, the net impact is positive by approximately 9.2 million dollars for the assumed 30-year lifetime.

The proposed regulation would affect public water agencies and is not expected to have adverse impacts on other state agencies. The adoption of the proposed regulation is crucial for the implementation of Water Code, section 10608.34.

[30] There are three state-owned utilities in total in the analysis. However, the other two would not be affected by the regulation.

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United State Census Bureau, https://www.census.gov/data/datasets.html

Economic Model Appendix

Additional background information on water loss economic model developed by the State Water Board.

Distribution system condition, typical leak flow rates and number of leaks for different types of leakage: Based on the American Water Works Association Water Audits and Loss Control Programs M36 Manual (American Water Works Association, 2016).

Marginal cost of avoided cost of water: The marginal cost of avoided cost of water is determined from the cost of alternative water sources available to the supplier. The most common alternative water sources are stormwater reuse, recycled water (indirect potable reuse), brackish water desalination and imported water. The Pacific Institute estimated costs for each of these sources (Pacific Institute, 2016), and the model uses the average cost for all these sources as the marginal avoided cost.

1. Cost of leak detection

Leak detection involves surveying pipes and other infrastructure with specialized equipment that can alert the supplier if a leak exists on that part of the infrastructure. This is followed by leak pinpointing, which involves determining the exact location of the leak with the appropriate equipment. The efficiency denotes the total number of actual leaks located out of the ones detected (indicating false positives). The costs in Table A.1 include the cost of equipment and labor for leak detection. The costs on the higher end of the range are associated with outsourcing.

Table A.1 Leak detection costs and efficiency

Equipment type	Lifecycle	Efficiency range	Cost	Cost per mile (dollars)	Average efficiency
Leak Survey	4 - 7 years	98 - 99%[a]	$170 - $595[c] per mile	595	98.5
Leak Pinpoint	9 - 10 years	50 - 92%[b]	$347 - $991[d] per leak	9.91[e]	71
			Total average cost	604.91	70%[f]

a. Highly trained and experienced staff.

b. Expected Efficiency of a new program (variable).

c. See d

d. Costs (low range) are typically utilities that do not include detection equipment cost. Variances in costs are also due to size of survey, type of pipe material and logistical issues withing the water system.

e. Based on an average of 0.01 leaks found per mile (American Water Works Association, 2016)

f. Product of efficiencies for surveying and pinpointing

The State Water Board also collected estimates of the number of miles surveyed realistically from consultants offering leak detection services. Estimates from suppliers on their current and future leak detection programs were also used to inform this parameter. The following estimates for current leak detection frequencies were collected and used to inform leak detection frequencies in the model:

Table A.2 Typical number of miles surveyed each year to detect leaks (all methods included)

Supplier	Total length of mains (miles)	Anticipated or typical annual survey frequency (miles/year)	Years taken to survey system
M.E. Simpson (Vendor)	N/A	1200	N/A
Irvine Ranch Water District	1886.1	840	2.24
East Bay Municipal Utility District (EBMUD)	4205.9	1236	3.4
City of Seal Beach	75	75	1.0
Trabuco Canyon Water District	66	66.5	1.0
City of La Habra	165	83	2.0
City of Tustin	172	102	1.7
East Orange County Water District	23.7	48	0.5
City of Huntington Beach	607.2	18	33.7
Mesa Water District	328.4	32	10.3
City of Orange	462	30	15.4
City of San Clemente	212.6	30	7.1
Yorba Linda Water District	367.1	110	3.3

The range was used to determine a reasonable range for surveying frequencies, and it was concluded based on these estimates and information from suppliers that most systems can survey their entire system once in two to three years. Two exceptions are the two largest systems in California: Los Angeles Department of Water and Power (LADWP) and EBMUD, which have 7,385 miles and 4,206 miles of distribution system, respectively. EBMUD surveys its system in just over three years. It was assumed that LADWP would be able to survey its distribution system once in the five years between 2022 and 2028. As LADWP's operating budget is 3.5 higher than EBMUD, it was assumed that LADWP would be able to survey an additional 15 miles per month as compared to EBMUD. The model uses the following tiered approach for assuming reasonable average survey frequencies. The regulation is not prescriptive in terms of implementing these frequencies, and only uses these estimates to determine anticipated costs for real loss reduction.

Table A.3 Time taken to survey distribution system

Miles of distribution system	Time taken to survey distribution system
Under 500	2 years
500 to 1000	2.5 years
1000 and above	3 years
EBMUD	3.07 years (as per their current survey frequency)
LADWP	4.7 years (assuming 130 miles surveyed per month)

2. Leak repair costs

Table A.4 Cost of repair per leak for different types of pipe provided by Irvine Ranch Water District

Type of pipe	2017 costs (dollars)	2018 costs (dollars)	Average costs
2 to 3 inch Polyvinyl Chloride	3000 - 5000	2000 - 6000	4000
4 inch Polyvinyl Chloride	3000 - 6000	4000 - 9000	5500
6 inch Polyvinyl Chloride	4000 - 6000	4000 - 9000	5750
6 inch Asbestos Cement	3000 -12000	4000 - 5000	6000
C-900 Asbestos Cement	3000 - 9000	4000 - 6000	5500
8 inch Ductile Iron	6000	12000	9000
10 inch Asbestos Cement	4000 - 6000	7000	5667
12 inch Cement mortar lined/ Asbestos Cement Pipe	6000 - 15000	15,000	12000
16 inch Cement mortar lined/ Asbestos Cement Pipe	4000 – 31650	6000 - 12000	13413

Table A.5 Cost of repair per leak for different types of pipe from PGE Report[31]

Tehama County Water system	Kings County Water System	Alpine County Water System	Madera County System
$2,745.00	$2,500.00	$2,500	$1,500
		$6,000.00	$1,500
		$7,900.00	
		$4,100.00	
		$8,600.00	
		$7,500.00	
		$6,800.00	
		$1,950.00	

Table A.6 Real annual price increase for treated water sold by Metropolitan Water District

Year	Price (Tier 1, treated)[32]	Consumer price indices (commodities)[33]	Real price as 2019$	Percent increase
2008	579	173.193	626.6	
2009	701	168.093	781.7	24.7%
2010	701	172.129	763.4	-2.3%
2011	744	180.192	773.9	1.4%

[31] Pacific Gas and Electric's Report ET13PGE1451: Water System Leak Identification and Control Field Evaluation (2015)
[32] Metropolitan Water district, Historical Water rates, obtained from Metropolitan Water District
[33] From the Bureau of Labor Statistics, https://www.bls.gov/cpi/data.htm

2012	794	183.705	810.2	4.7%
2013	847	183.443	865.5	6.8%
2014	890	183.920	907.1	4.8%
2015	923	180.260	959.8	5.8%
2016	942	178.010	991.9	3.3%
2017	979	180.509	1016.6	2.5%
2018	1015	184.966	1028.6	1.2%

The consumer price index for 2019 is 187.445. Tier 1 is the Tier used by all member agencies, for the typical volume of water use.