Docket		A.24-07-003
Exhibit Number	:	Cal Adv - #
Commissioner	:	Matthew Baker
Administrative Law Judge	:	Alberto Rosas
	:	
Public Advocates Office Witness(es)	:	Sam Lam

PUBLIC ADVOCATES OFFICE
California Public Utilities Commission

Report
on Sales Forecast, Conservation Budgets, Rate Design, and Special Requests #1, #2, #4, and #5

California Water Service Company
General Rate Case

Application 24-07-003

San Francisco, California
January 28, 2025

555499605

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MEMORANDUM

The Public Advocates Office at the California Public Utilities Commission (Cal Advocates) examined application material, data request responses, and other information presented by California Water Service Company (Cal Water or CWS) in Application (A.) 24-07-003 to provide the California Public Utilities Commission (Commission or CPUC) with recommendations in the interests of ratepayers for safe and reliable service at the lowest cost. Mr. Edward Scher is Cal Advocates' project lead for this proceeding. Ms. Syreeta Gibbs is the oversight supervisor, and Ms. Emily Fisher and Ms. Megan Delaporta are the legal counsels.

Although every effort was made to comprehensively review, analyze, and provide the Commission with recommendations on each ratemaking and policy aspect presented in the Application, the absence from Cal Advocates' testimony of any particular issue connotes neither agreement nor disagreement of the underlying request, methodology, or policy position related to that issue.

CHAPTER 1 CONSERVATION PROGRAM BUDGET

I. INTRODUCTION

This chapter presents Cal Advocates' analysis and recommendations on Cal Water's Test Year (TY) 2026 Conservation Program Budget request in this general rate case application (GRC). Cal Water requests ratepayer funding for an annual conservation program budget of $16,715,695 in TY 2026.[1] The budget request is a 95% (or $8,149,616)[2] increase to the latest authorized budget.[3] Table 1-1 below summarizes the latest authorized conservation program budget and Cal Water's request in this GRC.

Table 1-1: Cal Water's Conservation Program Budget

Cal Water's Conservation Program Budget				
	Current Authorized [D. 24-03-042]	Budget Request [A. 24-07-003]	Dollar Change	Percent Change
Conservation Programs	$ 4,406,156	$ 10,091,608	$ 5,685,452	129%
Public Information	$ 1,080,318	$ 2,018,322	$ 938,004	87%
School Education	$ 496,627	$ 744,953	$ 248,326	50%
Administration & Research	$ 2,582,978	$ 3,860,813	$ 1,277,835	49%
Total	***$ 8,566,079***	***$ 16,715,696***	***$ 8,149,617***	***95%***

Cal Water's budget request aims to "front-load" the conservation funding to address the urban water use targets established in the "Making Conservation a California Way of Life" regulation.[4,5] "Making Conservation a California Way of Life" is a 2018 legislative directive that establishes urban water use objectives[6] to help California adapt

[1] California Water Service Company 2024 GRC Testimony Book #2, Attachment H – California Water Service Conservation Budget Report at 40.

[2] ($16,715,695 - $8,566,079) / ($8,566,079) = 95.14% increase to the budget.

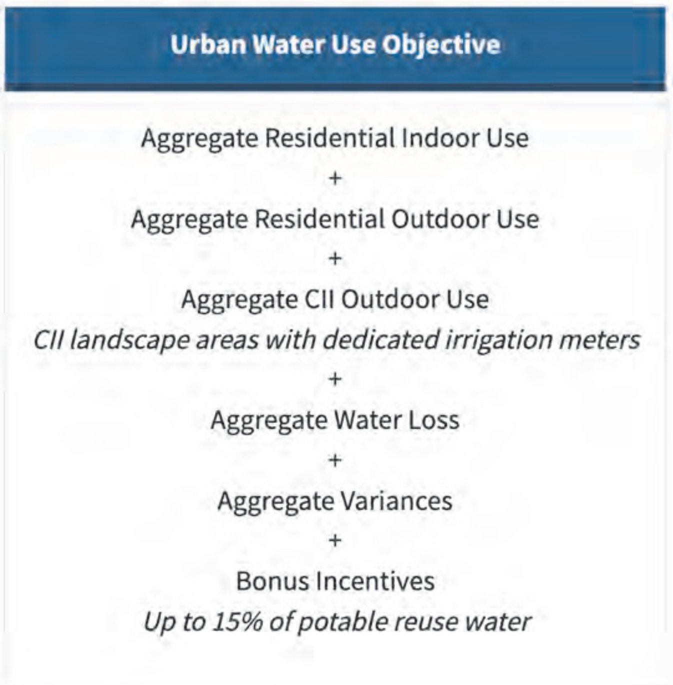
[3] Decision (D.)24-03-042, which decided Cal Water's 2021 GRC, authorized an annual conservation program budget of $8,566,079.

[4] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 6.

[5] Attachment 1-3, Final Text of Regulation to Make Conservation a California Way of Life.

[6] "California Statutes Making Conservation a Way of Life," State Water Resources Control Board (Last updated August 5, 2024), at https://www.waterboards.ca.gov/conservation/california_statutes.html.

to changing water supplies. Senate Bill (SB) 606 (Hertzberg) and Assembly Bill (AB) 1668 (Friedman), collectively the conservation regulatory framework, directed the State Water Board to adopt efficiency standards and performance measures for commercial, industrial, and institutional water use (the urban water use objectives).[7] The urban water use objectives are:[8]



The urban water use objectives (UWUO or WUO) were not finalized at the time this GRC application was filed and Cal Water conducted its UWUO compliance analysis based on the proposed regulations released on March 12, 2024.[9] The UWUO have since been adopted by "Board Resolution 2024-0019" on July 3, 2024 and is effective on January 1, 2025.[10] The UWUO consist of standards that apply to water supplier service

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[7] Attachment 1-2, "Making Conservation a California Way of Life" a Fact Sheet by the California State Water Board.

[8] California Statutes Making Conservation a California Way of Life, State Water Resources Control Board, https://www.waterboards.ca.gov/conservation/california_statutes.html (Accessed October 2024).

[9] California Water Service Company 2024 GRC Testimony Book #2, Attachment H – California Water Service Conservation Budget Report at 22.

[10] "Rulemaking to Make Conservation a California Way of Life," State Water Resources Control Board (Accessed December 18, 2024), at https://www.waterboards.ca.gov/conservation/california_statutes.html.

areas on an annual aggregate basis.[11] These water use standards are applied to the water supplier's conditions and characteristics and added up to represent the water suppliers' "urban water use objective."[12] This way, a water supplier can be above or below any individual efficient water use standard, so long as the water supplier's annual water use "does not exceed the aggregate sum of all the standards plus variances and bonus incentives terms (water use objective)."[13]

The UWUO directs water suppliers to demonstrate compliance with its urban water use objective starting January 01, 2027.[14] The conservation regulatory framework directs suppliers to develop and post to its public-facing website, a plan that is designed with the goal of achieving the supplier's urban water use objective by June 30, 2041.[15] The plan must include efforts to keep trees healthy and demonstrate that the supplier has carefully analyzed the data used to calculate its urban water use objective, including, but not limited to, the data associated with variances and special landscape areas.[16] The plan must also include efforts to increase support for disadvantaged communities, as defined in title 22, section 64300 of the California Code of Regulations, and low-income

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[11] Attachment 1-4, Results of the Indoor Residential Water Use Study at 2 (August 2021). https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/Performance-Measures/NEW_Results-of-the-Indoor-Residential-Water-Use-Study.pdf.

[12] Attachment 1-4, Results of the Indoor Residential Water Use Study at 2 (August 2021). https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/Performance-Measures/NEW_Results-of-the-Indoor-Residential-Water-Use-Study.pdf

[13] Attachment 1-4, Results of the Indoor Residential Water Use Study at 2 (August 2021). https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/Performance-Measures/NEW_Results-of-the-Indoor-Residential-Water-Use-Study.pdf

[14] Attachment 1-3, Final Text of Regulation to Make Conservation a California Way of Life at 5.

[15] Attachment 1-3, Final Text of Regulation to Make Conservation a California Way of Life, Section 966 (§ 966. Urban Water Use Objectives) (i) and (j).

[16] Attachment 1-3, Final Text of Regulation to Make Conservation a California Way of Life, Section 966 (§ 966. Urban Water Use Objectives) (i) and (j).

households; and leverage regional and local partnerships to support the installation and maintenance of climate-ready landscapes.[17]

Cal Water's budget request to nearly double its conservation budget in this GRC is unnecessary. Cal Water's analysis unreasonably assumes six districts (Bakersfield, Hermosa Redondo, Palos Verdes, Selma, Visalia, and Westlake) will not meet the 2035 UWUO.[18] This GRC application establishes rates for 2026 through 2028 and Cal Water's budget request would unreasonably burden ratepayers with higher bills in this GRC cycle.

II. SUMMARY OF RECOMMENDATIONS

The Commission should adopt the following conservation program budget for Cal Water in TY 2026.

Cal Water's Conservation Program Budget TY 2026		
	Cal Water's Budget Request	Cal Advocates' Budget Recommendation
Conservation Programs	$ 10,091,608	$ 4,406,156
Public Information	$ 2,018,322	$ -
School Education	$ 744,953	$ -
Administration & Research	$ 3,860,813	$ -
Total	***$ 16,715,696***	***$ 4,406,156***

[17] Attachment 1-3, Final Text of Regulation to Make Conservation a California Way of Life, Section 966 (§ 966. Urban Water Use Objectives) (j).

[18] California Water Service Company 2024 GRC Testimony Book #2, Attachment H – California Water Service Conservation Budget Report at 22.

III. ANALYSIS

Table 1-1: Cal Water's Conservation Program Budget

Cal Water's Conservation Program Budget				
	Current Authorized [D. 24-03-042]	Budget Request [A. 24-07-003]	Dollar Change	Percent Change
Conservation Programs	$ 4,406,156	$ 10,091,608	$ 5,685,452	129%
Public Information	$ 1,080,318	$ 2,018,322	$ 938,004	87%
School Education	$ 496,627	$ 744,953	$ 248,326	50%
Administration & Research	$ 2,582,978	$ 3,860,813	$ 1,277,835	49%
Total	***$ 8,566,079***	***$ 16,715,696***	***$ 8,149,617***	***95%***

Cal Water requests ratepayer funding for an annual conservation program budget of $16,715,695 in the Test Year (TY) 2026.[19] The budget request is a 95% (or $8,149,616)[20] increase to the latest authorized budget (of $8,566,079 in Decision (D.) 24-03-042). Cal Water's request in this GRC is not necessary.

Consider that the Commission utilizes two proven strategies to achieve conservation outcomes. The first being the implementation of a conservation rate design and the second being conservation programs that implement specific conservation measures like drought landscaping and direct installation of water efficient appliances. In Cal Water's 2021 GRC (as adopted by D.24-03-042), the residential rate structure was redesigned to encourage further water conservation by adding an additional rate tier (Tier 4) to incentivize residential conservation.[21] The redesigning of the rate structure is a cost-free approach to incentivize conservation outcomes when compared to utilizing ratepayer dollars to implement conservation programs such as drought landscaping and direct installations. The two methods are not either or and can be complementary in promoting conservation outcomes.

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[19] California Water Service Company 2024 GRC Testimony Book #2, Attachment H – California Water Service Conservation Budget Report at 40.

[20] ($16,715,695 - $8,566,079) / ($8,566,079) = 95.14% increase to the budget.

[21] Decision 24-03-042 at 2. Exception for KRV and ELA, which remain under a single quantity rate and a three-tier residential rate design, respectively.

A. Cal Water's Program Deployment Budget Increase is Unnecessary.

Cal Water's conservation program deployment budget is the largest component of the overall conservation budget.[22] Its budget request includes program implementation costs other than those associated with program marketing and internal program staffing.[23] Cal Water seeks to increase this budget by $5,685,452, from $4,406,156 to $10,091,608 (a 129% increase).[24] The utility presented three conservation program deployment budget adjustment multipliers to address various regulatory and operational conservation challenges.[25] However, these multipliers drive up the conservation budget and customer bills without yielding demonstrable conservation gains.

The three budget multipliers are:

1. 2035 Urban Water Use Objective (UWUO) compliance budget adjustments.
2. Adjustments for the Sustainable Groundwater Management Act (SGMA) impacted and high-water cost districts.
3. Adjustments to mitigate potential implementation feasibility and cost-of-service concerns.

Cal Water's deployment program budget request is summarized below on a per-district basis.[26]

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[22] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 35.

[23] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 35.

[24] California Water Service Company 2024 GRC Testimony Book #2, Attachment H – California Water Service Conservation Budget Report at 36.

[25] California Water Service Company 2024 GRC Testimony Book #2, Attachment H – California Water Service Conservation Budget Report at 35.

[26] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 35, Table 14 – Proposed Program Budget.

Table 14. Proposed Program Budget

District	Current Authorized	Current Multiplier	Program Budget Adjustments: WUO Compliance	SGMA/High Cost Supply	Implementation Feasibility & Cost-of-service	Total Multiplier	Proposed Program Budget
AV	$9,743	1.00	0.00	0.00	0.00	1.00	$9,743
BG	$318,645	1.00	0.00	0.50	0.00	1.50	$477,968
BK	$389,479	1.00	12.30	0.00	-8.30	5.00	$1,947,395
CH	$157,081	1.00	0.00	0.50	0.00	1.50	$235,622
DIX	$19,314	1.00	0.00	0.00	0.00	1.00	$19,314
DOM	$476,174	1.00	0.00	0.50	0.00	1.50	$714,261
ELA	$193,580	1.00	0.00	0.50	0.00	1.50	$290,370
HR	$298,860	1.00	1.54	0.00	0.00	2.54	$758,300
KC	$10,319	1.00	0.00	0.00	0.00	1.00	$10,319
KRV	$22,904	1.00	0.00	0.00	0.00	1.00	$22,904
LAS	$175,513	1.00	0.00	0.50	0.00	1.50	$263,270
LIV	$264,005	1.00	0.00	0.50	0.00	1.50	$396,008
MPS	$300,209	1.00	0.00	0.50	0.00	1.50	$450,314
MRL	$26,682	1.00	0.00	0.00	0.00	1.00	$26,682
ORO	$20,769	1.00	0.00	0.00	0.00	1.00	$20,769
PV	$327,446	1.00	1.95	0.00	0.00	2.95	$966,325
RDV	$10,145	1.00	0.00	0.00	0.00	1.00	$10,145
SEL	$47,849	1.00	2.61	0.00	0.00	3.61	$172,950
SLN	$354,036	1.00	0.00	0.50	0.00	1.50	$531,054
SSF	$300,208	1.00	0.00	0.50	0.00	1.50	$450,312
STK	$287,681	1.00	0.00	0.50	0.00	1.50	$431,522
VIS	$239,587	1.00	10.00	0.00	-6.00	5.00	$1,197,935
WIL	$4,035	1.00	0.00	0.50	0.00	1.50	$6,053
WLK	$132,546	1.00	6.90	0.00	-2.90	5.00	$662,730
Travis	$19,346	1.00	0.00	0.00	0.00	1.00	$19,346
Total	**$4,406,156**						**$10,091,608**

Cal Water's use of multipliers is based on a generalization that ratepayers' water conservation behavior will not change during the nine-year period of TY 2026 to 2035.

Cal Water's first multiplier, the UWUO Compliance assessment adjustment, compares the district's water use today and the expected reduction necessary to meet the 2035 standards over the next decade.[27] The assessment is unrealistic because it assumes that ratepayers in the six identified districts will not respond to other conservation signals without an increase in program deployment spending. This GRC establishes rates for TY

[27] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 22.

2026 and attrition years 2027 and 2028, so ratepayers have nine years (2026 – 2035) to respond to conservation signals and adjust their consumption behavior accordingly to meet the state's water use targets. As shown in Cal Water's sales forecast analysis, ratepayers' drought responses and water savings build over time,[28] such that conservation efforts may continue to yield water savings even after a drought has subsided.[29] Thus, the Commission should not adopt Cal Water's premature response to the conservation regulatory framework. Furthermore, Cal Advocates' rate design recommendation (discussed in Chapter 3) addresses conservation through price signals, which is a cost-free approach compared to Cal Water's request. Ratepayers should not pay for Cal Water's unnecessary and costly reaction to the 2035 WUO targets in this GRC.

Cal Water's second multiplier, the SGMA/High-Cost Supply adjustment, seeks to boost "program budgets by 50% in districts where budget increases are not already required for compliance with the new conservation regulations."[30] In other words, Cal Water asks to increase the conservation program deployment budget in districts where budget increases are not necessary. Its request lacks merit and inflates Cal Water's conservation program budget.

Cal Water's third multiplier, the Implementation Feasibility and Cost of Service adjustment, limits the potential increases that result from the previous two multipliers. This adjustment caps the budget increase request to "no more than a five-fold increase over a district's currently authorized budget."[31] Cal Water does not explain how it chose the five-fold limit as the arbitrary limit to the budget increase.

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[28] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 55.

[29] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 55.

[30] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 35.

[31] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 35.

Ratepayers should not fund Cal Water's proposed increase to its conservation program deployment budget because the utility's budget forecast relies on multiplier-based assumptions which are not reasonable. The Commission should adopt a conservation program deployment budget of $4,406,156, consistent with the latest authorized budget level.

B. Cal Water's School Education and Public Information Programs are Unnecessary.

Cal Water's Public Information and School Education conservation budget request includes program marketing costs and general conservation-related public outreach and information, and funds for school-based learning programs deployed across Cal Water service areas, respectively.[32] However, the water industry does not expect conservation education programs to produce any measurable water savings.[33] Cal Water's budget request would increase customer bills without ensuring measurable conservation or other tangible benefits.

Cal Water requests ratepayer funding to increase the school education budget by 50% over the currently authorized level (from $496,627 to $744,953) to fund new educational initiatives that Cal Water is developing.[34] However, the Application proposal does not contain details on what initiatives will be developed and to what extent, if any, these initiatives will result in conservation. Cal Water's budget request is unreasonable because it lacks clear objectives and evidence of tangible conservation benefits. Therefore, ratepayers should not pay for Cal Water's School Information program budget.

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[32] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 35.

[33] Attachment 1-5, A. 23-08-010, Cal Advocates Report and Recommendations on Golden State Water Company's General Office Expenses Budget, Conservation Program Budget, Special Request #2 and #3 [Public Version] at 1-3 – 1-4.

[34] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 37.

Cal Water also seeks ratepayer funds for a blanket increase to its public information budget, from $1,080,318 to $2,018,322.[35] Cal Water asserts that this increase is necessary to maintain a conservation marketing budget equivalent to 20% of its program deployment budget request.[36] Cal Water does not provide adequate support to substantiate its conservation program deployment budget request. Ratepayers should only pay for initiatives that have been proven to be effective in achieving conservation. Therefore, the Commission should deny Cal Water's public information budget request.

C. Administrative and Research Budget.

Cal Water's Administrative and Research budget covers the costs of existing and proposed conservation-related staffing and outside consulting services related to conservation-related research, measurement, and verification of program performance.[37] Cal Water proposes an Administrative and Research budget of $3,860,813.[38] The budget request is an increase (of 49% or $1,277,845) over the currently authorized budget of $2,582,978. This request is unreasonable because Cal Water does not adequately support its assertion that these programs are underfunded and lack staffing to improve conservation outcomes.

Cal Water seeks ratepayer funding to increase its conservation-related full-time equivalent (FTE) positions from 9 FTEs to 15 FTEs.[39] Cal Water claims its existing level of staffing has "restricted Cal Water's ability to launch and expand conservation

[35] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 37.

[36] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 36.

[37] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 35.

[38] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 38.

[39] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 34.

initiatives effectively."[40] When asked to provide instances to support this claim, Cal Water stated that the average conservation program staff for larger urban water supply agencies is 12 FTE positions per million people served,[41] and did not provide any specific instances where it struggled to launch and expand conservation initiatives due to staffing constraints, despite claiming so in testimony.[42] The Commission should therefore deny Cal Water's unsupported request to increase its conservation related staff.

In addition, Cal Water has not properly demonstrated reasonable utilization of the research portion of this budget, so this requested budget increase should be denied. Conservation-related research and reports were requested in discovery to review the outcome and effectiveness of Cal Water's conservation programs. In response, Cal Water explained that a simple before-after comparison of water usage is generally inadequate for assessing conservation program water savings because there are a multitude of other factors, such as differences in weather, changes in the economy, or coincident conservation orders or drought restrictions, that confound such comparisons.[43] It is agreeable that a simple before-after comparison is not the best representation of the effectiveness of Cal Water's conservation programs. Cal Water provided two water savings studies for its bathroom retrofit direct installation program, both dated May 2018.[44] Cal Water did not provide any other recent studies for review in discovery.[45] Cal Water further explained that, "generally, Cal Water bases it conservation program water savings estimates on empirically derived estimates of average savings for different types of conservation programs… that have been compiled by the Alliance for Water Use

[40] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 34.

[41] California Water Service Company Response to DR SLM-005 Question 7.

[42] California Water Service Company 2024 GRC Testimony Book #2, Attachment H - California Water Service Conservation Budget Report at 34.

[43] Attachment 1-6, California Water Service Company Response to DR SLM-005 Question 9.b.

[44] Attachment 1-6, California Water Service Company Response to DR SLM-005, Attachment #6.

[45] Attachment 1-6, California Water Service Company Response to DR SLM-005, Attachment #6.

Efficiency."[46] Cal Water has not utilized the budget for research purposes and instead relies on general estimates from the Alliance for Water Use Efficiency to determine its conservation program's effectiveness.[47] At the same time, Cal Water has spent $5,092,421.20 of its authorized $7,417,759.79 (68.65%) of its authorized budget for administration and research between 2020 to 2022, summarized in Table 1-2 below.[48]

Table 1-2: Cal Water's Recorded 2020 – 2022 Administrative and Research Conservation Spending[49]

Administrative and Research Budget	2020	2021	2022	Total
Authorized	$ 2,472,586.60	$ 2,472,586.60	$ 2,472,586.60	$ 7,417,759.79
Recorded	$ 1,424,129.82	$ 1,635,370.22	$ 2,032,921.16	$ 5,092,421.20
Difference	$ 1,048,456.78	$ 837,216.38	$ 439,665.44	$ 2,325,338.59

Ratepayers should no longer fund a conservation administrative and research budget, because Cal Water has failed to show proper utilization of the budget.

D. Cal Water is authorized a Conservation Regulation Memorandum Account (CRMA).

Cal Water filed Advice Letter No. 2509 to establish a Conservation Regulation Memorandum Account (CRMA). The CRMA is approved and effective as of January 25, 2024 and records "any incremental expenses that are required to comply with the 'Making Conservation a California Way of Life' Regulation of the State Water Resources Control Board (SWRCB) that are not in rates or otherwise tracked in another

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[46] Attachment 1-6, California Water Service Company Response to DR SLM-005, Attachment #6.

[47] Attachment 1-6, California Water Service Company Response to DR SLM-005, Question 9.b.

[48] California Water Service Company Response to DR SLM-004, Attachment 3 – 2020 – 2022 Conservation Worksheet_CEBA.

[49] California Water Service Company Response to DR SLM-004, Attachment 3 – 2020 – 2022 Conservation Worksheet_CEBA.

memorandum or balancing account."[50] Given that Cal Water's CRMA tracks any incremental expenses associated with the regulation, Cal Water has not demonstrated the necessity of the its proposed conservation program budget increase.

IV. CONCLUSION

The Commission should authorize a Conservation Program Budget of $4,406,156 for Cal Water in TY 2026. The budget recommendation is consistent with the level previously authorized for Cal Water to carry out its conservation program. The Commission should deny Cal Water's request for a budget related to Public Information and School Education purposes as these programs do not result in any measurable conservation benefits. In addition, the Commission should deny Cal Water's request for an Administration and Research budget as Cal Water has failed to show proper utilization of the program budget. Ultimately, any additional expenses required to comply with the ongoing SWRCB conservation rulemaking in this GRC period will be adequately and fairly addressed through the CRMA.

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[50] Attachment 1-7, California Water Service Company Advice Letter 2509-A at 2.

LIST OF ATTACHMENTS FOR CHAPTER 1

	Attachment #	Description
1	Attachment 1-1	Statement of Qualifications
2	Attachment 1-2	*"Making Conservation a California Way of Life"* a Fact Sheet by the California State Water Board.
3	Attachment 1-3	Final Text of Regulation to Make Conservation a California Way of Life.
4	Attachment 1-4	California Department of Water Resources, Results of the Indoor Residential Water Use Study.
5	Attachment 1-5	A.23-08-010 - Sam Lam - Report on General Office Expenses Budget, Conservation Program Budget, SR2 and SR3 [PUBLIC], pages 1-3 to 1-4.
6	Attachment 1-6	California Water Service Response to DR SLM-005, Attachment #6, Part 1, 2 and 3.
7	Attachment 1-7	California Water Service Company's Advice Letter 2509.

CHAPTER 2 SALES & REVENUE

I. INTRODUCTION

This chapter contains analysis and recommendations on the TY 2026 sales forecast in this General Rate Case (GRC). An accurate sales forecast is vital because any over or under forecasts lead to inaccurate customer rates that may result in under or over collection of revenues.

Revenue at present rates for the test year (TY) is forecast using customer counts by customer class and average sales per customer for each customer class. The forecasted number of customers multiplied by the forecasted average sales per customer for each class yields the total sales forecast for each customer class.

(Number of Customers Forecast) x (Average Use per Customer Forecast)

= Total Sales Forecast

D.20-08-047 requires sales forecasts in future rate cases to address the following factors:[51]

- Impact of revenue collection and rate design on sales and revenue collection;
- Impact of planned conservation programs;
- Changes in customer counts;
- Previous and upcoming changes to building codes requiring low flow fixtures and other water-saving measures, as well as any other relevant code changes;
- Local and statewide trends in consumption, demographics, climate, population density, and historic trends by Rate Making Area (RMA); and
- Past sales trends.

Operating revenues are a result of the customer and sales forecast and are collected from Cal Water's different customer classes across the utility's ratemaking areas. Operating revenues are collected from customers as the sum of service and quantity charges. Miscellaneous revenues refer to the total of the various sources of non-operating revenue sources.

Cal Water's Results of Operation, Application testimonies, historical data, and data request responses is reviewed to develop the following recommendations.

II. SUMMARY OF RECOMMENDATIONS

The Commission should adopt Cal Water's number of customers forecast. The Commission should deny Cal Water's request to use a drought-restriction based (Drought-Scenario) sales forecast and instead adopt the sales forecast based on normal weather assumptions (Normal-Scenario). The Commission should require Cal Water to include and submit the econometric model in future GRCs for review.

[51] D.20-08-047, Ordering Paragraph 1 at 105-106.

III. ANALYSIS

A. Number of Customers Forecast

Cal Water uses an ordinary least squares (OLS) regression model to forecast service connections based on the average change in the number of services for the previous five years.[52] In the case of Bakersfield (BK) and Selma (SEL), the forecast model controls for the conversion of flat to metered services.[53] As of the filing of this GRC, Bakersfield (BK) is the sole remaining district with flat rate services in the residential revenue class.[54] Cal Water projects that all flat-rate metered services will be converted to metered services prior to TY 2026.[55] The Commission should adopt Cal Water's number of customers forecast. The number of customers forecast is included as Attachment 2-1 in the Appendix.

B. Sales Forecast (Average Use per Customer Forecast)

Cal Water uses an econometric methodology to forecast TY 2026 sales in this GRC.[56] Econometrics is the use of statistical and mathematical models to forecast future trends from historical data.[57] Cal Water's econometric model uses the following factors to predict future average use per customer in its ratemaking areas: (1) customer

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[52] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 26.

[53] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 26.

[54] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 5.

[55] California Water Service Company 2024 GRC Testimony Book #2 at 112.

[56] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 26 and 38.

[57] Econometrics: Definition, Models, and Methods, Investopedia, https://www.investopedia.com/terms/e/econometrics.asp, (Accessed October 2024).

heterogeneity, (2) economic factors, (3) demand shocks, (4) seasonality, and (5) weather.[58] The average use model can be mathematically represented as:[59]

Model Specification

A general representation of the average use model is:

$$gpd_{it} = \mu_i + \beta_S \cdot Season_t + \beta_W \cdot Weather_t + \beta_E \cdot Economics_{it} + \beta_{SH} \cdot Shocks_t + \varepsilon_{it}$$

where i is an index of customers and t is an index of meter read dates. The dependent variable is customer i's average daily water use in gallons in each billing period t.

Cal Advocates requested Cal Water to submit the econometric model files through discovery for both the Drought-Scenario and Normal-Scenario sales forecast, but Cal Water explained that the econometric model files cannot be easily transferred and replicated due to the large amount of data necessary to reproduce the model separately in this GRC.[60] As a result, Cal Advocates met with Cal Water and the company's consultant, MCubed, to conduct a walkthrough of the econometric model.[61]

The Commission should require the full econometric model be submitted for review in future GRCs, consistent with Public Utilities Code Sections 1821 and 1822.

1. Analysis of Cal Water's 2023 sales forecast versus recorded from the 2021 GRC.

Comparing the 2023 forecast and actual recorded usage,[62] Cal Water's sales forecast model for the residential, multi-residential, commercial, and public authority

[58] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 38.

[59] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 39.

[60] California Water Service Company Response to DR SLM-002, Question 1.a.

[61] California Water Service Company Response to DR SLM-002, Question 1.a.

[62] 2023 is the first rate case year of Cal Water's 2021 GRC.

revenue classes had a combined error of 11%, summarized in Table 2-1 below.[63] These four revenue classes account for 95% of Cal Water's total water sales.[64]

Table 2-1 Cal Water's 2023 Forecast versus Actual Average Use

Forecast versus Actual 2023 Average Use (CCF/Service)					
	Revenue Class				
	Residential	Multi-Residential	Commercial	Public Authority	Combined
Mean Absolute Percentage Error	11.1%	3.0%	5.7%	11.2%	10.9%

The Mean Absolute Percentage Error (MAPE) measures the accuracy of a forecast system, and it is the most common measure used to forecast error.[65] A MAPE less than 5% is considered an indication that the forecast is acceptably accurate.[66] A MAPE between 10% and 25% indicates low, but acceptable accuracy, and a MAPE greater than 25% indicates very low, unacceptable accuracy.[67] Cal Water's 2021 GRC sales forecasting model can therefore be considered of low but acceptable accuracy. However, when the 2021 GRC sales forecast model is adjusted for actual 2023 weather conditions

[63] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 24.

[64] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 26.

[65] "MAPE (Mean Absolute Percentage Error)," Working with Planning, Oracle. Retrieved from https://docs.oracle.com/en/cloud/saas/planning-budgeting-cloud/pfusu/insights_metrics_MAPE.html.

[66] Swanson, D. A. (2015). On the Relationship among Values of the same Summary Measure of Error when used across Multiple Characteristics at the same point in time: An Examination of MALPE and MAPE. *Review of Economics and Finance*, 5(1) at 3. Retrieved from https://escholarship.org/uc/item/1f71t3x9.

[67] Swanson, D. A. (2015). On the Relationship among Values of the same Summary Measure of Error when used across Multiple Characteristics at the same point in time: An Examination of MALPE and MAPE. *Review of Economics and Finance*, 5(1) at 3. Retrieved from https://escholarship.org/uc/item/1f71t3x9.

and Governor Newsom's call for voluntary water conservation,[68] the MAPE improves, and the combined error is reduced from about 11% to 3%.[69]

2. Analysis of the components of Cal Water's econometric model.

As stated above, Cal Water's sales forecast model includes five different components, (1) customer heterogeneity, (2) economic factors, (3) demand shocks, (4) seasonality, and (5) weather.[70]

(1) The customer heterogeneity factor separates the customer water use data based on the customer type (e.g. residential vs. commercial) and the meter size. This factor ensures that the sales forecast model correctly attributes the difference in consumption patterns between a residential customer and a commercial customer.

(2) The economic factor studies the impact that marginal water costs, employment, and long-term conservation trends have on a customer's average water use. This factor directly responds to D.20-08-047's directive to address the impact of rate design and conservation trends on a consumer's water use in the sales forecast.

(3) The demand shock factor studies the impact of drought-related water use restrictions and the COVID-19 shelter-in-place orders and how these events impacted water use. It is important to study these demand shock events as the resulting water use behavior changes from these events are considered abnormal, and one should not expect these past events to affect the future water sales forecast. That is, one should not expect ratepayers in TY 2026 to use water in a similar manner as when the COVID-19 shelter-in-place orders were in effect during 2020.

(4) The seasonality factor addresses the seasonal variation in water use. For example, it studies how a ratepayer's water use changes between the winter and summer seasons.

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[68] https://www.gov.ca.gov/2023/03/24/governor-newsom-eases-drought-restrictions/ (Accessed October 2024).

[69] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 23.

[70] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 38.

(5) The weather factor studies how water use behavior differs in times where temperature and rainfall deviates from the normal expected averages.

Cal Water's sales forecast model factors are fair and reasonably addresses D.20-08-047's guidance on the sales forecast in GRCs.

3. Cal Water Presents Two TY 2026 Sales Scenarios

Cal Water presents two Test Year sales forecast scenarios for review in its current GRC application. The first scenario shows average use under normal weather patterns, which this report will refer to as the Normal-Scenario sales forecast.[71] The second scenario shows average use under possible drought restrictions impacting water use in the Test Year, which this report will refer to as the Drought-Restricted sales forecast.[72]

The Commission should adopt the Normal-Scenario sales forecast, based on the normal weather pattern studied.[73] The Normal-Scenario sales forecast is included in Attachment 2-2 in the Appendix. Note that Cal Water refers to the sales forecast based on normal weather patterns as the Unrestricted Sales;[74] this report renames the sales forecast and refers to it as the Normal-Scenario sales forecast. The Normal-Scenario sales forecast is estimated with monthly billing data between January 01, 2011, to December 21, 2022.[75] Cal Water's analysis found that drought response builds over time and that conservation efforts may continue to yield water savings even after a drought has

[71] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 62.

[72] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 62.

[73] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 62.

[74] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 62.

[75] California Water Service Company 2024 GRC Testimony Book #2, Attachment G – California Water Service Sales Forecast Report at 43.

subsided.[76] This finding shows that conservation has truly become a California way of life.

Cal Water uses the Drought-Restricted sales forecast to develop its final Test Year estimates, and approximates that drought restrictions could reduce Cal Water's sales by 4 million CCF in the Test Year.[77] The Drought-Restricted sales forecast unnecessarily imposes a drought scenario onto the Test Year forecast and artificially lowers the sales forecast by 4 million CCF as a result.[78] The Commission should deny Cal Water's request to use the Drought-Restricted sales forecast as it is unnecessary to assume California will impose statewide drought restrictions in the Test Year.

Cal Water misinterprets and misuses D.16-12-026 (Decision). The utility cites page 24 of the Decision as support for incorporating drought risks into the Test Year forecast.[79] Cal Water referenced this sentence in the Decision, where it states "[o]ur forecast mechanisms must recognize and use the drought years as a basis for forecasting or at least explain why any non-drought years should be considered a reliable predictor of future consumption."[80] The Decision gives weight to the importance of studying how drought years in the past has affected and may affect water use. Both the Normal-Scenario and Drought-Restricted sales forecast studies the past drought years and its effect on water use. The Decision, however, does not support Cal Water's method of imposing drought restrictions on its own test year sales forecast. Cal Water incorrectly cites to D.16-12-026 to support its unnecessarily rigid sales forecasting methodology in

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[76] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 55.

[77] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 60.

[78] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 60.

[79] California Water Service Company 2024 GRC Testimony Book #2, Attachment G - California Water Service Sales Forecast Report at 61, Footnote 18.

[80] D.16-12-026 at 24.

the Drought-Restricted sales forecast. The Commission should not adopt Cal Water's Drought-Restricted sales forecast as it is unsupported and lacks rationale.

IV. CONCLUSION

The Commission should adopt Cal Water's number of customers forecast. The Commission should deny Cal Water's request to use a drought-restriction based (Drought-Scenario) sales forecast and instead adopt the sales forecast based on normal weather assumptions (Normal-Scenario). In addition, the Commission should require Cal Water to include and submit its econometric model for review in future GRCs.

LIST OF ATTACHMENTS FOR CHAPTER 2

	Attachment #	Description
1	Attachment 2-1	Number of Customers Forecast.
2	Attachment 2-2	Normal-Scenario Sales Forecast.

CHAPTER 3 RATE DESIGN

I. INTRODUCTION

Rate design is the structure of prices charged to utility customers for tariffed services. The process for creating a rate design involves determining the revenue requirement and the allocation of revenue recovery between fixed and quantity charges (the revenue allocation), finding appropriate tier breakpoints for tiered meter services, calculating the standard quantity rate, and establishing a tiered quantity rate structure for tiered meter services. Effective rate design encourages conservation, offers affordable options for the baseline water use for human rights, and is revenue neutral.

In Cal Water's 2021 GRC (as adopted by D.24-03-042), the residential rate structure was redesigned to encourage further water conservation by adding an additional rate tier (Tier 4) to incentivize residential conservation.[81] The Tier 1 breakpoint was adjusted to reflect the basic human need for water at 6 CCF[82] and the Tier 1 rate is also set at a discount (at 25% of the Tier 2 rate) to provide all Cal Water's residential ratepayers an affordable access to the first tier of water use.[83]

With exceptions for the Bakersfield, East Los Angeles, Los Angeles County, and Visalia ratemaking areas (RMA) the Tier 2 breakpoint is set at the 70th percentile of recent consumption levels, the Tier 3 breakpoint is set at the 85th percentile of recent consumption levels, and Tier 4 is customers above the 85th percentile -- the highest 15% of all water use in Cal Water's districts.[84] For the Bakersfield, Los Angeles County, and Visalia RMAs, the breakpoints are set at the levels originally proposed by Cal Water in

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[81] Decision 24-03-042 at 2. Exception for KRV and ELA, which remain under a single quantity rate and a three-tier residential rate design, respectively.

[82] California Water Service Rate Design Analytics Report at 3. M.Cubed (March 2021).

[83] Decision 24-03-042 at 16.

[84] Decision 24-03-042 at 15.

its July 2021 application.[85] The East Los Angeles district continues to implement a three-tier residential rate design.[86]

The Tier 3 rate and Tier 4 rate is set at 125% and 187.5% of the Tier 2 rate, respectively. The rates are calculated using the Tier 2 rate as the starting point and are verified to be revenue neutral prior to adoption.[87] The rate design authorized in D.24-03-042 was implemented in May 2024 across Cal Water's districts.

II. SUMMARY OF RECOMMENDATIONS

The Commission should rename the tiers in the residential rate design to properly align the tier allocation with their intended use and to improve conservation goals and signals.

Conservation Rate Design		
Tiers	**New Name**	**Purpose**
Tier 1	Monthly Indoor Water Use Allocation	To reflect the conservation regulatory framework's indoor water use targets.
Tier 2	Monthly Reasonable Discretionary Water Use Allocation	To reflect a reasonable and equitable access to an affordable amount of water for discretionary purposes.
Tier 3	Additional Discretionary Water Use Allocation	To reflect water uses beyond a reasonable standard for indoor and discretionary water use. Conservation price signals begin here.
Tier 4	Excessive Discretionary Water Use	To reflect excessive water uses and is only applicable in districts as needed. The strongest conservation price signals are sent for water uses in this tier.

[85] California Water Service Reports on Conservation, Sales and Rate Design 2021 GRC, Section III Rate Design Analytics Report (March 2021) at 7. Cal Water proposed to shift the existing tier breakpoints one tier in the July 2021 application (2021 Cal Water GRC).

[86] D.24-03-042 at 15.

[87] Revenue neutrality is achieved when the expected revenue equals the revenue requirement in each district.

III. ANALYSIS

A. Conservation Rate Design - Tier 1

With exceptions for the Kern River Valley and Travis Districts, D.24-03-042 adopted a residential rate design (or conservation rate design) establishing the Tier 1 breakpoint at 6 CCF across all of Cal Water's RMAs. At the time, Cal Water determined that setting the Tier 1 breakpoint at 6 CCF would accommodate the Commission's directive that the appropriate Tier 1 breakpoint should not be less than the monthly baseline quantity of water necessary for basic human needs in each ratemaking area.[88]

Essentially, the Commission created a rate design policy that designated Tier 1 of the conservation rate design as a residential household's indoor water use allocation. The Commission should deny Cal Water's request to continue standardizing the Tier 1 breakpoint at 6 CCF in this GRC.[89] Continuing to standardize the Tier 1 breakpoint across all ratemaking areas is inequitable to districts with residential households that have a higher number of persons per household.

The conservation regulatory framework established a multi-year residential indoor water use standard.[90] AB 1668, as amended by SB 1157 (Hertzberg 2022), sets the following residential indoor water use targets:

- The standard for indoor residential water use shall be 55 gallons per capita daily until January 1, 2025;
- Beginning January 1, 2025, and until January 1, 2030, the standard for indoor residential water use shall be 47 gallons per capita daily; and
- Beginning January 1, 2030, the standard for indoor residential water use shall be 42 gallons per capita daily.[91]

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[88] D.20-08-047, Ordering Paragraph 2 at 106.

[89] California Water Service 2024 GRC Testimony Book #2 at 108.

[90] Senate Bill 606 (2018) and Assembly Bill 1668 (2018), commonly referred to as the conservation regulatory framework.

[91] SB 1157 (Hertzberg 2022).

The residential indoor water use standard converted to monthly CCF estimates is shown in Table 3-1 below.

Table 3-1 Standard for Residential Indoor Water Use Targets[92]

Standard for Residential Indoor Water Use Targets			
TIME	Gallons per Capita Daily [GPCD]	Monthly CCF per Household	Monthly CCF per Household [Rounded]
Before Jan 1, 2025	55	6.13	7.00
Until Jan 1, 2030	47	5.24	6.00
After Jan 1, 2030	42	4.68	5.00
Estimated based on, [I.] 2.78 person per household (2023 California Census Data). [II.] 30 days per month.			

The Commission should continue the policy to utilize the monthly Tier 1 water rates in the conservation rate design as a designation for the residential indoor water use allocation. However, the Commission should adopt the following Tier 1 breakpoints, summarized in Table 3-2 below. The Tier 1 breakpoint recommendation uses Cal Water's estimate of the person per household in each ratemaking area and is converted to a monthly CCF estimate that aligns with AB 1668/ SB 1157's residential indoor water use targets in the test year. The Tier 1 breakpoint calculation is rounded to the nearest whole number.

In addition, the Commission should rename the Tier 1 allocation of water the "Monthly Indoor Water Use Allocation (Tier 1)" to properly align the conservation regulatory framework policy goals with the conservation rate design. This renaming can

[92] Average household size 2023 California Census Data, United States Census Bureau (Accessed October 2024) https://data.census.gov/table?q=California%20Families%20and%20Living%20Arrangements&g=040XX00US06.

also provide additional clarification and messaging to ratepayers about the indoor water use targets and the conservation rate design purposes.

Table 3-2: Monthly Indoor Water Use Allocation (Tier 1 Breakpoint)

Ratemaking Area	Person per Household Estimate	Monthly Indoor Water Use Allocation [Tier 1]
BAR - Bay Area Region	2.39	5
BG - Bear Gulch	2.48	5
BKD - Bakersfield	3.49	7
DIX - Dixon	3.22	7
ELA - East Los Angeles	5.78	11
LAR - Los Angeles County Region	2.33	5
LAS - Los Altos	2.96	6
LIV - Livermore	2.73	6
MRL - Marysville	2.53	5
NVR - North Valley Region	2.59	5
SBR - South Bay Region	3.24	7
SEL - Selma	3.65	7
STK - Stockton	3.54	7
SVR - Salinas Valley Region	3.69	7
VIS - Visalia	2.96	6
WIL - Willows	2.99	6
WLK - Westlake	2.83	6

B. Conservation Rate Design - Tier 2

In the 2021 Cal Water GRC, Cal Advocates raised the concern that establishing the Tier 1 breakpoint at 6 CCF is likely to result in additional burden to larger households.[93] Cal Advocates recommended the Commission to adopt a residential rate design policy that designated Tier 1 and Tier 2 of monthly water uses as a household's affordable indoor and outdoor water use allocation, respectively.[94] In the 2021 Cal Water

[93] A.21-07-002, Cal Advocates Report on Sales Forecast, Conservation Budgets, Rate Design, and Special Request 2 – RSF Program Update at 3-11.

[94] A.21-07-002, Cal Advocates Report on Sales Forecast, Conservation Budgets, Rate Design, and Special Request 2 – RSF Program Update at 3-12.

GRC, the Commission adopted the following Tier 2 breakpoints, summarized in Table 3-3 below.

Table 3-3: Current Tier 2 Breakpoint & Tier 2 Width

Ratemaking Area	Current Tier 2 Breakpoint [CCF]	Current Tier 2 Width [CCF]
BAR - Bay Area Region	9	3
BG - Bear Gulch	18	12
BKD - Bakersfield	14	8
DIX - Dixon	13	7
ELA - East Los Angeles	14	8
LAR - Los Angeles County Region	17	11
LAS - Los Altos	20	14
LIV - Livermore	15	9
MRL - Marysville	12	6
NVR - North Valley Region	18	12
SBR - South Bay Region	12	6
SEL - Selma	20	14
STK - Stockton	13	7
SVR - Salinas Valley Region	12	6
VIS - Visalia	11	5
WIL - Willows	15	9
WLK - Westlake	25	19

[I.] The current Tier 1 breakpoint is standardized at 6 CCF.

The current conservation rate design allocates a different amount of water to customers in different districts. The Tier 2 width ranges from 3 CCF (BAR) to 19 CCF (WLK). The difference in the Tier 2 allocation creates inequity in customers' access to a reasonable and affordable amount of water for discretionary purposes. For example, the current conservation rate design will send the Tier 3 conservation price signal to a Stockton (STK) ratepayer 12 CCFs before it does to a Westlake (WLK) ratepayer.[95] This

[95] The current Tier 2 breakpoint in the Stockton and Westlake district is 13 and 25 CCFs, respectively.

means that a ratepayer using 15 CCF of water monthly in STK will be billed 2 CCFs of water at Tier 3 rates, while a ratepayer using 15 CCF of water monthly in WLK will be billed at Tier 2 rates. Table 3-4 below shows a comparison of the currently authorized tier width for Stockton and Westlake.

Table 3-4: Comparing Tier Widths between Stockton and Westlake

Current Residential Rate Design		
Tier Widths	**Stockton**	**Westlake**
Tier 1	1-6	1-6
Tier 2	7-13	7-25
Tier 3	14-18	26-44
Tier 4	18+	44+

Meanwhile, the average number of persons per household is larger in the Stockton district than it is in the Westlake district, 3.54 compared to 2.83 persons per household, respectively. In some instances, the current rate design (of Tier 1 and Tier 2 allocation) will send inequitable conservation signals, as shown in the above case study for an average ratepayer in the Stockton district when compared to an average ratepayer in the Westlake district.

Thus, the Commission should allocate a standardized amount of water for the Tier 2 water allocation across all ratemaking areas to promote equitable access to affordable discretionary water uses. In addition, the Tier 2 water use allocation can be used as a buffer for indoor water use for ratepayers with a larger household than the district's average. The Commission should rename the Tier 2 allocation of water the Monthly Reasonable Discretionary Water Use Allocation (Tier 2) to balance equitable and affordable access to water with the conservation regulatory framework policy goals. Renaming Tier 2 will also provide clarification and appropriate conservation messaging to ratepayers about their water use.

The Commission should adopt 6 CCF as the standard allocation of Monthly Reasonable Discretionary Water Use (Tier 2) across Cal Water's ratemaking areas in this GRC. The Commission should allocate a standardized amount of water for the Monthly

Reasonable Discretionary Water Use (Tier 2) allocation as it ensures all ratepayers have a fair and equitable access to affordable and non-wasteful discretionary water use. The Commission should adopt six CCF for this tier, calculated based on the state's average number of persons per household multiplied by the indoor residential water use targets.[96] Given that landscape irrigation (a discretionary water use) accounts for approximately 50% of the annual residential water consumption statewide,[97] Cal Advocates' recommendation extrapolates the indoor water use targets from the conservation regulatory framework and applies it to the Reasonable Discretionary Water Use (Tier 2) allocation in this GRC. In future GRCs, Cal Water's Monthly Reasonable Discretionary Water Use (Tier 2) allocation should be based on the conservation regulatory framework's standard for efficient residential outdoor use.[98]

The Commission should adopt the following Monthly Reasonable Discretionary Water Use (Tier 2) breakpoints, summarized in Table 3-5 below.

[96] See Table 3-1 for the calculations.

[97] Average percentages of developed water use in California during a non-drought year (Sources: Calif. Dept. of Water Resources, 2013 California Water Plan Update Chapter 3. UCLA Institute of Environment and Sustainability, So. Calif. Environmental Report Card, Fall 2009). (Accessed October 2024).

[98] Attachment 1-3, Final Text of Regulation to Make Conservation a California Way of Life, Section 968 (§ 968. Outdoor Residential Water Use Standard).

Table 3-5: Monthly Reasonable Discretionary Water Use Allocation (Tier 2 Breakpoint)

Ratemaking Area	Monthly Reasonable Discretionary Water Use Tier Breakpoint [Tier 2]
BAR - Bay Area Region	11
BG - Bear Gulch	11
BKD - Bakersfield	13
DIX - Dixon	13
ELA - East Los Angeles	17
LAR - Los Angeles County Region	11
LAS - Los Altos	12
LIV - Livermore	12
MRL - Marysville	11
NVR - North Valley Region	11
SBR - South Bay Region	13
SEL - Selma	13
STK - Stockton	13
SVR - Salinas Valley Region	13
VIS - Visalia	12
WIL - Willows	12
WLK - Westlake	12
[I.] Standardizing the Tier 2 allocation at 6 CCF.	

C. Conservation Rate Design – Tier 3 and 4

If the Commission adopts the recommended Monthly Indoor Water Use Allocation (Tier 1) and the Monthly Reasonable Discretionary Water Use Allocation (Tier 2), it should also review the necessity of a Tier 4 across all ratemaking areas. Table 3-5 below compares the Tier 2 breakpoint recommendation and the recorded (2023) 90th percentile of water use (i.e., the top 10% of recorded monthly water use).

Table 3-5: 2023 Recorded 90th Percentile Consumption Level vs the Monthly Reasonable Discretionary Water Use Allocation Recommendation (TY 2026)

Ratemaking Area	Monthly Reasonable Discretionary Water Use Tier Breakpoint [Tier 2]	2023's Top 10% of Monthly Water Use [90th Percentile]	Distance from T2 Breakpoint Recommendation
BAR - Bay Area Region	11	14	3
BG - Bear Gulch	11	41	30
BKD - Bakersfield	13	34	21
DIX - Dixon	13	18	5
ELA - East Los Angeles	17	19	2
LAR - Los Angeles County Region	11	32	21
LAS - Los Altos	12	30	18
LIV - Livermore	12	24	12
MRL - Marysville	11	19	8
NVR - North Valley Region	11	31	20
SBR - South Bay Region	13	16	3
SEL - Selma	13	30	17
STK - Stockton	13	19	6
SVR - Salinas Valley Region	13	18	5
VIS - Visalia	12	31	19
WIL - Willows	12	21	9
WLK - Westlake	12	42	30

Table 3-5 highlights the ratemaking areas where the 90th percentile (top 10%) of consumption is within 6 CCF of the Monthly Discretionary Water Use Allocation, thus raising doubt about the necessity of a Tier 4 in those districts.[99] Six CCF is used as a benchmark here as it is the conservation regulatory framework's indoor water use target, extrapolated to reflect the average Californian household size, and converted from a gallons-per-capita daily target to a monthly CCF target. The Commission should not adopt a rate design with tier widths that are less than the monthly indoor water use target,

[99] Bay Area Region, Dixon, East Los Angeles, South Bay Region, Stockton, and the Salinas Valley Region.

and Tier 4 should not create an unreasonably small lower-level tier, like the current Tier 2 width of 3 CCF in the Bay Area Region. As such, the Commission should revert these six highlighted ratemaking areas back to a three-tier conservation rate design.[100] In addition, the third tier of the conservation rate design should be named "Additional Discretionary Water Use Allocation (Tier 3)" to appropriately reflect the tier's purpose.

A Tier 4 in a conservation rate design should be reserved for the highest level of monthly water use, in which the strongest conservation price signals should be sent. The Commission should therefore rename the Tier 4 in the conservation rate design the "Excessive Discretionary Water Use Tier (Tier 4)" and set it to capture the highest 10% of all monthly water use in districts that require a Tier 4. Doing so will accurately reflect the excessive nature of the water use at the highest level and will inform a ratepayer who incurs monthly water use in Tier 4 that they are among the highest 10% of water users in their district. The Commission should adopt the following conservation rate design tiers, summarized in Table 3-6.

[100] Bay Area Region, Dixon, East Los Angeles, South Bay Region, Stockton, and the Salinas Valley Region.

Table 3-6: Rate Design Tier Breakpoint Recommendation

Ratemaking Area	Monthly Indoor Water Use Allocation [Tier 1]	Monthly Discretionary Water Use Allocation [Tier 2]	Additional Discretionary Water Use Allocation [Tier 3]	Excessive Water Use Tier [Tier 4]
BAR - Bay Area Region	5	11	11+	
BG - Bear Gulch	5	11	41	41+
BKD - Bakersfield	7	13	34	34+
DIX - Dixon	7	13	13+	
ELA - East Los Angeles	11	17	17+	
LAR - Los Angeles County Region	5	11	32	32+
LAS - Los Altos	6	12	30	30+
LIV - Livermore	6	12	24	24+
MRL - Marysville	5	11	19	19+
NVR - North Valley Region	5	11	31	31+
SBR - South Bay Region	7	13	13+	
SEL - Selma	7	13	30	30+
STK - Stockton	7	13	13+	
SVR - Salinas Valley Region	7	13	13+	
VIS - Visalia	6	12	31	31+
WIL - Willows	6	12	21	21+
WLK - Westlake	6	12	42	42+

Cal Water's sales forecasting model finds that urban water consumption adheres to the fundamental law of demand, "just like any other good or resource."[101] Cal Water calls this the "Price Effect," because "[c]onsumers do not have a fixed water requirement; instead they adjust their usage based on cost and perceived value."[102] Cal Water's Price Effect undermines the difference in a ratepayer's reaction to discretionary

[101] California Water Service Company 2024 GRC Testimony Book #2, Attachment G – California Water Service Sales Forecast Report at 47.

[102] California Water Service Company 2024 GRC Testimony Book #2, Attachment G – California Water Service Sales Forecast Report at 47.

water use as opposed to water for drinking and sanitation.[103] Specifically, residential water demand is defined by three important characteristics:[104]

1. Irrigation for landscapes consumes massive quantities of water.
2. Residential irrigation is a discretionary use as opposed to water for drinking and sanitation.
3. Demand for landscape irrigation is countercyclical to supply with demand rising during droughts and heat waves when water supplies are stressed.

While it can be argued that discretionary water use follows the fundamental law of demand, it is unclear whether *all* water use actually adheres to this law. For example, households will not stop drinking and bathing as the price of water increases, but they are more likely to reduce discretionary uses such as irrigation.[105] Thus, it is important that the Commission implement a rate design that allocates a reasonable and affordable amount of water for non-discretionary water uses in the Monthly Indoor Water Use Allocation (Tier 1). Subsequently, the rate design should send valuable conservation signals for discretionary water use in the higher tiers of the rate design, the Additional Discretionary Water Use Allocation (Tier 3) and Excessive Water Use Tier (Tier 4).

D. Conservation Rate Design – Rate Multiplier

Cal Water proposes two separate rate multipliers (or rate ratios) in this GRC, contingent on whether the Commission authorizes Cal Water to implement the Low Use Water Equity Program (Special Request #3) or the Monterey-Style Water Revenue Adjustment Mechanism. The Commission should deny Cal Water's request for different rate design treatments contingent on the revenue adjustment mechanism authorized. The

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[103] The United Nations deemed clean drinking water and sanitation to be a human right, while water for discretionary uses is widely considered to be an economic good. Attachment 3-1, Resolution 64-292, The Human Right to Water and Sanitation, The United Nations (Adopted July 28, 2010).

[104] Perry, Christopher J, CJ Perry, Michael Rock, D Seckler, Michael T Rock, and David William Seckler, *Water as an economic good: A solution or a problem?,* Vol. 14, IWMI, 1997.

[105] Daniel A. Brent (2016), *Estimating Water Demand Elasticity at the Intensive and Extensive Margin* at Footnote 4, Department of Economics, Louisiana State University.

rate design and the revenue adjustment mechanism a water utility is authorized to implement are independent of one another. The modern rate design process ensures conservation, offers an affordable option for baseline water use, and is revenue neutral.

The Commission should adopt Cal Water's requested adjustment to the rate multiplier, summarized in Table 3-7 below. Table 3-8 below summarizes the renaming of the tiers in the conservation rate design and its intended purpose.

Table 3-7: Conservation Rate Design Rate Multiplier (TY 2026)

Conservation Rate Design Tiers	Rate Multiplier
Monthly Indoor Water Use Allocation [Tier 1]	25%
Monthly Discretionary Water Use Allocation [Tier 2]	100%
Additional Discretionary Water Use Allocation [Tier 3]	200%
Excessive Water Use Tier [Tier 4]	400%
[I.] The rate multiplier is calculated as a % of the Monthly Discretionary Water Use Allocation (Tier 2) rate.	

Table 3-8: Conservation Rate Design Name and Purpose

Conservation Rate Design		
Tiers	**New Name**	**Purpose**
Tier 1	Monthly Indoor Water Use Allocation	To reflect the conservation regulatory framework's indoor water use targets.
Tier 2	Monthly Reasonable Discretionary Water Use Allocation	To reflect a reasonable and equitable access to an affordable amount of water for discretionary purposes.
Tier 3	Additional Discretionary Water Use Allocation	To reflect water uses beyond a reasonable standard for indoor and discretionary water use. Conservation price signals begin here.
Tier 4	Excessive Discretionary Water Use	To reflect excessive water uses and is only applicable in districts as needed. The strongest conservation price signals are sent for water uses in this tier.

E. Reviewing Customer Response to the New Rate Design.

The Commission should find that it is too early to evaluate the effectiveness of the implementation of a 4-Tier conservation rate design in this GRC, given that Cal Water only implemented the 4-Tier conservation rate design in May 2024. The Commission should require Cal Water to submit, in its next GRC application, a review of the effectiveness and average-use impact of the Tier 4 in the conservation rate design.

In 2024, the Water Resources and Economics Journal published *The Impact of Pricing Structure Change on Residential Water Consumption: A Long-Term Analysis of Water Utilities in California.* The report finds that long-term water policies, such as the implementation of a new 4th tier in the conservation rate design to improve water conservation, will take longer for consumers to adapt to and make changes in their water-use behavior.[106]

The study further supports that price mechanisms, such as the conservation rate design, can effectively curtail outdoor water use; however, the price response is not immediate.[107] As such, the conservation rate design should be viewed as a conservation tool best used for long-term purposes, such as to guide Californian's water-use behavior over time toward levels consistent with the State's conservation goals. The conservation rate design should not be seen as a tool to create immediate water-use behavioral changes.

F. Median & Mean Monthly Bill Analysis

The following section studies the quantity charge bill impact from transitioning customers onto the rate design recommendation. It compares the rate design recommendation to the currently authorized rate design. The average change in a ratepayer's monthly bills is measured in present rates. Tables 3-9 to 3-11 below summarizes the variables used for comparison. Table 3-12 and 3-13 shows the quantity charge bill analysis for Non-CAP and CAP customers, respectively.

[106] Attachment 3-2, Lee et. al. (2024), *The impact of pricing structure change on residential water*: *a long-term analysis of water utilities in California*, Journal of Water Resources and Economics 46 at 5.

[107] Attachment 3-2, Lee et. al. (2024), *The impact of pricing structure change on residential water*: *a long-term analysis of water utilities in California*, Journal of Water Resources and Economics 46 at 5.

Table 3-9: Tier Width Recommendation

Cal Advocates Tier Width Recommendation				
Ratemaking Area	Tier Breakpoints			
	Monthly Indoor Water Use Allocation [Tier 1]	Monthly Discretionary Water Use Allocation [Tier 2]	Additional Discretionary Water Use Allocation [Tier 3]	Excessive Water Use Tier [Tier 4]
BAR	5	11	11+	
BG	5	11	41	41+
BKD	7	13	34	34+
DIX	7	13	13+	
ELA	11	17	17+	
LAR	5	11	32	32+
LAS	6	12	30	30+
LIV	6	12	24	24+
MRL	5	11	19	19+
NVR	5	11	31	31+
SBR	7	13	13+	
SEL	7	13	30	30+
STK	7	13	13+	
SVR	7	13	13+	
VIS	6	12	31	31+
WIL	6	12	21	21+
WLK	6	12	42	42+

Table 3-10: Current Tier Width

Current Tier Width				
Ratemaking Area	Tier Breakpoints			
	Tier 1	Tier 2	Tier 3	Tier 4
BAR	6	9	13	13+
BG	6	18	35	35+
BKD	6	14	26	26+
DIX	6	13	18	18+
ELA	6	14	14+	
LAR	6	17	25	25+
LAS	6	20	30	30+
LIV	6	15	23	23+
MRL	6	12	19	29+
NVR	6	18	29	29+
SBR	6	12	16	16+
SEL	6	20	29	29+
STK	6	13	18	18+
SVR	6	12	17	17+
VIS	6	11	23	23+
WIL	6	15	23	23+
WLK	6	25	44	44+

Table 3-11: Present Rates

Present Rates				
Ratemaking Area	Tier 1	Tier 2	Tier 3	Tier 4
BAR	$ 3.45	$ 13.73	$ 17.16	$ 25.73
BG	$ 2.34	$ 9.33	$ 11.66	$ 17.49
BKD	$ 0.74	$ 2.93	$ 3.66	$ 5.49
DIX	$ 2.03	$ 8.06	$ 10.07	$ 15.10
ELA	$ 1.78	$ 7.09	$ 8.86	$ -
LAR	$ 1.83	$ 7.31	$ 9.14	$ 13.71
LAS	$ 2.22	$ 8.87	$ 11.09	$ 16.63
LIV	$ 1.76	$ 6.99	$ 8.73	$ 13.09
MRL	$ 0.92	$ 3.69	$ 4.62	$ 6.93
NVR	$ 0.50	$ 2.41	$ 3.05	$ 4.64
SBR	$ 1.71	$ 6.93	$ 8.67	$ 13.02
SEL	$ 0.64	$ 2.57	$ 3.22	$ 4.83
STK	$ 1.59	$ 6.32	$ 7.90	$ 11.84
SVR	$ 1.12	$ 4.45	$ 5.56	$ 8.33
VIS	$ 0.35	$ 1.38	$ 1.72	$ 2.58
WIL	$ 1.16	$ 4.65	$ 5.82	$ 8.72
WLK	$ 1.54	$ 6.15	$ 7.68	$ 11.53

Table 3-12: Quantity Charge Bill Analysis (Non-CAP)

	Current Rate Design		**CalAdv Rate Design**		**Current Rate Design**		**CalAdv Rate Design**	
	Non-CAP		Non-CAP		Non-CAP		Non-CAP	
Region	Median	Bill ($)	Median	Bill ($)	Average	Bill ($)	Average	Bill ($)
BAR	6	$ 20.71	6	30.9861	7	$ 34.44	7	$ 44.72
BG	8	$ 32.68	8	39.6743	19	$ 137.65	19	$ 160.96
BKD	13	$ 24.95	13	22.7505	17	$ 38.87	17	$ 37.40
DIX	7	$ 20.21	7	14.1764	9	$ 36.33	9	$ 30.30
ELA	8	$ 24.84	8	14.2192	10	$ 39.01	10	$ 17.77
LAR	9	$ 32.92	9	38.40125	14	$ 69.49	14	$ 80.45
LAS	9	$ 39.95	9	39.9462	14	$ 84.31	14	$ 88.74
LIV	8	$ 24.52	8	24.5162	11	$ 45.47	11	$ 45.47
MRL	6	$ 5.53	6	8.3041	9	$ 16.62	9	$ 19.39
NVR	7.5	$ 6.63	7.5	8.544375	12	$ 17.50	12	$ 20.05
SBR	7	$ 17.19	7	11.9658	8	$ 24.12	8	$ 18.90
SEL	11	$ 16.71	11	14.778	15	$ 27.00	15	$ 26.36
STK	7	$ 15.88	7	11.1468	10	$ 34.84	10	$ 30.11
SVR	7	$ 11.15	7	7.8169	9	$ 20.04	9	$ 16.71
VIS	11	$ 8.96	11	8.9649	15	$ 15.85	15	$ 15.51
WIL	7	$ 11.64	7	11.6426	10	$ 25.60	10	$ 25.60
WLK	10	$ 33.82	10	33.8242	20	$ 95.31	20	$ 107.60

	Current Rate Design		**CalAdv Rate Design**		**Current Rate Design**		**CalAdv Rate Design**	
	Non-CAP		Non-CAP		Non-CAP		Non-CAP	
Region	Average+3	Billl ($)	Average+3	Billl ($)	Average+5	Billl ($)	Average+5	Billl ($)
BAR	10	$ 79.06	10	$ 85.91	12	$ 113.38	12	$ 116.80
BG	22	$ 172.63	22	$ 195.95	24	$ 195.96	24	$ 219.27
BKD	20	$ 49.86	20	$ 48.39	22	$ 57.18	22	$ 55.72
DIX	12	$ 60.52	12	$ 54.48	14	$ 78.65	14	$ 72.62
ELA	13	$ 60.27	13	$ 33.73	15	$ 76.22	15	$ 47.90
LAR	17	$ 91.43	17	$ 107.88	19	$ 109.71	19	$ 126.16
LAS	17	$ 110.92	17	$ 122.00	19	$ 128.66	19	$ 144.18
LIV	14	$ 66.43	14	$ 69.92	16	$ 82.14	16	$ 87.37
MRL	12	$ 27.70	12	$ 31.40	14	$ 36.94	14	$ 40.63
NVR	15	$ 24.74	15	$ 29.20	17	$ 29.57	17	$ 35.30
SBR	11	$ 44.91	11	$ 39.69	13	$ 60.52	13	$ 53.56
SEL	18	$ 34.72	18	$ 36.01	20	$ 39.87	20	$ 42.44
STK	13	$ 53.81	13	$ 49.08	15	$ 69.61	15	$ 64.88
SVR	12	$ 33.38	12	$ 30.05	14	$ 44.50	14	$ 40.06
VIS	18	$ 21.02	18	$ 20.67	20	$ 24.46	20	$ 24.12
WIL	13	$ 39.56	13	$ 40.72	15	$ 48.87	15	$ 52.36
WLK	23	$ 113.75	23	$ 130.65	25	$ 126.05	25	$ 146.02

Table 3-13: Quantity Charge Bill Analysis (CAP)

	Current Rate Design		CalAdv Rate Design		Current Rate Design		CalAdv Rate Design	
	CAP		CAP		CAP		CAP	
Region	Median	Bill ($)	Median	Bill ($)	Average	Bill ($)	Average	Bill ($)
BAR	6	$ 20.71	6	30.9861	7	$ 34.44	7	$ 44.72
BG	7	$ 23.35	7	30.3437	10	$ 51.34	10	$ 58.34
BKD	12	$ 22.01	12	19.8187	16	$ 35.20	16	$ 33.74
DIX	7	$ 20.21	7	14.1764	9	$ 36.33	9	$ 30.30
ELA	8	$ 24.84	8	14.2192	10	$ 39.01	10	$ 17.77
LAR	9	$ 32.92	9	38.40125	12.5	$ 58.51	12.5	$ 66.74
LAS	7	$ 22.20	7	22.2026	11	$ 57.69	11	$ 57.69
LIV	8	$ 24.52	8	24.5162	10	$ 38.49	10	$ 38.49
MRL	7	$ 9.23	7	11.9987	9	$ 16.62	9	$ 19.39
NVR	7.5	$ 6.63	7.5	8.544375	10.5	$ 13.87	10.5	$ 15.79
SBR	8	$ 24.12	8	18.8975	9	$ 31.05	9	$ 25.83
SEL	12	$ 19.28	12	17.3511	15	$ 27.00	15	$ 26.36
STK	8	$ 22.20	8	17.4691	10	$ 34.84	10	$ 30.11
SVR	8	$ 15.59	8	12.2638	10	$ 24.49	10	$ 21.16
VIS	11	$ 8.96	11	8.9649	14	$ 14.13	14	$ 13.79
WIL	7	$ 11.64	7	11.6426	9	$ 20.95	9	$ 20.95
WLK	7	$ 15.38	7	15.3793	11	$ 39.97	11	$ 39.97

	Current Rate Design		CalAdv Rate Design		Current Rate Design		CalAdv Rate Design	
	CAP		CAP		CAP		CAP	
Region	Average+3	Billl ($)	Average+3	Billl ($)	Average+5	Billl ($)	Average+5	Billl ($)
BAR	10	$ 79.06	10	$ 85.91	12	$ 113.38	12	$ 116.80
BG	13	$ 79.33	13	$ 90.99	15	$ 97.99	15	$ 114.31
BKD	19	$ 46.19	19	$ 44.73	21	$ 53.52	21	$ 52.06
DIX	12	$ 60.52	12	$ 54.48	14	$ 78.65	14	$ 72.62
ELA	13	$ 60.27	13	$ 33.73	15	$ 76.22	15	$ 47.90
LAR	15.5	$ 80.46	15.5	$ 94.17	17.5	$ 96.00	17.5	$ 112.45
LAS	14	$ 84.31	14	$ 88.74	16	$ 102.05	16	$ 110.91
LIV	13	$ 59.44	13	$ 61.19	15	$ 73.42	15	$ 78.64
MRL	12	$ 27.70	12	$ 31.40	14	$ 36.94	14	$ 40.63
NVR	13.5	$ 21.12	13.5	$ 24.62	15.5	$ 25.94	15.5	$ 30.73
SBR	12	$ 51.85	12	$ 46.62	14	$ 69.19	14	$ 62.23
SEL	18	$ 34.72	18	$ 36.01	20	$ 39.87	20	$ 42.44
STK	13	$ 53.81	13	$ 49.08	15	$ 69.61	15	$ 64.88
SVR	13	$ 38.94	13	$ 34.50	15	$ 50.05	15	$ 45.61
VIS	17	$ 19.30	17	$ 18.95	19	$ 22.74	19	$ 22.40
WIL	12	$ 34.91	12	$ 34.91	14	$ 44.22	14	$ 46.54
WLK	14	$ 58.42	14	$ 61.49	16	$ 70.71	16	$ 76.86

Table 3-14: Quantity Charge Monthly Bill Analysis (Aggregate)

Bill Difference	Median	Average	Average+3	Average+5	Average+10	Average+15
Aggregate	-0.53%	-1.62%	0.52%	1.67%	2.62%	10.07%

The Quantity Charge Bill Analysis is summarized in Table 3-14 above. Transitioning ratepayers onto the recommended tier width will, on aggregate across all Cal Water's RMAs:

- Decrease the quantity charge portion of the monthly bill for the median ratepayer,
- Decrease the quantity charge portion of the monthly bill for the average (mean) ratepayer.
- Sends conservation price signal to ratepayers if they are above the district's monthly average consumption levels.
- Improve access to affordable discretionary water uses.

IV. CONCLUSION

The Commission should rename the tiers in the residential rate design to properly align the tier allocation with its intended use and to improve conservation goals and signals, summarized in the table below. The Commission should also eliminate the fourth Tier (designated as the Excessive Discretionary Water Use tier) in ratemaking areas where the forced application of a fourth tier will create inequity in ratepayer's access to a reasonable allocation of affordable water. The Commission should revert the following districts to a three-tier conservation rate design: Bay Area Region (BAR), Dixon (DIX), South Bay Region (SBR), Stockton (STK), and Salinas Valley Region (SVR). The Commission should maintain the 4-tier conservation rate design in all other ratemaking areas. In these ratemaking areas, the fourth tier will capture the highest 10% of monthly water use to send strong conservation signals to ratepayers for extreme water uses (when compared to a ratepayer's own district).

LIST OF ATTACHMENTS FOR CHAPTER 3

	Attachment #	Description
1	Attachment 3-1	The United Nations Resolution 64-292
2	Attachment 3-2	The impact of pricing structure change on residential water - Journal of Water Resources and Economics (2024)

CHAPTER 4 SPECIAL REQUESTS

I. SPECIAL REQUEST 1

Cal Advocates does not oppose Cal Water's request to discontinue the annual subsidy of $1.7 million currently provided to the Dixon district and instead, consolidate the Dixon district with the Livermore district.[108] Table 4-1 below shows the average bill impact on a residential customer in the Dixon and Livermore district, calculated based on the recorded 2023 median amount of water use and with Cal Water's proposed TY 2026 residential rates.[109]

Table 4-1: Comparison of Average Bill Impact between Consolidation or Not [Dixon & Livermore]

Residential Bill Changes [Dixon]	Proposed Rates 2026 (Cal Water)	
	With Consolidation	Without Consolidation
Non-CAP	$ 6.24	$ 16.00
CAP	$ 4.84	$ 10.73
% Change		
Non-CAP	8.8%	22.5%
CAP	10.6%	23.5%
Average	***9.7%***	***23.0%***

[108] California Water Service Company 2024 GRC Testimony Book #1 at 8.

[109] California Water Service Company 2024 GRC Testimony Book #1 at 4 – 5.

Residential Bill Changes [Livermore]	Proposed Rates 2026 (Cal Water)	
	With Consolidation	Without Consolidation
Non-CAP	$ 8.18	$ 7.18
CAP	$ 4.40	$ 4.13
% Change		
Non-CAP	14.8%	13.0%
CAP	11.1%	10.4%
Average	***13.0%***	***11.7%***

II. SPECIAL REQUEST 2

Cal Advocates does not oppose Cal Water's request to continue the Rate Support Fund (RSF) in the Kern River Valley (KRV) and Willows district and to introduce an annual RSF subsidy of $500,000 to decrease the revenue requirement and to mitigate the bill impact for customers in the Selma district.[110]

The RSF program in KRV currently provides a discounted rate for the first ten units of monthly consumption and charges a undiscounted rate for any monthly consumption over ten CCFs.[111] Cal Water proposes to modify the KRV RSF program to a three-tier system, (1) providing a discounted rate for the first six CCF of monthly use, (2) providing a less discounted rate for the next four CCF of monthly use, and (3) charging an undiscounted rate for any consumption above ten CCF in a month.[112] Table 4-2 below summarizes Cal Water's proposed RSF-based rate design in KRV, calculated based on Cal Water's proposed TY 2026 rates.[113] The currently authorized rate design in KRV is also included in Table 4-2.

[110] California Water Service Company 2024 GRC Testimony Book #1 at 9.

[111] California Water Service Company 2024 GRC Testimony Book #2 at 19.

[112] California Water Service Company 2024 GRC Testimony Book #2 at 20.

[113] California Water Service Company 2024 GRC Testimony Book #2 at 20 – 21.

Table 4-2: Kern River Valley's RSF Rate Design[114]

Cal Water's RSF-Based Proposed Rate Design [KRV]

District	RSF Discounted Rate [First 6 CCF]	RSF Discounted Rate [Next 4 CCF]	Undiscount Rate [10+ CCF]
Kern River Valley	$ 5.59	$ 8.39	$ 22.32

Currently Authorized Rate Design (KRV)

District	RSF Discounted Rate [First 10 CCF]	Undiscount Rate [10+ CCF]
Kern River Valley	$ 5.50	$ 28.03

Kern River Valley Monthly Bill Change

Non-CAP	Median [3 CCF]	Average [5 CCF]	CAP	Median [4 CCF]	Average [5 CCF]
Amount Change	$ (0.05)	$ 0.13	Amount Change	$ 0.11	$ 0.29
Percent Change	-0.10%	0.20%	Percent Change	0.20%	0.50%

Cal Water proposes to continue the RSF program in Willows, which decreases the revenue requirement by $700,000 in the test year.[115] Cal Water proposes to implement the RSF in the Selma district to help with affordability.[116] The RSF decreasing the revenue requirement by $500,000 in the test year.[117] Table 4-3 below summarizes the average rate impact in the Selma and Willows district. The RSF will decrease rates by 7.9% and 16.3% in Selma and Willows, respectively.

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[114] California Water Service Company 2024 GRC Testimony Book #2, Attachment I – California Water Service Affordability Metrics Report at 43.

[115] California Water Service Company 2024 GRC Testimony Book #2 at 20.

[116] California Water Service Company 2024 GRC Testimony Book #2 at 19.

[117] California Water Service Company 2024 GRC Testimony Book #2 at 19.

Table 4-3: Selma and Willows RSF Program

District	Cal Water's Proposed Revenue Requirement TY 2026 [$]	Cal Water's Proposed Rate Support Fund TY 2026 [$]	Average Rate Subsidy [%]
Selma	$ 6,367,377.53	$ 500,000.00	7.9%
Willows	$ 4,284,400.92	$ 700,000.00	16.3%

III. SPECIAL REQUEST 4

Cal Advocates does not oppose Cal Water's request to forecast sales and services annually over the GRC period to reflect the potentially changing annual water use forecast from the test year to the attrition years.[118]

IV. SPECIAL REQUEST 5

Cal Advocates does not oppose Cal Water's request to incorporate rate and revenue changes from other proceedings and the informal advice letter process into the calculation of the final rates adopted in this proceeding.[119] Pre-TY 2026 rate changes adopted outside of the GRC should be used to update the Revenue at Present Rates in the GRC.

[118] California Water Service Company 2024 GRC Testimony Book #1 at 10.

[119] California Water Service Company 2024 GRC Testimony Book #1 at 10.

ATTACHMENTS

LIST OF ATTACHMENTS FOR CHAPTER 1

	Attachment #	Description
1	Attachment 1-1	Statement of Qualifications
2	Attachment 1-2	*"Making Conservation a California Way of Life"* a Fact Sheet by the California State Water Board.
3	Attachment 1-3	Final Text of Regulation to Make Conservation a California Way of Life.
4	Attachment 1-4	California Department of Water Resources, Results of the Indoor Residential Water Use Study.
5	Attachment 1-5	A.23-08-010 - Sam Lam - Report on General Office Expenses Budget, Conservation Program Budget, SR2 and SR3 [PUBLIC], pages 1-3 to 1-4.
6	Attachment 1-6	California Water Service Response to DR SLM-005, Attachment #6, Part 1, 2 and 3.
7	Attachment 1-7	California Water Service Company's Advice Letter 2509.

ATTACHMENT 1-1:
Statement Of Qualifications of Witness Sam Lam

QUALIFICATIONS AND PREPARED TESTIMONY
OF
SAM LAM

Q.1 Please state your name and address.

A.1 My name is Sam Lam, and my business address is 320 West 4th Street, Suite 500, Los Angeles, California 90013.

Q.2 By whom are you employed and what is your job title?

A.2 I am employed by the Public Advocates Office – Water Branch and my job title is Public Utilities Regulatory Analyst.

Q.3 Please describe your educational and professional experience.

A.3 I received a Bachelor of Science degree in Business Administration from the University of Southern California. I have been with the Public Advocates Office – Water Branch since August of 2019.

Q.4 What is your area of responsibility in this proceeding?

A.4 I am responsible for the preparation of Cal Advocates' Report on Conservation Program Budget, Sales Forecast, Rate Design, and Special Requests 1, 2, 4, & 5.

Q.5 Does that complete your prepared testimony?

A.5 Yes, it does.

ATTACHMENT 1-2:
"Making Conservation a California Way of Life" a Fact Sheet by the California State Water Board.

Making Conservation a California Way of Life

What is *Making Conservation a California Way of Life*?

Making Conservation a California Way of Life is a new regulatory framework proposed by State Water Board staff that establishes individualized efficiency goals for each Urban Retail Water Supplier. These goals are based on the unique characteristics of the supplier's service area and give suppliers the flexibility to implement locally appropriate solutions. Once implemented, these goals are expected to reduce urban water use by more than 400-thousand-acre feet by 2030, helping California adapt to the water supply impacts brought on by climate change.

Why is the framework needed?

California has always experienced large swings between dry and wet weather, and due to climate change, these swings are becoming more severe. The recent storms and flooding seen statewide--following years of back-to-back extreme drought--make clear the importance of staying prepared. Hotter and drier periods that are increasing in frequency, reduced snowpack, and drier soils are making our water supplies more vulnerable. As part of the state's all-of-the-above strategy to expand storage, develop new water supplies, and promote more efficient water use, the proposed regulation seeks to cultivate long-term practices that help communities adapt to California's ongoing water challenges and lessen the need for the kinds of emergency water use reduction targets that were important in recent droughts.

Who is impacted by the framework?

In 2018, the California State Legislature passed Assembly Bill (AB) 1668 and Senate Bill (SB) 606, directing the State Water Board to adopt efficiency standards and also performance measures for commercial, industrial, and institutional water use.

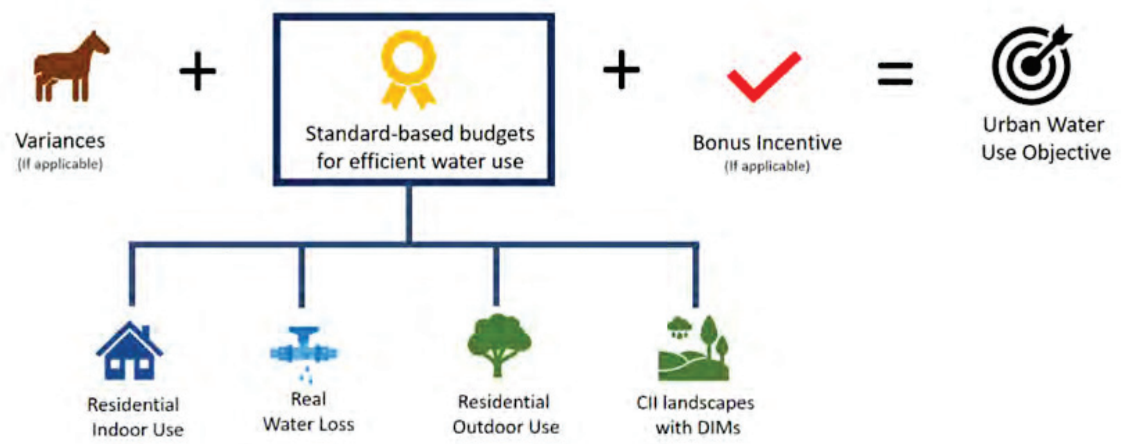
As part of the proposed regulation, *Urban Retail Water Suppliers – not individual households or businesses* – will be held to annual "urban water use objectives." Urban Retail Water Suppliers are publicly and privately run agencies that deliver water to 95% of Californians. The regulation gives suppliers significant flexibility to meet objectives in a way that works best for them.

To meet annual objectives, suppliers may use a wide variety of tools to encourage customers to use water wisely, indoors and outdoors. Examples include education and outreach, leak detection, rate reform, incentives to plant "climate ready" landscapes, and rebates to replace old and inefficient fixtures and appliances.

Water Boards

Fact Sheet

How would objectives be calculated?



The proposed regulation would require suppliers to annually calculate their objective, which is the sum of efficiency budgets for a subset of urban water uses: residential indoor water use, residential outdoor water use, real water loss and commercial, industrial and institutional landscapes with dedicated irrigation meters. Each efficiency budget will be calculated using a statewide efficiency standard and local service area characteristics such as population, climate, and landscape area. Where relevant, suppliers may also include in their objective "variances" for unique uses, or a bonus incentive for potable recycled water use.

Suppliers would need to meet the overall objective, not each individual budget. The one exception is the budget for water loss, which was set by a separate regulation.

What else would the framework do?

The proposed regulation would help realize the water savings outlined in California's Water Supply Strategy, released in 2022. The framework also is expected to result in suppliers making investments and programmatic changes that encourage individuals, businesses, and local governments to adapt how they use water. Such changes have the potential to advance the State Water Board's mission of preserving, enhancing, and restoring the quality of water resources and the statutory directive to advance California's climate change mitigation and adaptation goals. Specifically, the transition to climate-ready landscapes may:

- Bolster nature-based solutions.
    - Example: Increase the prevalence of native and pollinator-friendly plants.

- Create healthier soils and divert organic waste from landfills.
    - Example: Increase the use of compost and mulch.

- Advance equity.
  - Examples: Encourage suppliers to reevaluate rate structures and invest in partnerships that reduce urban heat.

What is the process and timeline for the State Water Board to consider adopting the framework?

Looking forward
The regular rulemaking process for the proposed regulation to Make Conservation a California Way of Life is underway. The notice of proposed rulemaking will be released on August 18, to be followed by a public comment period and public hearing. There will be multiple opportunities for the public to provide input before the board considers adopting it in 2024.

Looking Back
The standards for efficient residential indoor water use and water loss have already been set. The Legislature set the residential indoor standard in 2022 with the passage of Senate Bill 1157. The State Water Board adopted the water loss standard in early 2023.

Additional information

To learn more about the proposed regulation and upcoming opportunities to participate, visit: https://waterboards.ca.gov/conservation/framework/

(*This fact sheet was last updated on August 15, 2023.*)

ATTACHMENT 1-3:
Final Text of Regulation to Make Conservation a California Way of Life.

FINAL TEXT OF "MAKING CONSERVATION A CALIFORNIA WAY OF LIFE" REGULATION

California Code of Regulations
Title 23. Waters
Division 3. State Water Resources Control Board and Regional Water Quality Control Boards
Chapter 3.5. Urban Water Use Efficiency and Conservation
Article 1. Urban Water Use Efficiency Standards, Objectives, and Performance Measures
Effective January 1, 2025

Table of Contents

Adopt new section 965:

§ 965. Definitions

Definitions used in this Article:

(a) “Animal type-classes” (T) means major categories of animal types based on similar water use and animal weight.

(b) “Annual precipitation” means total annual precipitation, in inches per year. Annual precipitation will be updated annually by the Department and derived from Parameter-elevation Regressions on Independent Slopes Model data.

(c) “Augmented Surface Water Reservoir” or “Augmented Reservoir” has the same meaning as “reservoir water augmentation” in section 13561 of the Water Code.

(d) “Augmented Groundwater Basin” or “Augmented Basin” has the same meaning as “indirect potable reuse for groundwater recharge” in section 13561 of the Water Code.

(e) "Basin” means either a basin or subbasin as defined and delineated by bulletin 118, or as defined and delineated through an adjudication process.

(f) “Board” means the State Water Resources Control Board.

(g) “Budget” means the calculated volume of water for a discrete category of water use associated with efficiency standards, variances, or temporary provisions.

(h) “Climate zones” means the California Energy Code climate zones as defined by zip code and listed in California Energy Commission Reference Joint Appendix JA2 (Title 24, Part 6, Section 100.1).

(i) “Climate-ready landscapes” are designed and maintained to reduce greenhouse gas emissions and weather more extreme conditions, save water, reduce waste, nurture soil, sequester carbon, conserve energy, reduce urban heat, protect air and water quality, and create habitat for native plants and pollinators.

(j) “Collaboration and Coordination best management practices” means formalized operational and institutional arrangements, such as cooperative agreements among parties to streamline requirements, data collection, or implementation of best management practices by coordinating with necessary entities.

(k) “Commercial, industrial, and institutional water user” means a CII water user meeting any of the definitions in Water Code section 10608.12 (f), (p) and (q).

(l) “Crop-specific landscape area” means residential agricultural landscapes disaggregated by each crop or crop type grown within the supplier’s service area.

(m) “Customer” has the same meaning as in section 10611.3 of the Water Code.

(n) “Dedicated Irrigated Meter” (DIM) means a water meter that is operated and maintained by the supplier that exclusively measures the water a customer uses for irrigation.

(o) “Department” means the Department of Water Resources.

(p) “Direct Potable Reuse” (DPR) has the same meaning as in section 13561 of the Water Code. DPR does not require an environmental buffer.

(q) “Direct potable reuse project” or “DPR project” has the same meaning as in California Code of Regulations, title 22, section 64669.05.

(r) “Disclosable Building” has the same meaning as in section 1681 in California Code of Regulations, title 20.

(s) “Effective precipitation” (P_{eff}) means 25 percent of total annual precipitation, or a lower value generated by the California Simulation of Evapotranspiration of Applied Water model if provided by the Department, in inches per year.

(t) “ENERGY STAR Portfolio Manager” means the tool developed and maintained by the United States Environmental Protection Agency to track and assess building performance.

(u) “ENERGY STAR Portfolio Manager broad categories” means a superset of property types based on sector.

(v) "ENERGY STAR Portfolio Manager property types" means a subgroup of ENERGY STAR Portfolio Manager broad categories.
(w) "Equivalent Technologies" are technologies that are functionally equivalent to Dedicated Irrigation Meters in terms of accuracy and supplier access to the data.
(x) "Existing CII water users" means CII water users served by the supplier on or before the effective date of this article.
(y) "Finished water" has the same meaning as in California Code of Regulations, title 22, section 64400.41.
(z) "High levels of Total Dissolved Solids" (TDS) means concentrations above 900 mg/L.
(aa) "Indirect Potable Reuse" (IPR) includes "Indirect potable reuse for groundwater recharge" and "reservoir water augmentation" as defined in section 13561 of the Water Code. IPR requires an environmental buffer, including a river, lake, reservoir, or a groundwater aquifer that is used as a source of drinking water.
(bb) "Irrigable Irrigated Area" is residential area of healthy vegetation where the vegetation appears to be in growth, not senesced, and is foliated. The area is presumed to be maintained and managed through active irrigation, comprising an irrigated hydro-zone. Non-vegetative features may be included.
(cc) "Irrigable Not Irrigated Area" is residential area that is not currently being irrigated, but was irrigated in the past, or may be managed with irrigation in the future.
(dd) "In-Lieu Technologies" are technologies that support landscape water use efficiency improvements by means other than the direct measure of water use. They include but are not limited to the technologies identified in section 973.
(ee) "LA_{crop}" means the landscape area for a crop grown on residential landscapes included in the Department's agricultural land mask and associated with an account the supplier categorizes as residential, in square feet.
(ff) "Landscape efficiency factor" (LEF) means a factor applied at the supplier-level that adjusts net reference evapotranspiration for plant factors and irrigation efficiency, two major influences upon the amount of water that is applied to the landscape.
(gg) "Large landscapes" are Commercial, Industrial, and Institutional landscapes that are ½ acre in size or larger with Mixed-Use meters.
(hh) "Livestock" has the same meaning as in section 3080 of the Civil Code.
(ii) "Low-impact development" means new development or redevelopment projects that employ natural and constructed features that reduce the rate of stormwater runoff, filter out pollutants, facilitate stormwater storage onsite, infiltrate stormwater into the ground to replenish groundwater supplies, or improve the quality of receiving groundwater and surface water.
(jj) "Mixed-Use Meter" (MUM) means a water meter that is operated and maintained by the supplier and that measures the volume of water a customer uses indoors and outdoors.
(kk) "Net reference evapotranspiration" or "Net ET_0" is the difference between reference evapotranspiration and effective precipitation, in inches per year.
(ll) "Net $ET_{0\ crop}$" means the net reference evapotranspiration for a supplier's service area growing season, in inches per year.
(mm) "Newly constructed residential landscapes" (RLA_{new}) means landscapes that were added to a supplier's service area in accordance with section 968 (e) after the time period captured by the Landscape Area Measurements Project update released by the Department on December 6, 2023, or any subsequent update to the supplier's residential landscape area pursuant to section 968 (b)(3).
(nn) "Newly constructed CII landscapes with DIMs" (DIM LA_{new}) means CII landscapes with DIMs that are added to a supplier's service area in accordance with section 969 (d)(2) after the most recent analysis a supplier conducts in accordance with section 969 (b)(2).

(oo) “Owner’s Agent” means a person with authorization from a building owner to act on behalf of the building owner.

(pp) “Plant factor” has the same meaning as in section 491.

(qq) “Potable deliveries to residential properties and CII landscapes with DIMs” (D_{RLI}) means the total potable water volume delivered to both residential and landscape irrigation connections, as reported to the Board pursuant to Health and Safety Code section 116530.

(rr) “Potable Reuse Water” includes water produced through both direct potable reuse and indirect potable reuse systems.

(ss) “Potable Reuse Volume” (V_{PR}) is defined as the individual supplier’s volume of potable reuse water.

(tt) “Process water” has the same meaning as in section 10608.12 of the Water Code.

(uu) “Recycled water” means water produced by a wastewater treatment plant or water recycling treatment plant permitted to produce recycled water pursuant to California Code of Regulations, title 22.

(vv) “Reference evapotranspiration” or “ET_0” has the same meaning as in section 491 and is expressed in inches per year. Reference evapotranspiration will be updated annually by the Department and derived from the California Simulation of Evapotranspiration of Applied Water model using Spatial California Irrigation Management Information System data.

(ww) “Residential agricultural landscapes” means the residential agricultural area, in square feet, included in the Landscape Area Measurements Project update (released by the Department December 6, 2023), or as later updated by the Department. It is limited to land on which agricultural use is occurring and that is associated with a service connection the supplier categorizes as residential.

(xx) “Agricultural use” means “agricultural use” as defined in Government Code section 51201 (b), but does not include cleaning, processing, or other similar post-harvest activities.

(yy) “Residential landscape area” (RLA) means residential Irrigable Irrigated area plus approved Irrigable Not Irrigated area, in square feet.

(zz) “Residential service area population” (P) means the service area population reported to the Board as “residential” pursuant to Health and Safety Code section 116530 and California Code of Regulations, title 22, section 64412.

(aaa) “Residential special landscape area” (RSLA) means residential pools, spas, and similar water features, residential areas dedicated solely to edible plants, and residential areas irrigated with recycled water, in square feet.

(bbb) “Service Connection” (C) has the same meaning as in Health and Safety Code section 116275.

(ccc) “Temporary provision” means an additional volume of water that an urban retail water supplier may request to add to its urban water use objective for a limited time for a specified beneficial use that will require less water over time.

(ddd) “Turf” has the same meaning as in section 491.

(eee) “Total potable water production” (T_{PW}) means all potable water that enters into a supplier’s distribution system, excluding water placed into storage and not withdrawn for use during the reporting period and excluding water exported outsider the supplier’s service area during the reporting period, as reported to the Board pursuant to Health and Safety Code section 116530. Total potable water production includes all non-revenue water, which has the same meaning as in section 638.1 and is equal to the sum of the supplier’s unbilled authorized consumption and apparent and real losses.

(fff) “Urban retail water supplier” or “supplier,” has the same meaning as in section 980.

(ggg) "Urban water use objective" (WUO) means an estimate of aggregate efficient water use for the previous year based on adopted water use efficiency standards and local service area characteristics for that year, as described in Water Code section 10609.20 and as calculated pursuant to section 966 (d).

(hhh) "Variance" means an additional volume of water that an urban retail water supplier may request to add to its urban water use objective for a unique use that has a material effect on a supplier's urban water use objective.

Authority: Sections 1058, 10609.2, and 10609.10, Water Code.
References: Article X, Section 2, California Constitution; Sections 3080, 4080, 4100, and 4100, Civil Code; Section 51201, Government Code; Section 116275 and 116530, Health and Safety Code; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10609.2, 10609.10, 10609.20, 10611.3, and 13561, Water Code.

Adopt new section 966:

§ 966. Urban Water Use Objectives

(a) No later than January 1, 2025, and by January 1 every year thereafter, each urban retail water supplier shall calculate its urban water use objective and, beginning January 1, 2027, annually demonstrate compliance with its objective.

(b) The calculation shall be based on the supplier's water use conditions for the previous state fiscal year.

(c) The objective shall be composed of the sum of the following budgets:

(1) A budget for efficient indoor residential water use (R_{indoor}) as described in section 967.

(2) A budget for efficient outdoor residential water use ($R_{outdoor}$) as described in section 968.

(3) A budget for efficient water use on commercial, industrial, and institutional landscapes with dedicated irrigation meters or equivalent technology (CII_{DIM}) as described in section 969.

(4) A budget for efficient real water losses (L) as described in section 970.

(5) Budgets for any approved variances (V) and temporary provisions (Pr) as described in sections 967, 968, and 969.

(6) A bonus incentive for potable reuse (B_{PR}) as described in section 971.

(d) The formula for calculating a supplier's urban water use objective (*WUO*), in gallons, is expressed mathematically as follows:

$$\mathrm{WUO} = \mathrm{R_{indoor}} + \mathrm{R_{outdoor}} + \mathrm{CII_{DIM}} + \mathrm{L} + \mathrm{V} + \mathrm{Pr} + \mathrm{B_{PR}}$$

(e) If any system owned and operated by a supplier is lacking the data needed to calculate the budgets described in subdivision (c)(1) through (4), that system shall be excluded from the overall objective calculation until the requisite data are obtained. The requisite data must be obtained no later than July 1, 2028, for use in the 2030 reporting year.

(f) For systems that do not meet the criteria to be considered an urban retail water supplier until after the effective date of this section, and for a system that hydraulically consolidates with a supplier, this section applies beginning five (5) years after the system meets the criteria to be considered a supplier or consolidates with a supplier.

(g) Compliance with this section shall be assessed on the overall objective, not the individual budgets identified in subdivision (c), except for water loss, which shall also be assessed individually pursuant to section 981.

(h) If a supplier's calculated objective-based total use is larger than its target-based total use, the supplier's urban water use objective shall be its Water Code section 10608.20 individual target less excluded demands as described in paragraph (3). If the supplier's section 10608.20 target is expressed in gallons per capita daily, the supplier shall multiply the target by its residential service area population for the reporting year and the number of days in the year.
(1) For purposes of this subdivision, objective-based total water use, in gallons, is the sum of excluded demands and the urban water use objective calculated pursuant to subdivision (c).
(2) For purposes of this subdivision, target-based total water use, in gallons, is a supplier's individual Water Code section 10608.20 target plus demands not included in the target. Demands not included in the section 10608.20 target may include process water and recycled water.
(3) Excluded demands are those values provided by the supplier to the Board pursuant to Health and Safety Code section 116530, for the following delivery categories: other; commercial and institutional; and industrial.
(4) Until June 30, 2040, this subdivision does not apply to any supplier that is achieving its Water Code section 10608.20 target on a regional basis but has not achieved its individual target.

(i) Notwithstanding subdivision (a), a supplier shall be considered in compliance with its objective provided all of the following are met:
(1) The median household income of the supplier's service area is equal to or less than the median household income of California. The median household income of the supplier's service area shall be the average for the three years preceding the year the supplier initially asserts compliance with its objective pursuant to this subdivision;
(2) The supplier's urban water use objective calculated by the supplier pursuant to subdivision (c), using the standards that apply July 1, 2040, would result in an objective that is 80 percent or less of the supplier's average annual water use for the reporting categories identified in section 975 (c)(1)(D) for the state fiscal years ending in 2024, 2025, and 2026;
(3) The supplier develops, posts to its public-facing website, and implements a plan that is designed with the goal of achieving, by June 30, 2041, or a different date approved by Board staff, the supplier's urban water use objective. The plan must additionally include efforts to keep trees healthy; and
(4) The annual reports the supplier has submitted pursuant to section 975 show that the supplier is reducing its per capita water use by an average of no less than 1.0 percent per year, as shown by data from the reporting year and the immediately preceding two years, from its average per capita annual water use for the state fiscal years ending in 2024, 2025, and 2026.

(j) Notwithstanding subdivision (a), a supplier shall be considered in compliance with its objective provided all of the following are met:
(1) The supplier's urban water use objective, calculated pursuant to subdivision (c), using the standards that apply July 1, 2040, would result in an objective that is 70 percent or less of the supplier's average annual water use for the reporting categories identified in section 975 (c)(1)(D) for the state fiscal years ending in 2024, 2025, and 2026;
(2) The supplier develops, posts to its public-facing website, and implements a plan that is designed with the goal of achieving, by June 30, 2041, or a different date approved by Board staff, the supplier's urban water use objective. The plan must demonstrate that the supplier has carefully analyzed the data used to calculate its urban water use objective, including, but not limited to, the data associated with variances and special landscape areas. The plan must additionally include efforts to:

(A) Increase support for disadvantaged communities, as defined in title 22, section 64300 of the California Code of Regulations, and low-income households;
(B) Leverage regional and local partnerships to support the installation and maintenance of climate-ready landscapes; and
(C) Keep trees healthy;

(3) The supplier verifies adherence to the American Water Works Association G480-20 Water Conservation and Efficiency Program Operation and Management Standard (published February 1, 2021), which is hereby incorporated by reference; and

(4) The annual reports the supplier has submitted pursuant to section 975 show that the supplier is reducing its per capita urban water use by an average of no less than 2.0 percent per year, as shown by data from the reporting year and the immediately preceding two years, from its average per capita annual water use for the state fiscal years ending in 2024, 2025, and 2026.

(k) For the purposes of subdivisions (i) and (j):

(1) A supplier shall calculate average annual per capita water use by dividing the average annual demand for the reporting categories identified in section 975 (c)(1)(D) for the state fiscal years ending in 2024, 2025, and 2026, by the average annual residential service area population for the state fiscal years ending in 2024, 2025, and 2026, and by the days of the year; and

(2) A supplier shall calculate annual per capita water use for the reporting year and the immediately preceding two years by, for each year, dividing annual demand for the reporting categories identified in section 975 (c)(1)(D), by annual residential service area population, and by the days of the year.

Authority: Sections 1058, 10609.2, and 10609.20, Water Code.
References: Article X, Section 2, California Constitution; Section 3080, Civil Code; Section 51201, Government Code; Section 116530, Health and Safety Code; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10608.20, 10609.2, 10609.10, 10609.12, and 10609.27, Water Code.

<u>Adopt new section 967:</u>

§ 967. Indoor Residential Water Use Standard

(a)

(1) Each year, a supplier shall calculate its budget for residential indoor water use (R_{indoor}), in gallons, by multiplying the applicable standard (S_{indoor}) described in Water Code section 10609.4, subdivision (a) by the supplier's residential service area population (P), and by the number of days in the year. This formula is expressed mathematically as follows:

$$R_{indoor} = S_{indoor} \times P \times \text{days in year}$$

(2) For any reporting year that includes more than one standard, each applicable standard shall be multiplied by the number of days for which the standard applies pursuant to Water Code section 10609.4 that occur in the reporting period.

(b)

(1) An urban retail water supplier may, in calculating its urban water use objective, include budgets for variances identified in paragraph (2) for residential indoor use, if:
(A) The supplier submits supporting information meeting the criteria described in subdivision (e); and

(B) The associated water use, for any individual variance, represents 5 percent or more of the budget associated with the standard described in section 966 (c)(1).

(2) Variances may be requested for water use associated with any of the following:

(A) Significant use of evaporative coolers

(B) Significant fluctuations in seasonal population.

(c) Variances available pursuant to subdivision (b) shall be calculated as follows:

(1) A variance for water use associated with evaporative coolers (V_{EC}) represents the volume of water evaporative coolers used on operating days. Operating days (N_{DAYS}) are days when the average temperature in the supplier's service area was greater than 78 degrees Fahrenheit for at least one hour. V_{EC} shall be calculated by multiplying the number of evaporative coolers in the service area (N_{EC}) by the number of operating days (N_{DAYS}), the average daily evaporative cooler operating hours (H_O), and the average daily evaporative rate (R_{EC}). This formula is expressed mathematically follows:

$$V_{EC} = N_{EC} \times N_{DAYS} \times H_O \times R_{EC}$$

(A) The number of evaporative coolers in the service area (N_{EC}) may be estimated based on a representative sample of customers meeting the criteria specified in paragraph (D).

(B) The evaporative cooler operating hours (H_O) may be a daily average based on a sample meeting the criteria specified in paragraph (D). A supplier shall use the service area average operating hours or the daily maximum operating hours, whichever is lower.

(i) The service area wide average operating hours shall equal the average of all operating hours based on the sample.

(ii) The service area daily maximum operating hours shall equal the number of hours in a day when the temperature was above 78 degrees Fahrenheit within the supplier's service area.

(C) The evaporative cooler evaporation rate (R_{EC}) may be a daily average based on a sample meeting the criteria specified in paragraph (D). R_{EC}, in gallons per hour, shall be calculated by multiplying the average air exchange rate of the evaporative cooler units within the supplier's service areas (CFM), in cubic feet per minute, by the average daily difference in hourly wet and dry bulb temperatures (ΔT_{Bulb}), in degrees Fahrenheit, and by a representative efficiency rate of 80 percent. To convert the heat absorbed, in British Thermal Units, to the volume of water evaporated by the coolers, in gallons, that product shall be divided by 8700. This formula is expressed mathematically as follows:

$$R_{EC} = \frac{CFM \times \Delta T_{Bulb} \times 0.8}{8700}$$

The average air exchange rate of the evaporative cooler units within the supplier's service areas (CFM) and the average daily difference in hourly wet and dry bulb temperatures (ΔT_{Bulb}) shall be calculated according to the Department's Methods for Estimating Residential Cooler Water Consumption and Prevalence using Account-Level Water and Energy Consumption Data (published April 15, 2022), which is hereby incorporated by reference, or an alternative method that the supplier has demonstrated to the Department, in coordination with the Board, to be equivalent, or superior, in quality and accuracy.

(D) For the purposes of this section, the sample must represent at least 10,000 residential connections, or ten percent of residential connections, whichever is smaller.

(2) A variance for water use associated with seasonal populations (V_{SP}), in gallons, shall be calculated by multiplying the number of dwelling units associated with seasonal occupancy (N_{DU}) by the occupancy rate (R_O) and by the residential indoor use standard for the given time period (S_{indoor}). This formula is expressed mathematically as follows:

$$V_{SP} = N_{DU} \times R_o \times S_{indoor}$$

(A) The number of dwelling units associated with seasonal occupancy (N_{DU}) shall be calculated according to the Department's Methods for Estimating Seasonal Populations with Water and Energy Data (published by June 22, 2022), which is hereby incorporated by reference, or an alternative method that the supplier has demonstrated to the Department, in coordination with the Board, to be equivalent, or superior, in quality and accuracy.

(B) The occupancy rate (R_O) shall be calculated by dividing the average number of seasonally occupied rooms (R_S) by the average number of rooms occupied by permanent residents (R_P) and multiplying the quotient by the average number of people per permanently occupied household (H_P) and the average number of days households are seasonally occupied (S_{DAYS}). This formula is expressed mathematically as follows:

$$R_O = \frac{R_S}{R_P} \times H_P \times S_{DAYS}$$

The average number of days households are seasonally occupied (S_{DAYS}) shall be calculated according to the Department's Methods for Estimating Seasonal Populations with Water and Energy Data (published June 22, 2022), which is hereby incorporated by reference, or an alternative method that the supplier has demonstrated to the Department, in coordination with the Board, to be equivalent, or superior, in quality and accuracy.

(C) Notwithstanding subdivision (b)(1)(B), a supplier is eligible for the variance for water use associated with seasonal populations if the supplier uses detailed daily or hourly Advanced Metering Infrastructure (AMI) data to effectively identify dwelling units with seasonal population and the associated water use represents 1 percent or more of the budget associated with the standard described in section 966 (c)(1). If the supplier uses detailed daily or hourly AMI data, then the occupancy rate (R_O) shall be calculated by multiplying the water used by seasonally occupied homes (W_{SO}) by the supplier's residential service area population (P) and dividing the product by the water used for permanently occupied homes (W_{PO}). The quotient shall be multiplied by the average number of days households are seasonally occupied (S_{DAYS}). This formula is expressed mathematically as follows:

$$R_O = \left(\frac{W_{SO} \times P}{W_{PO}}\right) \times S_{DAYS}$$

The average number of days households are seasonally occupied (S_{DAYS}) shall be calculated according to the Department's Methods for Estimating Seasonal

Populations with Water and Energy Data (published June 22, 2022), or an alternative method that the supplier has demonstrated to the Department, in coordination with the Board, to be equivalent, or superior, in quality and accuracy.

(d) An urban retail water supplier may request a temporary provision to respond to negative impacts to wastewater collection, treatment, and reuse systems, if the supplier shows to the satisfaction of the Board that meeting the objective pursuant to section 966 would require adhering to the applicable residential indoor standard identified in Water Code section 10609.4 and that meeting the budget for efficient residential indoor use is causing challenges within wastewater collection, treatment, and reuse systems.

(e) In order to receive approval for a variance or a temporary provision, an urban retail water supplier must submit to the Board, in a machine-readable format for review and approval by the Executive Director, or the Executive Director's designee, a request that includes information quantifying and substantiating each request; information demonstrating that the water applicable to the request is water delivered by the supplier; information verifying that the approval of the request would not jeopardize the ability of a permittee within the supplier's service area to comply with existing permit requirements; and information describing and supporting the methodology the supplier will use to estimate the parameters described in subdivision (c), including the number of households sampled and the total number of residential connections, as reported to the Board pursuant to Health and Safety Code section 116530.

(1) Approved variances or temporary provisions submitted between July 1 and October 1 may be included in the associated budget for the prior state fiscal year.

(2) Approved variances or temporary provisions submitted between October 2 and June 30 may be included in the associated budget for the current state fiscal year.

(3) Approved variances and temporary provisions may be included in the associated budget for up to five years. Variance and temporary provision approval constitutes approval of both methodology and data. Unless otherwise specified in section 975, a supplier may use the same data for each year or update the data annually in accordance with the approved variance or temporary provision methodology.

Authority: Sections 1058,10609.2, and 10609.20, Water Code.
References: Article X, Section 2, California Constitution; Section 51201, Government Code; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10609.2, 10609.4, and 10609.10, Water Code.

Adopt new section 968:

§ 968. Outdoor Residential Water Use Standard

(a)

(1) Through June 30, 2035, the standard for efficient residential outdoor use ($S_{outdoor}$) shall be a landscape efficiency factor of 0.80.

(2) Beginning July 1, 2035, and through June 30, 2040, the standard for efficient residential outdoor use shall be a landscape efficiency factor of 0.63.

(3) Beginning July 1, 2040, the standard for efficient residential outdoor use shall be a landscape efficiency factor of 0.55.

(4) The standard for efficient residential outdoor use for residential special landscape areas shall be a landscape efficiency factor of 1.0.

(5) The standard for newly constructed residential landscapes (S_{new}) shall be a landscape efficiency factor of 0.55.

(b)

(1) Each year, an urban retail water supplier shall calculate its budget for efficient residential outdoor water use ($R_{outdoor}$), in gallons, by multiplying the applicable standard ($S_{outdoor}$) described in subdivision (a) by the square footage of the most current available residential landscape area (RLA) as described in subdivision (b)(2) or (b)(3), net reference evapotranspiration (Net ET_0), and a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$R_{outdoor} = S_{outdoor} \times RLA \times Net\ ET_0 \times 0.62$$

(2) Until updated residential landscape area data are available pursuant to paragraph (3), residential landscape area shall be, for each supplier:

(A)

(i) The supplier's unique square footage of Irrigable Irrigated area included in the Landscape Area Measurements Project update released by the Department on December 6, 2023. After the effective date of this section, a supplier may adjust this value by adding the residential parkway area provided by the Department that the supplier has confirmed is associated with a residential service connection; or

(ii) For a supplier that has not received residential landscape area data from the Department by the effective date of this section, the supplier's unique square footage of Irrigable Irrigated area shall be what the Department first provides after this section takes effect.

(B) If the supplier's actual urban water use for the reporting year, calculated in accordance with Water Code section 10609.22, is greater than the urban water use objective calculated pursuant to section 966 without inclusion of Irrigable Not Irrigated area, a supplier may include:

(i) Twenty percent of the supplier's unique square footage of Irrigable Not Irrigated area included in the Landscape Area Measurements Project update released by the Department on December 6, 2023; or

(ii) For a supplier that has not received residential landscape area data from the Department by the effective date of this section, twenty percent of the supplier's unique square footage of Irrigable Not Irrigated area first provided by the Department after this section takes effect.

(3) Residential landscape area shall be, for each supplier, the most current updated Irrigable Irrigated area:

(A) Provided by the Department;
(B) Updated by a supplier pursuant to paragraph (4); or
(C) Provided by an entity other than the Department or a supplier according to the following criteria:
  (i) The residential landscape area is generated as part of a transparent statewide analysis covering the service areas of all urban retail water suppliers;
  (ii) Developed with methodologies and procedures that have been demonstrated to the Department to be equivalent, or superior, in quality and accuracy, to those used by the Department to develop residential landscape area; and
  (iii) Results in landscape area data that have been demonstrated to the Department to be equivalent, or superior, in quality and accuracy to the data included in the Landscape Area Measurements Project update released by the Department on December 6, 2023.

(4) A supplier may, for each reporting year, use an alternative data source for reference evapotranspiration, effective precipitation, or its Irrigable Irrigated area, if it demonstrates to the Department, in coordination with the Board, that the data are equivalent, or superior, in quality and accuracy to the data included in the Landscape Area Measurements Project update released by the Department on December 6, 2023. Alternative data pursuant to this paragraph shall be reported pursuant to section 975.

(5) Notwithstanding subdivisions (b)(2) and (b)(3), a supplier may subtract landscape area that has been categorized as residential but that the supplier has identified as Commercial, Industrial, or Institutional (CII). If the area consists of CII landscapes with dedicated irrigation meters, it shall be included in a supplier's objective pursuant to section 969.

(c)

(1) Notwithstanding subdivision (b)(1), an urban retail water supplier may calculate its residential outdoor water use budget ($R_{outdoor}$), in gallons, by subtracting the square footage of residential special landscape areas (RSLA) from the square footage of the most currently available residential landscape area (RLA) as defined in subdivision (b)(2) and multiplying the result by the applicable standard ($S_{outdoor}$) described in subdivision (a); then, by adding that value to the product of the standard for residential special landscape areas (S_{RSLA}) as described in subdivision (a)(4) and the square footage of residential special landscape areas (RSLA); and lastly, by multiplying that sum by net reference evapotranspiration (Net ET_0) and a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$R_{outdoor} = (S_{outdoor} \times (RLA - RSLA) + S_{RSLA} \times RSLA) \times \text{Net } ET_0 \times 0.62$$

(2) In order to calculate a residential outdoor budget pursuant to this subdivision, a supplier shall demonstrate to the Department, in coordination with the Board, that the landscape areas meet the definition specified in section 965 (aaa). Residential special landscape area data shall be reported pursuant to section 975, and, unless updated by a supplier pursuant to this paragraph, data approved by the Department may be included for up to five years.

(3) For the purposes of this subdivision, the square footage of existing pools, spas, and similar water features shall be either (A) the value included in the Landscape Area Measurements Project update released by the Department on December 6, 2023, or any updates thereafter, or (B) alternative data, if the supplier demonstrates to the Department, in coordination with the Board, that the data are equivalent, or superior, in quality and accuracy to the data provided by the Department.

(d) If not included as a variance pursuant to subdivision (g)(3), an urban retail water supplier may add to its residential outdoor budget calculated pursuant to subdivisions (b)(1) or (c)(1) the volume of water associated with residential agricultural landscapes. The budget for residential outdoor water use associated with residential agricultural landscapes (R_{Ag}), in gallons, is calculated by multiplying a unit conversion factor of 0.62 by the standard for residential special landscape areas (S_{RSLA}) described in subdivision (a)(4) and by the values provided by the Department for the following parameters: the square footage of residential agricultural landscapes (LA_{Ag}) and the net reference evapotranspiration for the aggregated growing seasons associated with the crops grown on residential agricultural landscapes (Net $ET_{0\ Ag}$). This formula is expressed mathematically as follows:

$$R_{Ag} = S_{RSLA} \times LA_{Ag} \times \text{Net } ET_{0\ Ag} \times 0.62$$

(e)

(1) An urban retail water supplier may add to its residential outdoor budget calculated pursuant to subdivision (b)(1) or (c)(1) the volume of water associated with newly constructed residential landscapes. The budget for residential outdoor water use associated with newly constructed residential landscapes ($R_{outdoor,\ new}$), in gallons, is calculated by multiplying the standard (S_{new}) described in subdivision (a)(5) by the square footage of the supplier's newly constructed residential landscape area (RLA_{new}) as described in subdivision (e)(2), net reference evapotranspiration (Net ET_0), and a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$R_{outdoor,\ new} = S_{new} \times RLA_{new} \times \text{Net } ET_0 \times 0.62$$

(2) The existence of newly constructed residential landscape area shall be demonstrated by using:

(A) Data from annual reporting required by section 495 (b)(6), provided the report has disaggregated newly constructed residential landscapes from the total landscape area reported;

(B) On the ground measurements of newly constructed residential landscapes; or

(C) Measurements of newly constructed residential landscapes collected using accurate remote sensing methods.

(f)

(1) An urban retail water supplier may annually, in calculating its urban water use objective, include budgets for variances for residential outdoor water use as follows:

(A) the supplier submits supporting information meeting the criteria described in subdivision (j).

(B) The associated water use must, for any individual variance identified in paragraph (2)(A) through (C), represent 5 percent or more of the budget associated with the standard described in section 966 (c)(2).

(C) The associated water use for the variances identified in paragraph (2)(D) and in section 969 (e)(2)(A), or the associated water use for the variance identified in paragraph (2)(E) and in section 969 (e)(2)(B), must represent 5 percent or more of the sum of the budgets associated with the standards described in section 966 (c)(2) and (3).

(2) Variances may be requested for water use associated with any of the following:

(A) Populations of horses and other livestock

(B) Controlling dust on horse corrals or other animal exercise arenas

(C) Irrigating agricultural landscapes that are within residential areas but have not been classified as irrigable irrigated by the Department

(D) Responding to emergency events, not including drought

(E) Landscapes irrigated with recycled water containing high levels of TDS

(F) Supplementing ponds and lakes to sustain wildlife as required by existing regulations or local ordinances

(G) Irrigating existing residential trees.

(g) Variances available pursuant to subdivision (f) shall be calculated as follows:

(1) A variance for water use associated with horses and other livestock ($V_{livestock}$), shall be calculated as the sum of water allocations for each animal type-class (T). The water allocation for an animal type-class shall be calculated by multiplying the daily water use of the animal type-class (V_T), as specified in paragraphs (A) through (D), by the number of animals (N_T), by the average number of days per year where water is provided to the animal type (D_T). This formula is expressed mathematically as follows:

$$V_{livestock} = \sum_{T}(V_T \times N_T \times D_T)$$

(A) For sheep, llama, donkey, swine, and other medium-sized livestock between 200 and 500 pounds, the daily water use shall be the lesser of 8 gallons of water per day per animal or the amount specified in section 697.

(B) For cattle, bulls, and other livestock greater than 500 pounds, the daily water use shall be 11 gallons of water per day per animal.

(C) For horses and mules, the daily water use shall be 13 gallons of water per day per animal.

(D) For milking cows, the daily water use shall be 16 gallons of water per day per animal.

(2) A variance for water use associated with dust control on horse corrals or other animal exercise arenas (V_{corral}) shall be calculated by multiplying the square footage of corrals or other animal exercise arenas (A_{corral}) by the number of days per year the corrals or other animal exercise arenas may be watered (N_W) pursuant to paragraph (B), by 0.021 feet of water per water day, and then by 7.48 gallons per cubic foot. This formula is expressed mathematically as follows:

$$V_{corral} = A_{corral} \times N_W \times 0.021 \times 7.48$$

(A) The square footage of corrals or other animal exercise arenas in the supplier's service area (A_{corral}) shall be either the value included in the Landscape Area Measurements Project update released as a separate corral dataset by the Department on December 6, 2023, or any updates thereafter, or alternative data, if the supplier demonstrates to the Department, in coordination with the Board, that the data are equivalent, or superior, in quality and accuracy to the data provided by the Department.

(B) The number of days per year that corrals or other animal exercise arenas (N_W) may receive a water budget varies by climate zone as follows:

(i) For climate zones 1 through 5 and zone 7, corrals or other animal exercise arenas shall be watered no more than 2 days per week.

(ii) For climate zones 6, 8 through 10, 12, and 16, corrals or other animal exercise arenas shall be watered no more than 3 days per week.

(iii) For climate zones 11 and 13 through 15, corrals or other animal exercise arenas shall be watered no more than 4 days per week.

(iv) If a supplier's service area spans multiple climate zones, the supplier shall, for the purposes of calculating this variance, use the climate zone that covers the majority of the supplier's service area. A supplier may, upon a showing to the satisfaction of the Board, use the climate zone that covers the majority of the square footage of corrals or other animal exercise arenas within the supplier's service area.

(3) A variance for water used to irrigate residential agricultural landscapes (V_{Ag}) shall be calculated by multiplying a unit conversion factor of 0.62 by the values provided by the Department for the following parameters: the landscape efficiency factor (LEF_{Ag}) as described in paragraph (B), the square footage of residential agricultural landscapes (LA_{Ag}), and the net reference evapotranspiration for the aggregated growing seasons associated with the crops grown on residential agricultural landscapes (Net $ET_{0\ Ag}$). This formula is expressed mathematically as follows:

$$\mathrm{V_{Ag}} = \mathrm{LEF_{Ag}} \times \mathrm{LA_{Ag}} \times \mathrm{Net\ ET_{0\ Ag}} \times 0.62$$

(A) Notwithstanding subdivision (f)(1)(B), if a supplier is using crop-specific landscape area, then the supplier may, in calculating its residential outdoor budget, include an approved variance for water used to irrigate residential agricultural landscapes if the associated water use for this variance represents 1 percent or more of the budget associated with the standard described in section 966 (c)(2). A supplier using crop-specific landscape area shall calculate a variance for water used to irrigate residential agricultural landscapes (V_{Ag}) by multiplying the square footage of the landscape area used for each crop (LA_{crop}) by each crop's unique efficiency factor (EF_{crop}) described in paragraph (C), by the net reference evapotranspiration associated with each crop's growing season (Net $ET_{0\ crop}$), and by a unit conversion factor of 0.62; and then summing the products for each crop. This formula is expressed mathematically as follows:

$$V_{Ag} = \sum_{crop} EF_{crop} \times LA_{crop} \times Net\ ET_{o\ crop} \times 0.62$$

(B) The landscape efficiency factor for residential agricultural landscapes (LEF_{Ag}) shall be the annual factor, calculated using data provided by the Department, as the average regional crop coefficient divided by the average regional irrigation efficiency. The average regional crop coefficient for the reporting year will be based on the most recent Statewide Crop Mapping dataset developed by the Department and the most recent crop coefficients identified in the Food and Agriculture Organization of the United Nation's (FAO) Irrigation and Drainage Paper 24 (published in 1977), FAO's Irrigation and Drainage Paper 56 (published in 1998), the University of California Cooperative Extension's (UCCE) Leaflet 21427: Using Reference Evapotranspiration (ET_0) and Crop Coefficients to Estimate Crop Evapotranspiration (ET_C) for Agronomic Crops, Grasses, and Vegetable Crops (published in 1989), or UCCE's Leaflet 21428: Using Reference Evapotranspiration and Crop Coefficients to Estimate Crop Evapotranspiration for Trees and Vines (published in 1989), which are hereby incorporated by reference. The irrigation efficiency shall be based on the Application Efficiency: Hydrologic Region 2010 values developed by the University of California (UC) Davis Water Management Research Group that are located in the Research Report: Spatial Analysis of Application Efficiencies in Irrigation for the State of California (published in June 2013), hereby incorporated by reference, or a comparable tool if the supplier demonstrates to the Department that the tool is equivalent, or superior, in quality and accuracy.

(C) Each crop's unique efficiency factor (EF_{crop}) shall be calculated as the crop coefficient divided by efficiency of the irrigation system associated with that specific crop in the supplier's service area. The crop coefficient values shall be the most recent crop coefficients identified in the FAO's Irrigation and Drainage Paper 24 (published in 1977), FAO's Irrigation and Drainage Paper 56 (published in 1998), UCCE's Leaflet 21427: Using Reference Evapotranspiration (ET_0) and Crop Coefficients to Estimate Crop Evapotranspiration (ET_C) for Agronomic Crops, Grasses, and Vegetable Crops (published in 1989), or UCCE's Leaflet 21428: Using Reference Evapotranspiration and Crop Coefficients to Estimate Crop Evapotranspiration for Trees and Vines (published in 1989). The irrigation efficiency shall be based on Application Efficiency: Hydrologic Region 2010 values developed by the UC Davis Water Management Research Group that are located in the Research Report: Spatial Analysis of Application Efficiencies in Irrigation for the State of California (published in June 2013), or a comparable tool if the supplier demonstrates to the Department that the tool is equivalent, or superior, in quality and accuracy.

(4) A variance for water used to respond to a state or local emergency declared in accordance with Government Code section 8558 (b) or 8558 (c), not including a drought, shall be equal to the volume of water used to respond to the emergency event.

(A) To be eligible for this variance, a supplier shall provide a copy of the emergency declaration pursuant to Government Code section 8558 (b) or 8558 (c), official evacuation orders, official incident reports, a document describing or map showing impacted parcels, and records of the total volume of water used as part of the emergency response efforts.

(B) This variance shall not include water reported to the Board supporting a variance for unexpected adverse conditions pursuant to section 985.

(5)

(A) A variance for the volume of water associated with landscapes irrigated with recycled water containing high levels of TDS (V_{HTDS}) shall be calculated by multiplying the applicable landscape efficiency factor (LEF_A) described in paragraph (i) or (ii) by the square footage of the landscape area irrigated with recycled water containing high levels of TDS (LA_{HTDS}), by net reference evapotranspiration (Net ET_0), and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$V_{HTDS} = LEF_A \times LA_{HTDS} \times \text{Net } ET_0 \times 0.62$$

(i) The landscape efficiency factor (LEF_A) for landscapes using recycled water with TDS concentrations between 900 and 1,600 milligrams per liter (mg/L) shall be calculated by multiplying 0.000371 by the difference between the TDS concentration, in mg/L, of the applied recycled water and 900. This formula is expressed mathematically as follows:

$$LEF_A = 0.000371 \times (\text{Concentration of recycled water} - 900)$$

(ii) The landscape efficiency factor (LEF_A) for landscapes using recycled water with concentrations of TDS equal to or above 1,600 mg/L shall be 0.26.

(B) Notwithstanding subdivision (f)(1)(C), a supplier may include a variance for water used to irrigate landscapes with recycled water containing high levels of TDS for which the sum of the associated water use calculated pursuant to this paragraph and section 969 (e)(2)(B) represents 1 percent or more of the sum of budgets described in section 966(c)(2) and (c)(3), if the supplier is using detailed plant based leaching requirements. A supplier using detailed, plant based leaching requirements shall calculate a variance for water used to irrigate landscapes with recycled water containing high levels of TDS (V_{HTDS}) by subtracting one from the applicable landscape efficiency factor (LEF_B) described below and multiplying the difference by the square footage of the landscape area irrigated with recycled water containing high levels of TDS (LA_{HTDS}), net reference evapotranspiration (Net ET_0), and a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$V_{HTDS} = (LEF_B - 1) \times LA_{HTDS} \times \text{Net } ET_0 \times 0.62$$

(i) The landscape efficiency factor (LEF_B) for recycled water applied via sprinkler systems shall be calculated by dividing the plant factor (PF) described in paragraph (iii) by the product of an irrigation efficiency factor of 0.75 and the difference between one and the plants' leaching requirement (LR) described in paragraph (iv). This formula is expressed mathematically as follows:

$$LEF_B = \frac{PF}{0.75 \times (1 - LR)}$$

(ii) The landscape efficiency factor (LEF_B) for recycled water applied via drip irrigation systems shall be calculated by dividing the plant factor (PF) as described in paragraph (iii) by the product of an irrigation efficiency factor of 0.81 and the difference between one and the plants' leaching requirement (LR) as described in paragraph (iv). This formula is expressed mathematically as follows:

$$LEF_B = \frac{PF}{0.81 \times (1 - LR)}$$

(iii) The plant factor shall be that of the lowest water-using plant that is present in at least 30 percent of the landscaped area.

(iv) The leaching requirement (LR) shall be equal to the salinity of the recycled water measured as electrical conductivity (EC_{iw}), in dS/m, divided by the difference between the product of 5 and the plant's salinity threshold measured as electrical conductivity (EC_e), in dS/m, and the salinity of the recycled water measured as electrical conductivity (EC_{iw}), in dS/m. EC_{iw} shall be capped at the equivalent of 1,600 mg/L. This formula is expressed mathematically as follows:

$$LR = \frac{EC_{iw}}{(5 \times EC_e) - EC_{iw}}$$

(C) Suppliers delivering recycled water with high levels of TDS for landscape irrigation shall only be eligible for the variance if the following conditions are met:

(i) The facility that produces the recycled water has completed annual volumetric reporting requirements consistent with the Board's Water Quality Control Policy for Recycled Water, Resolution No. 2018-0057 (adopted by the Board on December 12, 2018), which is hereby incorporated by reference;

(ii) The application of the recycled water complies with all applicable waste discharge requirements;

(iii) The application of the recycled water does not violate the terms of the applicable salt or nutrient management plan;

(iv) The application of the recycled water adheres to the Board's Anti-Degradation Policy, Resolution No. 68-16 (adopted by the Board on October 28, 1968), which is hereby incorporated by reference, or any update thereto.

(6) A supplier may include a variance for water use associated with ponds and lakes for sustaining wildlife, if the pond or lake is required to be maintained by regulation or local ordinance. A variance for water associated with ponds or lakes required to be maintained by regulation or local ordinance ($V_{wildlife}$) shall be calculated by multiplying 1.1 by the square footage of applicable ponds and lakes, by reference evapotranspiration less annual precipitation, and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$V_{wildlife} = 1.1 \times \text{Ponds and Lakes Area} \times (ET_0 - \text{Annual Precipitation}) \times 0.62$$

(A) A supplier may, for each reporting year, use an alternative data source for annual precipitation, if it demonstrates to the Department, in coordination with the Board, that the data are equivalent, or superior, in quality and accuracy to the data provided by the Department. Alternative data pursuant to this paragraph shall be reported pursuant to section 975.

(7)

(A) Beginning July 1, 2040, a supplier may include a variance for water use associated with the irrigation of existing residential trees. This variance ($V_{R\text{-trees}}$), in gallons, shall be calculated by multiplying the square footage of existing residential trees ($A_{R\text{-trees}}$), by 0.08, by net reference evapotranspiration (Net ET_0), and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$V_{R\text{-trees}} = A_{R\text{-trees}} \times 0.08 \times \text{Net } ET_0 \times 0.62$$

(B) The square footage of existing residential trees ($A_{R\text{-trees}}$) shall be the square footage of existing residential tree canopy coverage within the supplier's residential landscape area, as described in subdivisions (b)(2) and (3). A supplier must describe and substantiate how the square footage of existing tree canopy was quantified.

(C) A supplier shall only be eligible for the variance for existing residential trees if the following conditions are met:

(i) The supplier submits to the Board an analysis that quantifies the irrigation needs of existing trees and evaluates how those needs are being met. The analysis shall be based on an inventory of existing trees within the supplier's service area. The inventory must include detailed tree data including but not limited to tree species and tree diameter at breast height for at least 10 percent of trees, or a statistically valid sample. The analysis and inventory must be prepared or validated by a credentialed or certified urban forester or certified arborist.

(ii) The supplier submits to the Board an analysis demonstrating that meeting its water use objective pursuant to section 966 would require adhering to the residential outdoor standard identified in section 968 (a)(3) and that meeting the budget for efficient residential outdoor use would unavoidably and adversely affect tree health. The analysis must also demonstrate that the supplier cannot meet its water use objective pursuant to section 966 by first taking, incentivizing, or causing other feasible actions, such as the conversion of high-water use landscapes to climate-ready landscapes.

(iii) The supplier submits, as an attachment to its annual report required by section 975(a), a link to, or an electronic copy of, the urban forest management plan or plans covering the supplier's service area and a description of efforts to prioritize water for existing residential trees, as described in subdivision (j); leverage regional and local partnerships to support the installation and maintenance of climate-ready landscapes; and expand green infrastructure, such as swales or rain gardens, to help meet tree irrigation needs.

(h)

(1) An urban retail water supplier may, in calculating its annual urban water use objective, include budgets for temporary provisions for residential outdoor use if the supplier submits supporting information meeting the criteria described in subdivision (j).

(2) Temporary provisions may be requested for water use associated with any of the following:

(A) The planting of new, climate-ready trees

(B) The establishment of qualifying landscapes.

(i) Temporary provisions available pursuant to subdivision (h) shall be calculated as follows:

(1) A temporary provision for the volume of water associated with planting climate-ready trees (Pr_{trees}) shall be calculated by multiplying the number of newly planted climate-ready trees (N_{trees}) by 4 square feet, by the number of days per year the newly planted climate-ready trees may be watered (N_W) pursuant to paragraph (C), by 0.85, by net reference evapotranspiration (Net ET_0), and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$Pr_{trees} = (N_{trees} \times 4) \times N_W \times 0.85 \times \text{Net } ET_0 \times 0.62$$

(A) A climate-ready tree is a tree that can be reasonably expected to survive both present and future climatic challenges such as heat, drought, extreme weather events, and pests within the supplier's service area. Each newly planted climate-ready tree is assumed to occupy 4 square feet.

(B) A temporary provision for the volume of water associated with planting climate-ready trees applies for three years, starting with the fiscal year in which the trees were planted.

(C) The number of days per year that newly planted climate-ready trees (N_W) may receive a water budget varies by climate zone as follows:

(i) For climate zones 1 through 5 and zone 7, no more than 2 days per week.

(ii) For climate zones 6, 8 through 10, 12, and 16, no more than 3 days per week.

(iii) For climate zones 11 and 13 through 15, no more than 4 days per week.

(iv) If a supplier's service area spans multiple climate zones, the supplier shall, for the purposes of calculating this temporary provision, use the climate zone that covers the majority of the supplier's service area.

(2) A temporary provision for the volume of water associated with the establishment of qualifying landscapes (Pr_{land}) as described in paragraph (A), shall be calculated by multiplying the square footage of the qualifying landscapes (LA_{land}) by 0.85, by net reference evapotranspiration (Net ET_0), and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$Pr_{land} = LA_{land} \times 0.85 \times \text{Net } ET_0 \times 0.62$$

(A) Qualifying landscapes are those that require temporary irrigation and are associated with at least one of the following: low-impact development, ecological restoration, and mined-land reclamation projects.

(B) A temporary provision for water for the establishment of qualifying landscapes applies for three reporting periods, starting with the fiscal year in which irrigation of the qualifying landscape begins.

(j) In order to receive approval for either a variance or a temporary provision, an urban retail water supplier must submit to the Board in a machine-readable format for review and approval by the Executive Director, or the Executive Director's designee, a request that includes information quantifying and substantiating each request; information demonstrating that the water applicable to the request is water delivered by the supplier; information verifying that the approval of the request would not jeopardize the ability of a permittee within the supplier's service area to comply with existing permit requirements; information describing and supporting the methodology the supplier will use to estimate the parameters described in section 968 (f) and 968 (h); and a description of efforts to prioritize water for existing trees, including, but not limited to service-area wide rebate, direct install, and educational programs focused on transitioning to irrigation systems that promote deep and healthy root growth. Such irrigation systems include but are not limited to soaker hoses, deep drip watering stakes, drip tubing, and emitters.

(1) Approved variances or temporary provisions submitted between July 1 and October 1 may be included in the associated budget for the prior state fiscal year.

(2) Approved variances or temporary provisions submitted between October 2 and June 30 may be included in the associated budget for the current state fiscal year.

(3) Approved variances and temporary provisions may be included in the associated budget for up to five years. Variance and temporary provision approval constitutes approval of both methodology and data. Unless otherwise specified in section 975, a supplier may use the same data for each year or update the data annually in accordance with the approved variance or temporary provision methodology.

Authority: Sections 1058 and 10609.2, Water Code.
References: Article X, Section 2, California Constitution; Section 3080, Civil Code; Sections 8558 and 51201, Government Code; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10609.2, and 10609.6, Water Code.

Adopt new section 969:

§ 969. Standard for outdoor irrigation of landscape areas with dedicated irrigation meters or equivalent technology in connection with commercial, industrial, and institutional (CII) water use.

(a)

(1) Through June 30, 2028, an urban retail water supplier's budget for commercial, industrial, and institutional landscapes with dedicated irrigation meters (S_{DIM}) shall be the supplier's actual deliveries associated with landscape irrigation reported to the Board pursuant to Health and Safety Code section 116530.

(2) Beginning July 1, 2028, and through June 30, 2035, the standard for CII landscapes with DIMs (S_{DIM}) shall be a landscape efficiency factor of 0.80.

(3) Beginning July 1, 2035, and through June 30, 2040, the standard for CII landscapes with DIMs (S_{DIM}) shall be a landscape efficiency factor of 0.63.

(4) Beginning July 1, 2040, the standard for CII landscapes with DIMs (S_{DIM}) shall be a landscape efficiency factor of 0.45.

(5) For CII landscapes with DIMs that are special landscape areas, the standard ($S_{DIM\ SLA}$) shall be a landscape efficiency factor of 1.0. The $S_{DIM\ SLA}$ shall be applied to CII landscapes with DIMs that are special landscape areas as defined in section 491 as well as CII landscapes with DIMs that are any of the following:

(A) Slopes designed and constructed with live vegetation as an integral component of stability;

(B) Ponds or lakes receiving supplemental water for purposes of sustaining wildlife, recreation, or other public benefit, excluding water reported to the Board supporting a variance for ponds and lakes for sustaining wildlife required to be maintained by regulation or local ordinance;
(C) Plant collections, botanical gardens, and arboretums;
(D) Public swimming pools and similar recreational water features;
(E) Cemeteries built before 2015; and
(F) Landscapes irrigated with recycled water.

(6) The standard for newly constructed CII landscapes with DIMs shall be a landscape efficiency factor of 0.45.

(b)

(1) Beginning July 1, 2028, an urban retail water supplier shall calculate its budget for commercial, industrial, and institutional landscapes with dedicated irrigation meters (CII_{DIM}), in gallons, by multiplying the applicable standard (S_{DIM}) described in subdivision (a) by the measured total square footage of the irrigated area of CII landscapes with DIMs (DIM LA), by net reference evapotranspiration (Net ET_0), and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$CII_{DIM} = S_{DIM} \times \text{DIM LA} \times \text{Net } ET_0 \times 0.62$$

(2) No later than July 1, 2028, and periodically thereafter, a supplier shall quantify the measured total square footage of the irrigated area of CII landscapes with DIMs (DIM LA) and describe and substantiate how that area was quantified. Annual updates shall include the square footage of large landscapes that have had DIMs installed in accordance with section 973.

(3) A supplier may, for each reporting year, use alternative data sources for reference evapotranspiration and effective precipitation if the supplier demonstrates to the Department, in coordination with the Board, that the data are equivalent, or superior, in quality and accuracy to the data provided by the Department. The alternative data shall be reported pursuant to section 975.

(c)

(1) Notwithstanding subdivision (b)(1), if an urban retail water supplier delivers water to commercial, industrial, and institutional landscapes with dedicated irrigation meters that are special landscape areas, the supplier may calculate its budget for CII landscapes with DIMs as follows: Subtract the square footage of CII landscapes with DIMs that are special landscape areas (DIM SLA) from the total area of CII landscapes with DIMs (DIM LA). Then multiply the result by the applicable standard for CII landscapes with DIMs (S_{DIM}) described in subdivision (a). Add that value to the product of the standard for CII landscapes with DIMs that are special landscape areas ($S_{DIM\ SLA}$) described in subdivision (a)(5) and the square footage of CII landscapes with DIMs that are special landscape areas (DIM SLA). Then, multiply that sum by net reference evapotranspiration (Net ET_0) and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$CII_{DIM} = ((S_{DIM} \times (\text{DIM LA} - \text{DIM SLA})) + (S_{DIM\ SLA} \times \text{DIM SLA})) \times \text{Net } ET_0 \times 0.62$$

(2) In order to calculate the budget pursuant to this subdivision, a supplier may demonstrate to the Department, in coordination with the Board, that the landscape areas meet the definition specified in subdivision (a)(5). Special landscape area data shall be reported pursuant to section 975, and, unless updated pursuant to this paragraph, approved data may be included for up to five years.

(d)

(1) Beginning July 1, 2028, an urban retail water supplier may add to its budget for commercial, industrial, and institutional landscapes with dedicated irrigation meters (CII_{DIM}) calculated pursuant to (b)(1) or (c)(1) the volume of water associated with CII landscapes with DIMs that are newly constructed landscapes. The budget for CII landscapes with DIMs that are newly constructed landscapes ($C_{DIM,\ new}$), in gallons, is calculated by multiplying the standard ($S_{DIM\text{-}new}$) described in subdivision (a)(6) by the square footage of newly constructed CII landscapes with DIMs ($DIM\ LA_{new}$), by net reference evapotranspiration ($Net\ ET_0$), and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$CII_{DIM,\ new} = S_{DIM\text{-}new} \times DIM\ LA_{new} \times Net\ ET_0 \times 0.62$$

(2) The existence of newly constructed CII landscapes with DIMs shall be demonstrated by using:

(A) Data from annual reporting required by section 495(b)(6), provided the report has disaggregated newly constructed CII landscapes with DIMs from the total landscape area reported,

(B) On the ground measurements of newly constructed CII landscapes with DIMs, or

(C) Measurements of newly constructed CII landscapes with DIMs collected using accurate remote sensing methods.

(e)

(1) An urban retail water supplier may annually, in calculating its urban water use objective, include budgets for variances for water use on commercial, industrial, and institutional landscapes with dedicated irrigation meters, if the supplier submits supporting information meeting the criteria described in section 968(j), and, for the variances identified in (2)(A) and (2)(B), the associated water use meets the applicable criteria specified in section 968(f)(1)(C) or section 968(g)(5)(B).

(2) Variances may be requested for water use associated with any of the following:

(A) Responding to emergency events, not including drought

(B) Irrigating landscapes with recycled water containing high levels of TDS

(C) Supplementing ponds and lakes to sustain wildlife as required by existing regulations or local ordinances

(D) Irrigating existing trees on CII landscapes with DIMs.

(f) Variances available pursuant to subdivision (e) shall be calculated as follows:

(1) A variance for water used to respond to a state or local emergency, not including a drought, shall be calculated in the manner described in section 968(g)(4).

(2) A variance for water used for landscapes irrigated with recycled water containing high levels of TDS shall be calculated in the manner described in section 968(g)(5).

(3) A variance for water used to supplement ponds and lakes to sustain wildlife as required by existing regulations or local ordinances shall be calculated in the manner described in section 968(g)(6).

(4)

(A) Beginning July 1, 2040, a supplier may include a variance for water use associated with the irrigation of existing trees on CII landscapes with DIMs. The variance ($V_{CII\text{-}trees}$) for water used to irrigate existing trees on CII landscapes with DIMs, in gallons, shall be calculated by multiplying the square footage of existing trees ($A_{CII\text{-}trees}$) by 0.18, by net reference evapotranspiration (Net ET_0), and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$V_{CII\text{-}trees} = A_{CII\text{-}trees} \times 0.18 \times \text{Net } ET_0 \times 0.62$$

(B) The square footage of existing trees on CII landscapes with DIMs ($A_{CII\text{-}trees}$) shall be the square footage of existing tree canopy coverage within the square footage of CII landscapes with DIMs calculated pursuant to subdivision (b)(2). A supplier must describe and substantiate how the square footage of existing tree canopy was quantified.

(C) A supplier shall only be eligible for this variance if the conditions described in section 968(g)(7)(C) are met for existing trees on CII landscapes with DIMs, except that the supplier must substantiate that meeting its water use objective pursuant to section 966 would require adhering to the outdoor standard identified in section 969(a)(3) and that meeting the budget for efficient outdoor use on CII landscapes with DIMs would unavoidably and adversely affect tree health. The analysis must also demonstrate that the supplier cannot meet its water use objective pursuant to section 966 by first taking, incentivizing, or causing other feasible actions, such as the conversion of high-water use landscapes to climate-ready landscapes.

(g)

(1) An urban retail water supplier may annually, in calculating its urban water use objective, include budgets for temporary provisions for water use on commercial, industrial, and institutional landscapes with dedicated irrigation meters if the supplier submits supporting information meeting the criteria described in section 968(j).

(2) Temporary provisions may be requested for water use associated with any of the following:

(A) Planting new, climate-ready trees

(B) Establishing qualifying landscapes, as defined in section 968(i)(2)(A).

(h) Temporary provisions available pursuant to subdivision (g) shall be calculated as follows:

(1) A temporary provision for the planting of new, climate-ready trees shall be calculated in the manner described in section 968(i)(1).

(2) A temporary provision for water used for the establishment of qualifying landscapes that require temporary irrigation shall be calculated in the manner described in section 968(i)(2).

Authority: Sections 1058 and 10609.2, Water Code.
References: Article X, Section 2, California Constitution; Section 51201, Government Code; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10609.2, 10609.8, and 10609.9, Water Code.

Adopt new section 970:

§ 970. Water Loss

(a) Suppliers shall calculate system-specific standards for real water loss pursuant to section 982.

(b)

(1) Each year, suppliers that own and operate a single system shall calculate their water loss budget ($B_{water\ loss}$), in gallons, by multiplying the applicable water loss standard ($S_{water\ loss}$) calculated pursuant to section 982 by the number of days in the year, and, depending on the units associated with the standard calculated pursuant to section 982, by either the number of total service connections (C) or the length of the distribution system, in miles (M). These formulas are expressed mathematically as follows:

$$B_{water\ loss} = S_{water\ loss} \times C \times \text{days in the year}$$

OR

$$B_{water\ loss} = S_{water\ loss} \times M \times \text{days in the year}$$

(2) Suppliers that own and operate multiple systems shall calculate an aggregate annual water loss budget ($SB_{water\ loss}$) as described in paragraph (1) for each system and then by summing the estimated efficient water loss budgets associated with each system. This formula is expressed mathematically as follows, with $B_{water\ loss\ for\ system\ (i)}$ referring to the water loss budget for system i in the set of all the systems owned and operated by the supplier (i is the summation index):

$$SB_{water\ loss} = \sum_{\substack{i\ in\ the\ set\ of \\ all\ the\ systems \\ of\ the\ supplier}} B_{water\ loss\ for\ system\ (i)}$$

(c) Prior to a supplier's initial compliance deadline specified in section 981, the supplier's water loss budget may, alternatively, be equal to its previous year's real water losses reported in its annual water loss audit submitted to the Department pursuant to Water Code section 10608.34 (c).

Authority: Sections 1058 and 10609.2, Water Code.
References: Article X, Section 2, California Constitution; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10608.34, 10609.2, and 10609.12, Water Code.

Adopt new section 971:

§ 971. Bonus Incentive

(a) If an urban retail water supplier delivers water from a groundwater basin, reservoir, or other source that is augmented by potable reuse water, the supplier may add a bonus incentive to its objective. The bonus incentive shall be calculated pursuant to subdivision (b), in accordance with one of the following:

(1) If the potable reuse water is produced at an existing facility as defined in Water Code section 10609.20(d)(4), the bonus incentive shall not exceed 15 percent of the sum of the budgets described in section 966(c)(1) through (5).

(2) For potable reuse water produced at all other facilities, the bonus incentive shall not exceed 10 percent of the sum of the budgets described in section 966(c)(1) through (5).

(b) The bonus incentive shall be calculated by multiplying the urban retail water supplier's potable reuse volume (V_{PR}), in gallons, calculated in accordance with any combination of paragraphs (1), (2), or (3), depending on where the potable reuse water is obtained, by the portion of total potable water production (T_{PW}) delivered to residential and landscape irrigation connections (D_{RLI}) for the reporting year. This formula is expressed mathematically as follows:

$$Bonus\ Incentive = V_{PR} \times \frac{D_{RLI}}{T_{PW}}$$

(1) A supplier shall calculate the volume of potable reuse water obtained from a groundwater source (V_{PRG}) by dividing the product of the loss factor for groundwater recharge and recovery (LF_G) and the volume of potable recycled water recharging the groundwater basin (R) by total groundwater basin extractions (V_{BP}). The quotient is then multiplied by the supplier's groundwater basin extraction (V_G). The formula is expressed mathematically as follows:

$$V_{PRG} = \left(\frac{LF_G \times R}{V_{BP}}\right) \times V_G$$

The loss factor for groundwater recharge and recovery (LF_G) shall be calculated according to the Department's Recommendations for Bonus Incentive Methods of Calculation and Supporting Data Requirements (published September 22, 2022), which is hereby incorporated by reference, or an alternative method that the supplier has demonstrated to the Department, in coordination with the Board, to be equivalent, or superior, in quality and accuracy.

(2) A supplier shall calculate the volume of potable reuse water obtained from an augmented reservoir source (V_{PRS}) by dividing the product of the loss factor for evaporation and seepage (LF_S) and the volume of potable recycled water augmenting the reservoir (A) by the total volume of water produced from the augmented reservoir (V_{SWP}). The quotient is then multiplied by the volume of water the supplier produced from the augmented reservoir (V_{SW}). The formula is expressed mathematically as follows:

$$V_{PRS} = \left(\frac{LF_S \times A}{V_{SWP}}\right) \times V_{SW}$$

(3) A supplier shall calculate the volume of potable reuse water obtained from a Direct Potable Reuse project (V_{PRD}) by multiplying the volume of finished water produced from the DPR project ($V_{FIN\text{-}DPR}$) by the fraction (F) of water the supplier derived from the facility producing the finished water. The formula is expressed mathematically as follows:

$$V_{PRD} = V_{FIN-DPR} \times F$$

Authority: Sections 1058 and 10609.20, Water Code.
References: Article X, Section 2, California Constitution; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10609.2, 10609.20, and 10609.21, Water Code.

Adopt new section 972:

§ 972. Performance Measures: Commercial, Industrial, and Institutional classification system

(a) Each urban retail water supplier shall annually classify each commercial, industrial, and institutional water user, based on the end-use of water for the water user, in accordance with ENERGY STAR Portfolio Manager's broad categories.

(b) In addition to ENERGY STAR Portfolio Manager's broad categories, each supplier shall identify every CII water user associated with:

(1) CII laundries

(2) Landscapes with Dedicated Irrigation Meters

(3) Water recreation

(4) Car wash. For every CII water user associated with a car wash for which the car wash accounts for the majority of that water user's water use, the supplier shall also identify the water user's ENERGY STAR Portfolio Manager property type.

(c) Each supplier shall classify its existing CII water users by June 30, 2027. By June 30, 2028 and thereafter, the supplier shall maintain, for each reporting year, at least a 95 percent classification rate of all its CII water users.

(d) For systems that do not meet the criteria to be considered an urban retail water supplier until after the effective date of this section, and for a system that hydraulically consolidates with a supplier, this section applies beginning five (5) years after the system meets the criteria to be considered a supplier or consolidates with a supplier.

Authority: Sections 1058 and 10609.10, Water Code.
References: Article X, Section 2, California Constitution; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10609.2, and 10609.10, Water Code.

Adopt new section 973:

§ 973. Threshold for converting Commercial, Industrial, and Institutional landscapes with mixed meters to Dedicated Irrigation Meters or employing in-lieu water management technologies

(a) Each urban retail water supplier shall either:

(1) By June 30, 2027, identify all existing commercial, industrial, and institutional (CII) water users associated with large landscapes; or

(2) By June 30, 2029, identify all existing CII water users associated with a large landscape and for which estimated outdoor water use exceeds the water budget calculated pursuant to subdivision (c)(1).

(b)

(1) For existing CII water users identified pursuant to subdivision (a), a supplier shall either install dedicated irrigation meters (DIMs) or employ at least one of the in-lieu technologies from paragraph (2) and offer the best management practices (BMPs) from paragraph (3).

(2) In-lieu technologies include:

(A) Water budget-based management program without a rate structure

(B) Water budget-based rate structures

(C) Installation of technologies that enables the supplier to identify, estimate, and analyze outdoor water use, which may include but is not limited to Advanced Metering Infrastructure

(D) Use of technologies that enable suppliers to identify, estimate, and analyze outdoor water use, which may include but are not limited to remote sensing

(E) Other in-lieu technologies that enable suppliers to identify, estimate, and analyze water use or improve outdoor water use efficiency, subject to Board approval.

(3) Best management practices include, at a minimum, one BMP from section 974(f)(1) and at least two BMPs identified in section 974 (f)(3), including (B) and (C).

(c)

(1) A supplier that calculates a budget for commercial, industrial, and institutional water users associated with large landscapes (CII_{MUM}) pursuant to subdivision (a)(2) shall do so by multiplying the area of those landscapes (LA_{LL}) by net reference evapotranspiration (Net ET_0), by 0.63 or, for Special Landscape Areas, 1.0, and by a unit conversion factor of 0.62. This formula is expressed mathematically as follows:

$$CII_{MUM} = LA_{LL} \times \text{Net } ET_0 \times (0.63 \text{ or, for Special Landscape Areas, } 1.0) \times 0.62$$

(2) For purposes of this section, the area of the landscapes (LA_{LL}) shall include only CII water users associated with large landscapes and shall be quantified and substantiated by the supplier using data generated by the Department.

(3) Notwithstanding paragraph (2), a supplier may use data that it has demonstrated to the Department, in coordination with the Board, to be equivalent or superior in quality and accuracy.

(d) By June 30, 2039, a supplier shall have either installed dedicated irrigation meters (DIMs) on, or employed in-lieu water technologies for and offered BMPs to, all the water users identified pursuant to subdivision (a). By June 30, 2040 and thereafter, the supplier shall either have installed a DIM on, or employed in-lieu water technologies for and offered BMPs to, at least 95 percent of all commercial, industrial, and institutional (CII) water users associated with large landscapes, as assessed on a reporting year basis.

(e) For systems that do not meet the criteria to be considered an urban retail water supplier until after the effective date of this section, and for a system that hydraulically consolidates with a supplier, this section applies beginning fifteen (15) years after the system meets the criteria to be considered a supplier or consolidates with a supplier.

Authority: Sections 1058 and 10609.10, Water Code.
References: Article X, Section 2, California Constitution; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10609.2, and 10609.10, Water Code.

Adopt new section 974:

§ 974. Commercial, Industrial and Institutional water use best management practices for customers that exceed a recommended size, volume of water use, or other threshold

(a) By June 30, 2024, or the effective date of this section, whichever comes later, each supplier shall identify the disclosable buildings in its service area. In identifying the disclosable buildings within its service area, a supplier shall use the list of disclosable buildings the California Energy Commission has made available on its public website pursuant to California Code of Regulations, title 20, section 1683.

(b) For a building that meets the definition of a disclosable building in section 1681 of the California Code of Regulations at title 20, a supplier shall, upon the building owner or Owner's Agent request, complete the following:

(1) For each meter, deliver the last four characters of the meter serial number serving the building.

(2) For each meter, aggregate water use data, in monthly intervals, for at least the previous year, by one of the following methods:

(A) A supplier not using ENERGY STAR Portfolio Manager's Data Exchange Services shall send the data to the building owner or Owner's Agent using the template provided by ENERGY STAR Portfolio Manager or in a format compatible with the template.

(B) Suppliers using ENERGY STAR Portfolio Manager's Data Exchange Services shall provide the data by direct upload to the building owner's or Owner's Agent's ENERGY STAR Portfolio Manager account, or, at the building owner's or Owner's Agent's request, send the data to the building owner or Owner's Agent using the template provided by ENERGY STAR Portfolio Manager or in a format compatible with the template.

(c) Each supplier shall identify CII water users according to one of the following paragraphs (1), (2), or (3):

(1) By June 30, 2025, identify:

(A) Existing CII water users at or above the 97.5th percentile for CII water use; and

(B) Existing CII water users at or above the supplier's 80th percentile for CII water use.

(2) By June 30, 2027, identify:

(A) Existing CII water users at or above the supplier's 97.5th percentile for CII water use; and

(B) Existing CII water users at or above the supplier's 80th percentile for water use in each of the classification categories described in section 972.

(3) By June 30, 2029, identify existing CII water users that appear to be inefficient according to key business activity indicators (KBAI) the supplier has developed for the classification categories described in section 972. A supplier may also develop KBAIs for the specific ENERGY STAR Portfolio Manager property types.

(d) For the water users identified pursuant to (c)(1)(A) or (c)(2)(A), a supplier shall design, and implement pursuant to subdivision (h), a conservation program that includes at least two of the best management practices from each of paragraphs (1) through (5) in subdivision (f).

(e) For the water users identified pursuant to (c)(1)(B), (c)(2)(B), or (c)(3), a supplier shall design, and implement pursuant to subdivision (h), a conservation program that includes at least one of the best management practices from each of paragraphs (1) through (5) in subdivision (f).

(f)

(1) Outreach, Technical Assistance, and Education best management practices.

(A) Direct contacts via site visits or phone calls
(B) Informative or educational bill inserts
(C) Conducting workshop or developing training videos
(D) Webpage portals to access information, tools, and rebates
(E) Cost-effectiveness analysis tools
(F) Commercials or advertisements
(G) Grass roots marketing
(H) Community based social marketing
(I) Other CII-best management practices derived from additional innovation and technology advancement that can be taken by suppliers, subject to Board approval

(2) Incentive best management practices.

(A) Rebates and cost-sharing for replacing inefficient fixtures, equipment, irrigation systems or landscapes with water efficient ones
(B) Certification or branding programs that recognize customers as water efficient
(C) Incentives for technologies that enable customers to identify, measure, and analyze indoor and outdoor water use
(D) Other CII-best management practices derived from additional innovation and technology advancement that can be taken by suppliers, subject to Board approval

(3) Landscape best management practices.

(A) Landscape and irrigation management practices to promote improved water use efficiency
(B) Irrigation system inspections, audits, or surveys
(C) Training or guidance on irrigation scheduling and maintenance
(D) New development landscape inspection, workshops, and training
(E) Programs to remove turf and replace it with climate-ready vegetation
(F) Programs to decrease urban heat and reduce turf water use by planting trees
(G) Programs to install green infrastructure such as swales or rain gardens that offset irrigation needs
(H) Other CII-best management practices derived from additional innovation and technology advancement that can be used by suppliers, subject to Board approval

(4) Collaboration and coordination best management practices.

(A) Coordination with “green” building certification or recognition programs to promote water use efficiency
(B) Coordination with land use authorities to check new landscapes design and implementation
(C) Collaboration with non-governmental organizations on outreach and education
(D) Collaboration with municipal arborists and tree planting organizations to expand and maintain urban forests
(E) Collaboration with stormwater agencies to install green infrastructure such as swales or rain gardens to also offset irrigation needs

(F) Other CII-best management practices derived from additional innovation and technology advancement that can be taken by suppliers, subject to Board approval

(5) Operational best management practices.

(A) Infrastructure changes (for example, smart meter replacement programs)

(B) Billing or data collection procedures (for example, data tracking, analysis, and reporting improvements)

(C) Other operational best management practices to facilitate CII best management practices program implementation and evaluation

(D) Other CII best management practices derived from additional innovation and technology advancement that can be taken by suppliers, subject to Board approval

(g)

(1) Notwithstanding subdivisions (d) and (e), a supplier for which annual CII water deliveries are 10 percent or less of total deliveries, as averaged over a five-year period, shall design and implement pursuant to subdivision (h) a conservation program that includes at least two of the best management practices from in subdivision (f)(1).

(2) Notwithstanding subdivisions (d) and (e), a supplier need not offer BMPs from subdivision (f)(3) to customers that meet the criteria identified in this section but do not use water outdoors.

(3) For purposes of subdivisions (d) and (e), a supplier may rely on a regional entity in lieu of designing its own conservation program.

(h)

(1) By June 30, 2039, a supplier shall implement a conservation program for existing CII customers meeting the criteria identified in this section. After June 30, 2040, the supplier shall maintain a conservation program for all CII customers meeting the criteria identified in this section.

(2) For purposes of this section, a supplier may rely on implementation by a regional entity in lieu of implementing its own conservation program.

(i) For systems that do not meet the criteria to be considered an urban retail water supplier until after the effective date of this section, and for a system that hydraulically consolidates with a supplier, this section applies beginning fifteen (15) years after the system meets the criteria to be considered a supplier or consolidates with a supplier.

Authority: Sections 1058 and 10609.10, Water Code.
References: Article X, Section 2, California Constitution; Section 4185, Civil Code; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10609.2, and 10609.10, Water Code.

Adopt new section 975:

§ 975. Reporting

(a) Each urban retail water supplier shall submit to the Board, no later than January 1, 2024, and by January 1 every year thereafter, the report required by Water Code section 10609.24. The report shall reflect the conditions of the previous state fiscal year, except as specified in subdivision (b).

(b) No later than January 1, 2025, and by January 1 every year thereafter, each urban retail water supplier shall submit to the Board, on a machine-readable form provided by the Board, the supplier’s urban water use objective calculated pursuant to section 966 along with relevant and supporting data. Relevant and supporting data shall reflect the previous state fiscal year’s conditions, unless approved pursuant to section 967(e) or section 968(j), and shall include:

(1) For the residential indoor water use budget described in section 967, the following parameters:
   (A) The volume of water associated with the residential indoor budget (R_{indoor}) calculated pursuant to section 967.
   (B) Residential service area population. The residential service area population shall be the annual value reported to the Board pursuant to Health and Safety code section 116530 and California Code of Regulations, title 22, section 64412.
   (C) If the supplier has requested and received approval to include in its objective a budget associated with the evaporative cooler variance pursuant to section 967(b)(2), the following information:
      (i) The volume of water associated with the variance (V_{EC}) calculated pursuant to section 967(c)(1). This must be calculated and updated annually.
      (ii) The number of evaporative coolers in the service area (N_{EC})
      (iii) The average daily operating hours (H_O)
      (iv) The average daily evaporative rate (R_{EC})
      (v) The number of operating days as described in section 967(c)(1). This must be calculated and updated annually.
   (D) If the supplier has requested and received approval to include in its objective a budget associated with the seasonal population variance pursuant to section 967(b)(2), the following information:
      (i) The volume of water associated with the variance (V_{SP}) calculated pursuant to section 967(c)(2)
      (ii) The number of dwelling units associated with seasonal occupancy (N_{DU})
      (iii) The occupancy rate (R_O)
      (iv) If using the method described in section 967(c)(2)(C), the parameters described in this paragraph must be calculated and updated annually.
(2) For the residential outdoor water use budget described in section 968:
   (A) The volume of water associated with the residential outdoor budget ($R_{outdoor}$) calculated pursuant to section 968.
   (B) Annual reference evapotranspiration and effective precipitation data provided by the Department, or alternative reference evapotranspiration or effective precipitation data meeting the criteria specified in section 968(b)(4).
   (C) Residential landscape area data provided by the Department, or alternative residential landscape area data meeting the criteria specified in section 968(b)(3).
   (D) Any residential special landscape area meeting the criteria specified in section 968 (c). For residential special landscape areas irrigated with recycled water, the supplier shall, unless otherwise specified, provide information to trace the recycled water network at least once every five years:
      (i) The Public Water System Identification (PWSID) number associated with each system delivering recycled water to residential landscapes
      (ii) Annual metered non-potable residential landscape irrigation demand, as reported to the Board pursuant to Health and Safety Code section 116530. This must be updated annually.
      (iii) The GeoTracker Global Identification Number used for Volumetric Annual Reporting by each facility producing the recycled water that the supplier reported delivering to residential landscapes
      (iv) The PWSID number associated with each system producing the recycled water from each facility identified in (iii)

(v) The square footage of residential land irrigated with recycled water. If annually reported to a Regional Water Quality Control Board, the value reported pursuant to this section shall be the same value as annually reported to the Regional Water Quality Control Board.
(vi) The Waste Discharge Identification Number (WDID) associated with the land application of recycled water.

(E) Any residential landscape area associated with new construction and meeting the criteria specified section 968 (e)(2).

(F) If the supplier has requested and received approval to include in its objective a budget associated with the variance for horses and other livestock water use pursuant to section 968(f)(2):
(i) The volume of water associated with the variance ($V_{livestock}$) calculated pursuant to section 968(g)(1)
(ii) The number of animals according to each animal type-class
(iii) The average number of days per year that water is provided to each animal type-class.

(G) If the supplier has requested and received approval to include in its objective a budget associated with the variance for water associated with dust control on horse corrals or other animal exercise arenas pursuant to section 968(f)(2):
(i) The volume of water associated with the variance (V_{corral}) calculated pursuant to section 968(g)(2)
(ii) The square footage of corrals or other animal exercise arenas provided by the Department, or alternative data as specified in section 968(g)(2)(A).

(H) If the supplier has requested and received approval to include in its objective a budget associated with the variance to irrigate residential agricultural landscapes pursuant to section 968(f)(2), the following information:
(i) The volume of water associated with the variance (V_{Ag}) calculated pursuant to section 968(g)(3). This must be calculated and updated on an annual basis.
(ii) Reference evapotranspiration and effective precipitation data for the aggregated growing seasons associated with the crops grown on residential agricultural landscapes This must be calculated and updated on an annual basis
(iii) The average regional crop coefficient
(iv) The average regional irrigation efficiency
(v) The square footage of residential agricultural landscapes.

(I) If the supplier has requested and received approval to include in its objective a budget associated with the variance to irrigate residential agricultural landscapes pursuant to section 968(f)(2) and if the variance is calculated using crop-specific landscape area, the following information:
(i) The volume of water associated with the variance (V_{Ag}) calculated pursuant to section 968(g)(3)(A). This must be calculated and updated on an annual basis
(ii) The reference evapotranspiration and effective precipitation data associated with each crop's growing season. This must be calculated and updated on an annual basis
(iii) The unique efficiency factor for each crop, calculated according to section 968(g)(3)(C)
(iv) The landscape area associated with each crop, as estimated by the supplier.

(J) If the supplier has requested and received approval to include in its objective a budget associated with the variance for water used to respond to state or local emergency events pursuant to sections 968(f)(2), the following information, which must be calculated and updated on an annual basis:

(i) The volume of water associated with the variance

(ii) The required documentation described in section 968(g)(4).

(K) If the supplier has requested and received approval to include in its objective a budget associated with the variance to irrigate landscapes with recycled water containing high levels of TDS pursuant to section 968(f)(2) and relied on the calculation method described in section 968(g)(5)(A):

(i) The volume of water associated with the variance (V_{HTDS}) calculated pursuant to section 968(g)(5)(A). This must be calculated and updated on an annual basis.

(ii) The square footage of residential land irrigated with recycled water containing high levels of TDS. If reported to a Regional Water Quality Control Board, the value reported pursuant to this section shall be the same value as reported to the Regional Water Quality Control Board.

(iii) The concentration of TDS, in mg/L

(iv) The Public Water System Identification (PWSID) number associated with each system delivering to residential landscapes recycled water containing high levels of TDS

(v) Annual metered non-potable residential landscape irrigation demand, as reported to the Board pursuant to Health and Safety Code section 116530. This must be updated annually.

(vi) The GeoTracker Global Identification Number used for Volumetric Annual Reporting by each facility producing the recycled water containing high levels of TDS

(vii) The PWSID associated with each system producing the recycled water from each facility identified in (vi)

(viii) The waste discharge identification number (WDID) for the Waste Discharge Requirements associated with the land application of treated recycled water with high levels of TDS

(ix) The permitted concentration of TDS, in mg/L

(x) The permitted volume of applied recycled water, in gallons

(xi) An electronic copy of the applicable salt and nutrient management plan or plans, if any.

(L) If the supplier has requested and received approval to include in its objective a budget associated with the variance to irrigate landscapes with recycled water containing high levels of TDS pursuant to section 968(f)(2) and relied on the calculation method described in section 968(g)(5)(B):

(i) All parameters identified in paragraph (K), except (iii)

(ii) The plant factor

(iii) The leaching requirement

(iv) The salinity of the recycled water

(v) The plant threshold salinity.

(M) If the supplier has requested and received approval to include in its objective the budget associated with the variance for water used to sustain wildlife in ponds and lakes pursuant to section 968 (f)(2):

(i) The volume of water associated with the variance ($V_{wildlife}$), calculated pursuant to section 968 (g)(6). This must be calculated and updated annually

(ii) The area of ponds and lakes, in square feet

(iii) Annual precipitation data provided by the Department or annual precipitation data meeting the criteria in section 968 (g)(6)(A).

(N) If the supplier has requested and received approval to include in its objective the budget associated with the variance for water used to irrigate existing residential trees pursuant to section 968 (f)(2):

(i) The volume of water associated with the variance ($V_{R\text{-}trees}$), calculated pursuant to section 968 (g)(7). This must be calculated and updated annually

(ii) The area of existing residential trees, in square feet.

(O) If the supplier has requested and received approval to include in its objective a budget associated with the temporary provision for new, climate-ready trees pursuant to section 968 (h)(2):

(i) The volume of water associated with the temporary provision (Pr_{trees}), calculated pursuant to section 968 (i)(1). This must be calculated and updated annually

(ii) The number of newly planted trees.

(P) If the supplier has requested and received approval to include in its objective a temporary provision associated with establishing qualifying landscapes pursuant to section 968 (h)(2):

(i) The volume of water associated with the temporary provision (Pr_{land}), calculated pursuant to section 968 (i)(2). This must be calculated and updated annually

(ii) The square footage of qualifying landscapes receiving temporary irrigation.

(3) For the budget for commercial, industrial, and institutional landscapes with Dedicated Irrigation Meters described in section 969:

(A) The volume of water for CII landscapes with DIMs (CII_{DIM}) calculated pursuant to section 969.

(B) Annual reference evapotranspiration and effective precipitation data provided by the Department, or alternative reference evapotranspiration or effective precipitation data meeting the criteria specified in section 969(b)(3).

(C) The area of CII landscapes with DIMs measured by the supplier and meeting the criteria specified in section 969(b)(1).

(D) Any special landscape area meeting the criteria specified in section 969(c). For CII landscapes with DIMs irrigated with recycled water, the supplier shall, unless otherwise specified, provide information to trace the recycled water network at least once every five years:

(i) The Public Water System Identification (PWSID) number associated with each system delivering recycled water to CII landscapes with DIMs

(ii) Annual Non-Residential Recycled Water demand, as reported to the Board pursuant to Health and Safety Code section 116530. This must be updated annually.

(iii) Annual Non-Residential Non-Potable demand, as reported to the Board pursuant to Health and Safety Code section 116530. This must be updated annually.

(iv) The GeoTracker Global Identification Number used for Volumetric Annual Reporting by each facility producing the recycled water

(v) The PWSID associated with each system producing the recycled water from each facility identified in (iv)

(vi) The square footage of CII landscapes with DIMs irrigated with recycled water. If annually reported to a Regional Water Quality Control Board, the value reported pursuant to this section shall be the same value as annually reported to the Regional Water Quality Control Board

(vii) The Waste Discharge Identification Number (WDID) associated with the land application of recycled water.

(E) Any CII landscape area with DIMs associated with new construction and meeting the criteria specified section 969(d)(2).

(F) Any landscape area associated with a DIM that the Department classified as residential and included in the residential landscape area defined in section 968(b)(2), but that the supplier classifies as CII and has therefore subtracted from residential landscape area.

(G) If the supplier has requested and received approval to include in its objective a budget for the variance for water used to respond to state or local emergency events pursuant to section 969(f)(1), the following information, which must be calculated and updated on an annual basis:

(i) The volume of water associated with the variance

(ii) The required documentation described in section 968(g)(4).

(H) If the supplier has requested and received approval to include in its objective a budget associated with the variance to irrigate landscapes with recycled water containing high levels of TDS pursuant to section 969(f)(2) and relied on the calculation method described in 968(g)(5)(A):

(i) The volume of water associated with the variance (V_{HTDS}) calculated pursuant to section 968(g)(5)(A). This must be calculated and updated on an annual basis.

(ii) The square footage of CII landscapes with DIMs irrigated with recycled water containing high levels of TDS. If reported to a Regional Water Quality Control Board, the value reported pursuant to this section shall be the same value as reported to the Regional Water Quality Control Board.

(iii) The concentration of TDS, in mg/L

(iv) The Public Water System Identification (PWSID) number associated with each system delivering recycled water containing high levels of TDS to CII landscapes with DIMs

(v) Annual metered non-potable non-residential landscape irrigation demand, as reported to the Board pursuant to Health and Safety Code section 116530. This must be updated annually.

(vi) The GeoTracker Global Identification Number used for Volumetric Annual Reporting by each facility producing the recycled water containing high levels of TDS

(vii) The PWSID associated with each system producing the recycled water from each facility identified in (vi)

(viii) The waste discharge identification number (WDID) for the Waste Discharge Requirements associated with the land application of treated recycled water with high levels of TDS

(ix) The permitted concentration of TDS, in mg/L

(x) The permitted volume of applied recycled water, in gallons

(xi) An electronic copy of the applicable salt and nutrient management plan or plans, if any.

(I) If the supplier has requested and received approval to include in its objective a budget associated with the variance to irrigate landscapes with recycled water containing high levels of TDS pursuant to section 969(f)(2) and relied on the calculation method described in section 968(g)(5)(B):

(i) All parameters identified in paragraph (H), except (iii)

(ii) The plant factor

(iii) The leaching requirement

(iv) The salinity of the recycled water

(v) The plant threshold salinity

(J) If the supplier has requested and received approval to include in its objective a budget associated with the variance for water used to sustain wildlife in ponds and lakes pursuant to section 969(f)(3):

(i) The volume of water associated with the variance ($V_{wildlife}$), calculated pursuant to section 968(g)(6). This must be calculated and updated annually.

(ii) The area of ponds and lakes, in square feet

(iii) Annual precipitation data provided by the Department or annual precipitation data meeting the criteria in section 968(g)(6)(A).

(K) If the supplier has requested and received approval to include in its objective the budget associated with the variance for water used to irrigate existing trees on CII landscapes with DIMs pursuant to section 969(f)(4):

(i) The volume of water associated with the variance ($V_{CII\text{-}trees}$), calculated pursuant to section 969(f)(4). This must be calculated and updated annually

(ii) The area of existing trees on CII landscapes with DIMs, in square feet.

(L) If the supplier has requested and received approval to include in its objective a budget associated with the temporary provision to plant new, climate-ready trees pursuant to section 969(g)(2):

(i) The volume of water associated with the temporary provision (Pr_{trees}), calculated pursuant to section 968(i)(1). This must be calculated and updated annually.

(ii) The number of newly planted trees.

(M) If the supplier has requested and received approval to include in its objective a budget associated with the temporary provision for qualifying landscapes pursuant to section 969(g)(2):

(i) The volume of water associated with the temporary provision (Pr_{land}) calculated pursuant to section 968(i)(2). This must be calculated and updated annually.

(ii) The square footage of qualifying landscapes receiving temporary irrigation.

(4) For the budget for real water losses described in section 970:

(A) The volume of water in gallons per year associated with the real water loss budget ($B_{water\ loss}$) calculated pursuant to section 970.

(B) For systems with water loss standards expressed in units of gallons per connection per day, the supplier shall report the number of service connections for each system it owns and operates, as reported to the Department pursuant to Water Code section 10608.34.

(C) For systems with water loss standards expressed in units of gallons per mile per day, the supplier shall report the length of mains for each system it owns and operates, as reported to the Department pursuant to Water Code section 10608.34.

(5) For the bonus incentive described in section 971, the following parameters, which, unless otherwise specified, must be calculated and updated on an annual basis:

(A)

(i) The volume of the bonus incentive calculated pursuant to section 971(b) and subject to the limitations described in section 971(a)

(ii) Annual total potable water production (T_{PW}) reported to the Board pursuant to Health and Safety Code section 116530

(iii) Annual potable water deliveries to single-family residential, multi-family residential, and landscape irrigation (D_{RLI}) reported to the Board pursuant to Health and Safety Code section 116530.

(B) If a supplier delivers water from a groundwater basin that is augmented by potable reuse water, the following information:

(i) Volume of potable reuse water obtained from a groundwater source (V_{PRG}) for the reporting year, calculated pursuant to section 971(b)(1)

(ii) The annual loss factor for recharge and recovery (LF_G). The supplier shall document that the loss factor was calculated and provided by the appropriate groundwater basin management authority in accordance with section 971(b)(1).

(iii) The total volume of potable recycled water recharged into the basin. The total volume of potable recycled water recharged into the basin shall be an annual average, calculated using the values provided to the Board through the Volumetric Annual Report, for the preceding five years, for each facility producing recycled water used to recharge the basin. It shall be confirmed by the appropriate groundwater basin authority.

(iv) The GeoTracker Global Identification Number used for Volumetric Annual Reporting by each facility producing recycled water used to recharge the basin. This identifier shall be provided at least once every five years.

(v) The total volume of water extracted from the augmented groundwater basin (V_{BP}), to be obtained from the appropriate groundwater basin authority

(vi) The Public Water System Identification (PWSID) number associated with each system drawing from the augmented basin

(vii) The Primary Station Codes identifying each source drawing from the augmented basin

(viii) The volume of water the supplier produces from the augmented basin (V_G) reported to the Board pursuant to Health and Safety Code section 116530

(ix) The name of the basin augmented by potable reuse water. This shall be provided at least once every five years.

(x) The Bulletin 118 identification number. This shall be provided at least once every five years.

(C) If a supplier delivers water from a reservoir that is augmented by potable reuse water, the following information:

(i) The volume of potable reuse water obtained from an augmented surface water reservoir source (V_{PRS}) for the reporting year, calculated pursuant to section 971(b)(2)

(ii) The annual loss factor for evaporation and seepage (LF_S). The supplier shall document that the loss factor was calculated and provided by the owner or operator of the augmented surface water reservoir.

(iii) The total volume of potable recycled water used to augment the reservoir. The total volume of potable recycled water used to augment the reservoir shall be an annual average, calculated using the values provided to the Board through the Volumetric Annual Report, for the preceding five years, for each facility producing recycled water used to augment the reservoir. It shall be confirmed by the appropriate surface water authority.

(iv) The GeoTracker Identification Number used for Volumetric Annual Reporting by each facility producing recycled water used to augment the surface water reservoir. This identifier shall be provided at least once every five years.
(v) The total volume of water obtained from the augmented reservoir (V_{SWP}), to be obtained from the owner or operator of the augmented surface water reservoir
(vi) The Public Water System Identification (PWSID) number associated with each system drawing from the augmented reservoir
(vii) The Primary Station Codes identifying each source drawing from the augmented reservoir
(viii) The volume of water the supplier produces from the augmented reservoir (V_{SW}), as reported to the Board pursuant to Health and Safety Code section 116530.

(D) If a supplier delivers water from direct potable reuse (DPR) project, the following information:
(i) The volume of potable reuse water obtained from the DPR project (V_{PRD})
(ii) The volume of finished water produced from the DPR project ($V_{FIN\text{-}DPR}$)
(iii) The fraction of water the supplier derived from the facility producing the finished water

(6) The supplier's urban water use objective calculated pursuant to section 966.

(7)
(A) If a supplier meets the criteria described in section 966(i), the following:
(i) For the reporting year the supplier initially asserts compliance with its objective pursuant to section 966(i), the average median household income of the service area in accordance with section 966(i)(1), based on data from the United States Census Bureau's American Community Survey or an alternative source that the supplier has demonstrated to the Board to be equivalent, or superior, in quality and accuracy.
(ii) Average annual per capita water use for the state fiscal years ending in 2024, 2025, and 2026, pursuant to section 966(k)(1).
(iii) Annual per capita water use for the reporting year and the immediately preceding two years pursuant to section 966(k)(2).
(iv) A link to the plan required pursuant to section 966(i)(3).

(B) If a supplier meets the criteria described in section 966(j), the following:
(i) Average annual per capita water use for the state fiscal years ending in 2024, 2025, and 2026, pursuant to section 966(k)(1).
(ii) Annual per capita water use for the reporting year and the immediately preceding two years pursuant to section 966(k)(2).
(iii) Verified adherence to the American Water Works Association G480-20 Water Conservation and Efficiency Program Operation and Management Standard (published February 1, 2021).
(iv) A link to the plan required pursuant to section 966(j)(2).

(c) No later than January 1, 2025, and by January 1 every year thereafter, each urban retail water supplier shall submit to the Department and the Board, on a machine-readable form provided by the Board, the actual urban water use for the previous state fiscal year, calculated in accordance with section 10609.22 along with relevant supporting data for:

(1) Demands relevant to the objective, specifically:
(A)
(i) Annual deliveries to "Single-Family Residential" connections, as reported to the Board pursuant to Health and Safety Code section 116530

(ii) Annual deliveries to "Multi-Family Residential" connections, as reported to the Board pursuant to Health and Safety Code section 116530
(iii) Annual "Residential Recycled Water Demand," as reported to the Board pursuant to Health and Safety Code section 116530
(iv) Annual "Residential Non-potable Water Demand," as reported to the Board pursuant to Health and Safety Code section 116530
(v) The volume of annual deliveries to single-family residential customers that are at or above the 90th percentile for single-family residential water use across the supplier's service area
(vi) The volume of annual deliveries to multi-family residential customers that are at or above the 90th percentile for multi-family residential water use across the supplier's service area
(vii) Deliveries to residential landscapes with dedicated irrigation meters, where the supplier classifies those landscapes as residential, and the Department included those landscapes in the supplier's residential landscape area described in section 968(b)(2)
(viii) Deliveries to landscapes the supplier categorizes as residential landscapes but were not included in the supplier's residential landscape area described in section 968(b)(2). The supplier shall report these deliveries separate from paragraph (A)(i) or (A)(ii) until residential landscape area is updated to include these landscapes pursuant to section 968(b)(2) or 968(b)(3).

(B) Aggregate annual deliveries to "Metered Irrigation of Commercial, Industrial, or Institutional Landscapes," as reported to the Board pursuant to Health and Safety Code section 116530. This shall be limited to:
(i) Potable demand
(ii) Non-potable demand
(iii) Deliveries to landscapes the Department included in the supplier's residential landscape area described in section 968(b)(2) but that the supplier categorizes as CII. If this condition is met, the supplier shall correspondingly adjust its residential landscape area pursuant to section 968(b)(2) or (b)(3).

(C) Aggregated real water losses. If available, the real water losses shall be those reported in the water audits submitted to the Department pursuant to Water Code section 10608.34.

(D) Total demands relevant to the objective, which shall be the sum of the values reported in paragraphs (A)(i) through (iv), (B)(i) and (B)(ii), and (C).

(2) Excluded demands, specifically:

(A) Aggregate annual water deliveries to "Commercial and Institutional" connections, as reported to the Board pursuant to Health and Safety Code section 116530. This includes deliveries to landscapes the supplier categorizes as commercial or institutional and that are served by mixed-use meters. If the Department included such landscapes in a supplier's residential landscape area described in section 968(b)(2), then the supplier shall correspondingly adjust its residential landscape area pursuant to section 968(b)(2) or (b)(3).

(B) Aggregate annual water deliveries to "Industrial" connections, as reported to the Board pursuant to Health and Safety Code section 116530. The supplier shall additionally estimate the percentage of aggregate annual water deliveries to "Industrial" connections that is process water, as defined by Water Code section 10608.12(y).

(C) Aggregate annual water deliveries to "Other" connections, as reported to the Board pursuant to Health and Safety Code section 116530.

(D) Aggregate annual water deliveries to "Agriculture" connections, as reported to the Board pursuant to Health and Safety Code section 116530.

(E) Total aggregate demands excluded from the objective, which shall be the sum of the values reported in paragraphs (A), (B), and (C).

(d) No later than January 1, 2025, and by January 1 every year thereafter, each urban retail water supplier shall submit to the Department and the Board, for the previous state fiscal year, on a machine-readable form provided by the Board, the following:

(1) Relevant data pursuant to section 972, specifically:

(A) The total number of commercial, industrial, and institutional (CII) connections served, as reported to the Board pursuant to Health and Safety Code section 116530.

(B) The total number of CII water users classified pursuant to section 972.

(C) The number of CII water users falling into each of the classification categories specified in section 972(a) and section 972(b).

(2) Relevant data pursuant to section 973, specifically:

(A) For all suppliers:

(i) The total number of water users associated with large landscapes

(ii) The total estimated, aggregate volume of water applied to large landscapes

(iii) The total aggregate square footage of large landscapes.

(B) For suppliers that identified water users pursuant to section 973(a)(2):

(i) The number of water users associated with those large landscapes

(ii) The estimated, aggregate volume of water applied to those large landscapes

(iii) The total aggregate square footage of those large landscapes.

(C) For suppliers that have installed dedicated irrigation meters (DIMs) pursuant to section 973(b):

(i) The number of water users associated with large landscapes that have had a DIM installed

(ii) The aggregate square footage of large landscapes that have had a DIM installed.

(D) For suppliers that have employed in-lieu technologies and offered Best Management Practices (BMPs) pursuant to section 973(b):

(i) The number of water users associated with large landscapes for which the supplier has employed in-lieu technologies and offered BMPs

(ii) The aggregate square footage of those large landscapes

(iii) The in-lieu technologies that have been employed

(iv) If the Board has approved the use of an in-lieu technology other than those listed in section 973(b)(2), a narrative description of the technology employed

(v) The BMPs offered pursuant to section 973(b)(3)

(vi) The estimated annual water savings associated with section 973(b).

(3) Relevant data pursuant to section 974(a) and (b), specifically:

(A) The number of disclosable buildings identified pursuant to 974(a).

(B) The number of customers for which the supplier has provided the information required pursuant to section 974(b).

(4) Relevant data pursuant to section 974(c) through 974(h) in accordance with paragraph (A), (B), or (C) below, as applicable:

(A) For suppliers that have identified water users pursuant to 974(c)(1):

(i) The number of CII water users at or above the 97.5^{th} percentile for water use

(ii) The best management practices (BMPs) offered to the water users identified in paragraph (i)

(iii) The estimated annual water savings associated with the BMPs identified in paragraph (ii)
(iv) The number of CII water users at or above the 80th percentile for CII water use
(v) The BMPs offered to the water users identified in paragraph (iv)
(vi) The estimated annual water savings associated with the BMPs identified in paragraph (v).

(B) For suppliers that have identified water users pursuant to 974(c)(2):
(i) The number of CII water users at or above the 97.5th percentile for water use
(ii) The best management practices offered to the water users identified in paragraph (i)
(iii) The estimated annual water savings associated with the BMPs identified in paragraph (ii)
(iv) The number of water users at or above the 80th percentile for water use in each of the classification categories specified in section 972(a) and 972(b)
(v) The BMPs offered to the water users within each of the classification categories identified in paragraph (iv)
(vi) The estimated annual water savings associated with the BMPs identified in paragraph (v).

(C) For suppliers that have identified water users pursuant to 974(c)(3):
(i) The key business activity indicators (KBAI) developed for each of the classification categories specified in section 972(a) and 972(b)
(ii) Any KBAI the supplier has developed for specific ENERGY STAR Portfolio Manager property types
(iii) For each of the classification categories specified in section 972(a) and(b), the number of water users identified pursuant to section 974(c)(3)
(iv) The BMPs offered to the water users within each of the classification categories identified in paragraph (iii)
(v) The estimated annual water savings associated with the BMPs identified in paragraph (iv).

(e) Unless otherwise specified, any volume of water reported pursuant to this section shall be reported in gallons.

(f) On or before January 1, 2027, a copy of a supplier’s regulation, ordinance, or policy governing water service that shows the supplier’s compliance with Water Code section 10608.14.

Authority: Sections 1058 and 10609.28, Water Code.
References: Article X, Section 2, California Constitution; Section 116530, Health and Safety Code; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10608.12, 10608.14, 10608.34, 10609.2, 10609.10, 10609.22, 10609.24, 10728, and 12924 Water Code.

Adopt new section 978:

§ 978. Urban Water Use Objectives – Enforcement

(a) The failure to provide the information requested under this article within the time provided in the order, or as specified under this article, is a violation subject to civil liability pursuant to Water Code section 1846 or 1846.5.

(b) A decision or order issued under this article or under Water Code section 10609.24, subdivision (c), section 10609.26, subdivisions (a) or (c), or section 10609.28 is subject to reconsideration under article 2 (commencing with section 1122) of chapter 4 of part 1 of division 2 of the Water Code.

(c) Orders issued under this article are effective upon issuance.

Authority: Sections 1058, Water Code.
References: Article X, Section 2, California Constitution; Sections 102, 104, 105, 350, 1122, 1123, 1124, 1846, 1846.5, 10609.24, 10609.26, 10609.27, 10609.28, 10617, and 10632, Water Code.

Title 23. Waters
Division 3. State Water Resources Control Board and Regional Water Quality Control Boards
Chapter 3.5. Urban Water Use Efficiency and Conservation
~~Article 1~~Article 2. Water Loss Performance Standards for Urban Retail Water Suppliers
…

~~Article 2~~Article 3. Reporting
…

~~Article 3~~ Article 4. Prevention of Drought Wasteful Water Uses
…

ATTACHMENT 1-4:
California Department of Water Resources, Results of the Indoor Residential Water Use Study.

Results of the Indoor Residential Water Use Study

A Report to the Legislature Prepared pursuant to Water Code Section 10609.4(b)

August 2021

California Department of Water Resources
Water Use Efficiency Branch

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City of Sacramento
City of Santa Cruz
City of Redwood City
Coachella Valley Water District
Eastern Municipal Water District
Irvine Ranch Water District
Moulton Niguel Water District
California Water Service Agencies, including: Bakersfield, Bear Gulch, Chico, East Los Angeles, Livermore, Palos Verdes, Salinas, South San Francisco, Stockton, and Visalia

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18 Participating Suppliers: City of Folsom, Sacramento, Santa Cruz, Redwood City, Coachella Valley Water District, Eastern Municipal Water District, Irvine Ranch Water District, Moulton Niguel Water District, and several California Water Service agencies, including: Bakersfield, Bear Gulch, Chico, East Los Angeles, Livermore, Palos Verdes, Salinas, South San Francisco, Stockton, and Visalia.

1.0 INTRODUCTION

1.1 Background

Water planning has always been important for urban retail water suppliers (Suppliers) but is even more critical today, as development progresses and California grapples with frequent droughts and expected long-term climate impacts. Prior to the adoption of the Urban Water Management Planning (UWMP) Act in 1983, there were no specific requirements that mandated urban water suppliers to conduct long-term water resources planning. While many Suppliers did conduct long-term water planning, those that did not were more vulnerable to supply disruptions during dry periods and catastrophic events. Urban water management planning is needed at the local level because only local Suppliers have the knowledge and ability to tailor their planning to their unique conditions and involve their local community in the planning effort.

The UWMP Act has been modified over the years in response to the State's water shortages, droughts, and other factors. A significant amendment was made in 2009, after the drought of 2007- 2009, as a result of the Governor's call for a statewide 20% reduction in urban water use by the year 2020. This was the Water Conservation Act of 2009 (SB X7-7, Steinberg). SB X7-7 required agencies to establish water use targets for 2015 and 2020 in order to achieve a statewide goal of 20% reduction in urban per capita water use by 2020. This was a major shift in the approach to water management planning (www.drought.gov). This volumetric reduction approach to water use efficiency was a precursor to the current approach to water use efficiency and water resources management that is based on standards and objectives.

In 2018, two policy bills were enacted by the California Legislature, Assembly Bill 1668 (AB1668, Friedman) and Senate Bill 606 (SB606, Hertzberg), collectively referred to as the "2018 Water Conservation Legislation." The 2018 Water Conservation Legislation revised the California Water Code (Water Code) enacting measures aimed at adopting long-term standards for the efficient use of water as we move beyond 2020 and into a water future where water supplies and uses will be greatly affected by climate change, population growth, and new development. These standards are the basis of determining Suppliers' water use objectives to ensure efficient beneficial use of the State’s limited water supplies. This approach to water use efficiency, based on standards and objectives, is informed by the framework for one of the four SB X7-7 methods that could be used to calculate water use targets.

From the 2018 Water Conservation Legislation, a Supplier’s ***water use objective is determined by the sum of the following standards***, considering local conditions and characteristics (population, landscape area, and others):

1. Indoor residential water use standard for efficient use.
2. Outdoor residential water use standard for efficient use.
3. Large commercial, industrial, and institutional (CII) landscape areas irrigated with dedicated meters or in-lieu technologies standard for efficient use.
4. Water losses.
5. Variances for unique uses of water that have a material effect (for example, seasonal populations that may artificially increase the calculated water use per person).
6. Bonus incentives for potable reuse.

1.2 How Water Use Standards Are Used

All of the standards will apply to Supplier service areas on an annual aggregate basis; they will not apply to individual customers nor will they be assessed daily or monthly. The standards are applied to the Supplier’s conditions and characteristics and summed to represent the Suppliers’ “urban water use objective”. This allows a Supplier to be above or below any individual efficient water use standard, so long as the Supplier’s annual water use does not exceed the aggregate sum of all the standards plus variances and bonus incentives terms (water use objective).

The Suppliers’ water use objectives are effective after June 2022, when the State Water Resources Control Board (Water Board) adopts urban water use efficiency standards, performance measures, and variances. The 2018 Water Conservation Legislation does not modify the current statewide goal of a 20-percent reduction in urban per capita use by 2020 or limit individual customers’ water use.

1.3 Statutory Indoor Residential Water Use Standard

The indoor residential water use standard is a service area average for indoor residential water consumption in order to accommodate inherent variability in local service area characteristics and individual customer needs and use (Water Code §10609(a)). The indoor residential water use standard was set by the Legislature, independent of the other standards, as:

Water Code Section 10609.4:

> *(a) (1) Until January 1, 2025, the standard for indoor residential water use shall be 55 gallons per capita daily.*
>
> *(2) Beginning January 1, 2025, and until January 1, 2030, the standard for indoor residential water use shall be the greater of 52.5 gallons per capita daily or a standard recommended pursuant to subdivision (b).*
>
> *(3) Beginning January 1, 2030, the standard for indoor residential water use shall be the greater of 50 gallons per capita daily or a standard recommended pursuant to subdivision (b).*

DWR's Directive

Water Code Section 10609.4

> *(b) (1) The department, in coordination with the board, shall conduct necessary studies and investigations and may jointly recommend to the Legislature a standard for indoor residential water use that more appropriately reflects best practices for indoor residential water use than the standard described in subdivision 10609.4 (a)(1).*

1.4 Development of Remaining Standards

The outdoor residential and CII large landscape irrigation efficient water use standards, along with the variances, are set through a process where the Department of Water Resources (Department) conducts studies, in coordination with the Water Board, and makes recommendations to the Water Board by October 1, 2021, for the Water Board to adopt as regulation.

1.5 Stakeholder Process

In developing these studies and standards, Stakeholder collaboration is required by statute (Water Code Section §10609.4(b)(2))[1].

The Water Use Studies Working Group was formed by the Department in July 2019 and comprised of water suppliers, non-governmental organizations, and State and local agency personnel. Three meetings were held with this 33-member Working Group to present and solicit stakeholder feedback on the study approach, study results, and the Department and Water Board proposed joint recommendations. Stakeholder meetings were open to the public with attendance typically over 180 participants.

Additional public outreach and engagement was accomplished through meetings requested by individual stakeholders, the Association of California Water Agencies (ACWA), and a presentation given at the California Water Efficiency Partnership (CalWEP) Peer to Peer Conference (December 8, 2020). The indoor residential water use study team also received feedback from the 18 Suppliers' study participants who were selected to provide data and collaborate with the Department on the study.

A Draft Report was subject to public review for 25 calendar days, beginning on May 11, 2021 and ending on June 4, 2021. A Working Group workshop and public meeting was held May 21, 2021 to present the report and solicit public and stakeholder feedback. Public comments were posted on the Department's SharePoint site and were accessible by all interested parties. The Department and Water Board reviewed the written public comments and decided to hold a second public meeting on July 19, 2021 where additional public comments were received and considered in finalizing the Report.

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[1] Water Code Section 10609.4 (b) (2) The studies, investigations, and report described in paragraph (1) shall include collaboration with, and input from, a broad group of stakeholders, including, but not limited to, environmental groups, experts in indoor plumbing, and water, wastewater, and recycled water agencies.

Beginning October 2019, monthly coordination meetings were held with the Water Board. Shortly thereafter, beginning July 2020, weekly and bi-weekly coordination meetings were held to collaborate on the study and development of the joint recommendations.

1.6 Study Purpose and Goals

Following the legislative directive of Water Code §10609.4(b), the Department, in coordination with the Water Board, conducted a study on indoor residential water use and prepared this report. In accordance with the legislative directive, this study was to include the information necessary to determine if a recommendation was needed and if so, support any joint recommendation made with the Water Board on a different indoor residential water use standard that more appropriately reflects best practices (Water Code §10609.4(b)(1)). The goals of this study and report were to:

- Identify what the current or baseline, statewide average indoor residential water use is in gallons per capita (person) per day (R_i-gpcd) for California. This information can be used to determine how different the baseline is from any standard.
- Identify whether demographic or geographic factors associated with Suppliers may relate to high (or low) R_i-gpcd.
- Identify the current and future projected statewide Supplier R_i-gpcd distribution to:
    - Inform how many suppliers and total population would be affected and how much water savings may be achieved with any standard.
    - Ensure that lower income service areas are not disproportionately affected by any standard.
    - Inform if statewide climate zones/hydrologic regions are disproportionately affected by any standard.
- Qualitatively identify benefits and impacts on water supply, recycled water, and wastewater systems of a changing indoor residential water use standard.

- Inform the joint recommendation for an indoor residential water use standard that more appropriately reflects best practices.

1.7 Overall Study Approach

With the technical assistance of acknowledged water use experts and in consultation with Suppliers, the Department developed a robust study plan to estimate the current statewide average per-capita indoor residential water use (R_i-gpcd) and the current distribution of Supplier service area average (R_i-gpcd). The current distribution of Supplier R_i-gpcd was also projected for 2025 and 2030 in order to capture the effects of a stepped-down standard.

The difficulty in analyzing indoor residential water use is that residential water meters measure total residential water use and as such, do not distinguish between indoor and outdoor water use; indoor use must therefore be inferred from the total residential water use through calculations or models in a process referred to as 'disaggregation'.

The Department used total residential water use data from three main sources to characterize the current statewide average indoor residential water use and both the current and future projected distribution of indoor residential water use across all Suppliers.

1.7.1 Baseline Indoor Residential Water Use

The current statewide average indoor residential water use (Baseline) analysis was determined to allow for a direct comparison with the SB X7-7 2020 statewide average total water use target of 158 gpcd [2] because the legislative directive for efficient water use standards includes ensuring that the overall per-capita water use remains below the SB X7-7 water use target for 2020. This analysis used customer-level data from the entire service areas of 18 Suppliers, which provides for a robust statistical analysis at the Census tract-, Supplier service arear-, and state-level. This approach stands in contrast to previous disaggregation studies of residential water use that typically relied on simple methods applied to monthly water use data that

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[2] State of CA, CNRA, Department of Water Resources, August 2017, Status of 2015 Urban Water Management Plans, A report to the Legislature pursuant to Section 10644 and 10608.42 of the California Water Code

had been rolled-up to the Supplier-level or very short duration, high-frequency data from a few carefully selected customers[3]. Although the few high-frequency water use studies can provide accurate results, the short duration and limited number of metered sites do not allow for a robust statistical analysis or an accurate characterization of Supplier service area or statewide indoor residential water use.

The baseline analysis was conducted using primarily customer-level monthly billing data from 18 Suppliers and United States Census (Census) tract characteristics that represent the diversity of all Census tracts in California. Hourly meter read data from Advance Meter Infrastructure (AMI or Smart Meters) was also explored to see if hourly data could provide a more precise analysis.

1.7.2 Supplier R_i-gpcd Distribution

Because the baseline analysis was performed using only 18-Suppliers' customer-level monthly data, a simple disaggregation analysis of rolled-up, Supplier service area (Supplier-level) water use data, reported annually to the Water Board (electronic Annual Report [eAR] data), was used to characterize the distribution and range of Supplier R_i-gpcd. This distribution analysis estimated Supplier level R_i-gpcd from the eAR data using one of the simplest methods that was also used in the baseline analysis. The resulting Supplier-level R_i-gpcd distribution analysis allows for an estimate of the magnitude of any standard's effect (i.e., how many suppliers and population could be affected by any standard). A comparison of the Supplier-level R_i-gpcd analysis to the baseline study results, described in Section 4.1, and using the more robust methods and data, confirmed the applicability of using the monthly Supplier-level data to inform the R_i-gpcd distribution.

1.7.3 Projected Statewide R_i-gpcd in 2025 and 2030

The current Water Code indoor residential water use standard steps down in 2025 and again in 2030. To assess the suitability of long-term standards, it

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[3] Mayer, P.W., W.B. DeOreo, et. al. 1999. Residential End Uses of Water. American Water Works Association Research Foundation, Denver, CO.; DeOreo, W.B., P. Mayer, J. Kiefer, and B. Dziegielewski. 2016. Residential End Uses of Water, Version 2. Water Research Foundation. Denver, CO

was important to estimate what the Supplier-level R_i-gpcd will be in the future. Future Supplier-level R_i-gpcd was projected to 2025 and 2030 by applying estimates of 'natural' water use reductions due to plumbing codes and 'natural' appliance turnover rates, by county.[4] These 'natural' reductions (passive conservation) are based on estimates of new housing built to current water efficient codes, turnover of existing housing stock subject to efficient toilet and fixture requirements, as well as replacement of old appliances with newer water-efficient appliances. This projection did not include any adjustments in indoor residential water use for potential pandemic effects, changes in population, or accelerated reductions from conservation programs (active conservation).

1.7.4 Benefits and Impacts

To address Water Code Section §10609.4(b)(2), a qualitative analysis was performed on water supply, wastewater, and recycled water systems' benefits and impacts that may result from a changing R_i-gpcd standard. Benefits and impacts to these inter-related sectors are highly variable and depend on local systems' conditions, as well as the magnitude of the effect of a changing standard within the local agencies service area. As such, a quantitative analysis is beyond the scope of this study.

1.8 Best Practices

This study is required to include the information necessary to support a different indoor residential water use standard that more appropriately reflects best practices (Water Code §10609.4(b)(1)). These "best practices" can include practices that Suppliers can implement (e.g., fixture and appliance rebate programs, conservation education, leak detection programs) and those that individual customers can implement (e.g., actual fixing of leaks, replacing appliances and fixtures, and changes in behavioral water use patterns). In considering best practices, it is important to note that while water use efficiency improvements depend on both Suppliers and

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[4] M Cubed, August 2016, TM - Projected Statewide and County-Level Effects of Plumbing Codes and Appliance Standards on Indoor gpcd, (see Appendix F)

their customers implementing best practices, the indoor residential water use standard applies only to Suppliers and not to individual customers.

California's urban water supplier best management practices and potential-best management practices were developed in the late 1990s and 2000s and administered through the California Urban Water Conservation Council (CUWCC) and now maintained by the California Water Efficiency Partnership (CalWEP). Cost-effectiveness has always been a key consideration for selecting best practices in California.[5]

There is guidance on ongoing best practices available through partnerships including: the Alliance for Water Efficiency[6], California Water Efficiency Partnership (CalWEP) (formerly the California Urban Water Conservation Council (CUWCC) established in 1991), SoCal Water$mart (established in 1990), Regional Water Authority Water Efficiency Program (formed in 2001)[7], Santa Ana Watershed Project Authority (established in 1968)[8],and Bay Area Water Supply & Conservation Agency (established in 2002)[9] to name a few.

How effective or appropriate a best practice is will depend on a number of factors including: cost, saturation (e.g., how many customers have already replaced high water use fixtures and appliances with efficient ones), customer behavior and culture (e.g., how long people shower or how many times they flush their toilets), water conservation programs currently being

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[5] California Water Efficiency Partnership. Utility Operations BMP Implementation Guidebook, https://calwep.org/wp-content/uploads/2020/04/UtilityOperationsGuidebook.pdf
[6] Alliance for Water Efficiency Water Conservation Programs, Planning, and Evaluation, https://www.allinaceforwaterefficiency.org/rsources/programs. Accessed April 1, 2021.
[7] Regional Water Authority Water Efficiency Program Available at: https://rwah2o.org/programs/wep/. Accessed April 1, 2021.
[8] Santa Ana Watershed Project Authority. Water Use Efficiency Info and Tools to Assist Retail Water Agencies. Available at: https://sawpa.org/water-use-efficiency/. Accessed April 1, 2021.
[9] Bay Area Water Supply & Conservation Agency. Available at: (http://bayareaconservation.org). Accessed April 1, 2021.

implemented, demand hardening,[10] as well as local conditions such as climate, water scarcity, pricing, and other factors.

A good way to understand why a service area demonstrates high (or low) R_i-gpcd, is through a comprehensive End Use study.[11] A comprehensive End Use study can identify the household factors that influence indoor and outdoor residential water use and their specific effects on service area R_i-gpcd. End Use studies can identify the efficiency of a residence's fixtures and appliances, presence of leaks, and customer water use patterns, all of which affect indoor residential water use. End Use studies also allow for an estimation of what appropriate best practices might be and what effect those could have on the service area R_i-gpcd. A comprehensive End Use analysis was not conducted for this study because of time and resource constraints.

2.0 METHODS

Included in this section are the methods used to estimate and evaluate the statewide indoor residential water use for the Baseline and the Supplier Distribution. This section presents the different types of data that were available and used in the analyses, the methods of disaggregating total residential water use into its indoor and outdoor components from monthly billing data, hourly meter reads, end-use (pilot study) components, and aggregate water use reported by Suppliers to the State Water Board. Also discussed, is a comparison of indoor residential water use estimates for single-family and multi-family dwelling units. Details on methods are included in Appendices A - G.

[10] Alliance for Water Efficiency. Available at: https://www.allianceforwaterefficiency.org/impact/our-work/research-report-water-use-efficiency-and-demand-hardening. Accessed April 1, 2021.
[11] Unique local conditions are recognized in Water Code and may be subject to variances (CWC §10609.14) such as high seasonal populations where service area RI-gpcd does not reflect service area indoor residential water use because the population count does not capture all of the water users.

2.1 Indoor Residential Use Study Components

The statewide baseline R_i-gpcd and R_i-gpcd distribution among Suppliers was estimated based on disaggregating single-family total residential water use data[12] to separate out the indoor fraction.

Customer-level data is the most appropriate data for determining indoor residential water use. Collecting and analyzing customer-level data from all 400-plus Suppliers in California was not feasible within the timeframe[13]. Therefore, a subset of 18 Suppliers was selected to conduct the analyses for the baseline statewide central tendency (e.g., average). The 18 Suppliers were selected to provide a good geographic mix of tracts and sufficient variation in household and tract characteristics to build models for estimating the baseline R_i-gpcd. Refer to Appendix D – Sample Selection Tool Description and Appendix E – Sampling Strategy to Estimate Central Tendencies for details on Supplier selection and suitability for analysis. The baseline analysis was then augmented with analysis of a larger set of Supplier-level aggregated values in order to better inform the distribution and range of Suppliers' R_i-gpcd. Figure 2.1-1 shows the location of Suppliers contributing to this study:

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[12] Multi-family residential water use data was disaggregated for a few of the 18-Suppliers and the estimated RI-gpcd were found to be not very different, on average, than single-family RI-gpcd. However, inherent difficulties in disaggregating total residential water use into indoor and outdoor components from multi-family account data resulted in extreme variability between census tract averages of Single- and Multi-family RI-gpcd estimates within a Supplier's service area.

[13] For the Department to acquire the customer-level data used in the disaggregation analyses, a Non-Disclosure Agreement (NDA) with Suppliers was needed to protect private information pursuant to the California Consumer Privacy Act of 2018. Obtaining signed NDA's with and data from each supplier can be a lengthy process, is not always guaranteed, constitutes hundreds of thousands to millions of monthly records, and is subject to the Suppliers' agreement and resources constraints.

Figure 2.1-1. Study Participants and Locations [14]

2.1.1 Baseline Analysis for Statewide Central Tendencies

The statewide baseline central tendencies provides a measure of the statewide current average R_i-gpcd for comparison with the SB X7-7, 20-percent reduction in statewide average per capita water use by 2020 target. Customer-level monthly billing data from 18 Suppliers distributed throughout California allowed for use of four different disaggregation methods and two statistical methods for extrapolating results to Supplier service areas and for statewide Baseline. Suppliers used for the baseline analysis were selected

[14] In addition to the monthly disaggregation participants shown, the following suppliers also participated in the hourly disaggregation: Eastern MWD, Folsom, Redwood City, and Sacramento

based on service area characteristics that represent demographic characteristics known or suspected to affect indoor residential water use based on the results of previous studies as summarized in described in Section 2.2.1 and described in Appendix C – Pilot End-Use Analysis.

The statewide estimates of indoor residential water use is the average of 2017, 2018, and 2019 data to represent baseline conditions (2020 will not be available until summer 2021). This three-year average was used because high variability in water use from year to year precludes use of a single-year, where possible. Additionally, water use during the 5-year California drought from 2011-2016[15] that preceded 2017 does not represent 'normal' conditions because of the associated voluntary and regulatory required reductions and overall water use has changed considerably in the past two decades.

Although 2017 may retain some lingering effects associated with the 5-year drought, 2018 was a below normal water year[16] that may have encouraged extra water use. Based on the expertise of the technical advisory team, the average of all three years provides a reasonable 'current' indoor residential water use estimate in the absence of detailed information about individual Supplier and customer practices during that time frame.

Disaggregated customer-level data from the 18-Suppliers' were rolled up to the tract level and combined with American Community Survey (ACS) tract-level data and characteristics. A key assumption is that the tract estimates from the 18-Suppliers are representative of similar tracts statewide. Using this assumption, two different approaches were then used to extrapolate the tract estimates of R_i-gpcd used for estimating the statewide Baseline:

1. Strata-Based Approach
2. Correlation-Based Approach

Two types of analyses were run on the tract-level averages of R_i-gpcd from the 18-Supplier customer-level data. Because the tract-level averages are

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[15] https://www.drought.gov/states/california#historical-conditions
[16] http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

based on customer-level data, confidence intervals for the averages (margins of error) could also be determined.

Strata-Based Approach

The Strata-Based Approach divided up all 8,057 tracts within California and classified them into 'strata' or 'bins' with similar demographic characteristics as derived from the ACS data. Tracts were grouped into 54 different strata based on similarities in their ACS characteristics including the representation of population over 65, age of housing stock, and median household income (refer to Appendix E for more details):

- **Age of housing stock.** Age of housing is well-documented as affecting indoor residential water use because of housing codes in effect at the time of construction, as well as wear and tear on household water infrastructure fixtures and appliances. This study did not look at what effects retrofit and replacement programs may have had on baseline water use.

- **Median Household Income and Disadvantaged Community Status.** Higher economic status can indicate a greater likelihood of home improvements that could reduce indoor residential water use. Additionally, in high income areas, there may be fewer people in larger residences.

- **Population over 65.** The population over 65 is expected to capture situations where customers are home during the day and may show higher residential water use.

For example, a 'bin' may be created for all tracts with median plus or minus 25 percent: population over 65, median household income, and housing built after 2000. Some of the tracts in this bin would have estimated R_i-gcpd, some would not.

Rolled-up customer-level R_i-gpcd estimates were derived for each sampled Census tract (tract estimates). The population-weighted average of these tract estimates were then used as the best estimate of R_i-gpcd for entire strata the tracts fell within (e.g., population-weighted average of all sampled tracts that fell within the bin for 25-percent less than to 25-percent more than median population over 65, median household income, and housing built after 2000). Next, the strata-level estimates were aggregated to the statewide-level with strata population serving as the weight. Because the tract estimates also have an associated standard error based on the customer-level data analysis, these error terms could be carried through to the strata estimates and statewide aggregate Baseline (assuming independence of standard errors across tracts) to generate a confidence interval for the estimated Baseline for each disaggregation method.

The advantage of the Strata-Based approach is that minimal assumptions are made about what household characteristics cause variations in tract estimates of R_i-gpcd. As long as the Suppliers selected for producing the tract estimates have sufficient tract diversity to be representative of statewide diversity, this Strata-Based roll-up can lead to robust statewide estimates. A more detailed description of how strata are defined, the total number of tracts within each strata, and the number of sampled tracts from the 18-Suppliers within each strata statewide is included in Appendix D - Sample Selection Tool Description.

Correlation-Based Approach

Using the same 18-Supplier tract estimates, correlations using regression models were developed based on ACS tract characteristics as opposed to strata classifications. For example, instead of using a 'bin' average for all tracts within the strata, the tract estimates were correlated with each tract's actual percent population over 65, median household income, and housing built after 2000. A regression equation was developed to model this relationship between factor percentages and tract estimate of R_i-gpcd. This analysis allowed for exploration of tract characteristics that can explain variation in R_i-gpcd across tracts, which may provide meaningful policy insights.

The model included factors for:

- Proportion of housing in a tract built pre-1979
- Proportion of housing in a tract built between 1980-1999
- Proportion of housing in a tract built after 2000
- Tract median household income
- Proportion of tract population over 65
- Total residential per-capita water use (R-gpcd)

The resulting R_i-gpcd equations were then applied to all other census tracts where customer-level data was not obtained and tract R_i-gpcd were not directly estimated. The predicted tract-level R_i-gpcd could then be rolled up into a statewide average with tract population serving as the weight. Similar to the Strata-Based approach, error terms from the analyzed tract-level data could be carried through to provide confidence intervals for the statewide Baseline. A weakness of the Correlation-Based approach is that there are more assumptions in the equations used to estimate R_i-gpcd. The Correlation-Based approach was also used to produce Supplier-level estimates because mapping of tracts to agency boundaries is known.

2.1.2 Distribution Analysis

Although the customer-level data allowed for use of more robust equations in the Baseline Analysis, the limited sample size of 18 Suppliers meant that the range of statewide tract R_i-gpcd was not well-captured. To better capture the distribution of Supplier R_i-gpcd throughout the State, a simpler disaggregation method and the less robust monthly, aggregated Supplier-level data, reported annually to the Water Board (electronic Annual Report [eAR] data), were used. This allowed the Department to infer R_i-gpcd for 157 Suppliers who had sufficient information for the Distribution Analysis. To predict the 2025 and 2030 distributions, the expected ‘natural’ declines by county were applied to each Supplier’s R_i-gpcd (see Appendix F). This larger set of Supplier R_i-gpcd could then be used to better inform the effect of any standard. Neither the baseline nor the future year projected R_i-gpcd includes any adjustments for effects of potential pandemic, active conservation, or changes in population.

2.1.3 Pilot End-Use

A pilot End-Use study was also conducted within the service area of one study participant to test deployment of a non-invasive, high read-frequency metering device. The pilot study provides a limited verification of the monthly and hourly data disaggregation results that have limited applicability. Only 20 households could be metered and readings did not occur during the same timeframe as the Baseline or Distribution Analysis study data. However, this allowed the Department to compare household water use with tract-level estimates and assess efficacy of expanding the End-Use study to a larger sample. A larger sample from multiple Suppliers would assist in understanding the causes for different household R_i-gpcd and inform how Supplier service area R-gpcd efficiencies could be achieved.

Homes were fitted with a Flume Smart Home Water Monitor device capable of continuously measuring flow at 5-second increments for at least 30 days during July and August 2020. Similar to previous studies using high frequency read meters (see Appendix C), these data were disaggregated into indoor and outdoor residential water use, as well as characterization of specific indoor water uses including the type of water use, flow rate, and duration (e.g., length of showers, flow rates of faucets, etc.). Details of this analysis are described in Appendix C.

2.2 Data

2.2.1. Data Sets and Quality Assurance

Four datasets were used in this study:

1. Five to ten years (2011 - 2020) of total single-family residential **monthly/ bi-monthly** customer-level water use billing data from 18 Suppliers using the methods described in Appendix A - Monthly Analysis. Results from this analysis are used to estimate the baseline statewide R_i-gpcd central tendencies.
2. One year (2019) of total single-family residential customer-level **hourly** water use data from four water Suppliers. Methods for this analysis are described in Appendix B – Hourly (AMI) Analysis. Results from this analysis inform and validate monthly R_i-gpcd single-family and multi-family residential water use disaggregation.
3. Three years (2017, 2018, and 2019) of Supplier-level single-family residential monthly total residential water use data, reported annually to the Water Board (**eAR data**). 157 Suppliers had sufficient data to use for this analysis. Details on the methods are described in Appendix H - Distribution Analysis (eAR Data).
4. 30 days (July/August 2020) of 5-second interval water use data from the pilot **End-Use study** for 20 homes also with AMI water meters. Details are described in Appendix C – Pilot End Use Analysis

All customer-level data was screened for consistency and errors then cross-compared with the different data sets before conducting the disaggregation analysis. This step is important because water use data can be noisy due to the presence of estimated meter reads, erroneous meter reads, extreme meter reads caused by leaks, and missed meter reads. Additionally, billing corrections may result in negative meter reads and input errors can occur when reporting data in the eAR.

Rules to detect and remove suspect customer-level monthly/bi-monthly billing data and hourly data are described in Appendix A and B, respectively. The rules to detect and remove or correct suspect Supplier-level eAR data are described in Appendix H. In some cases, the screening resulted in elimination of a customer or Supplier from the study analysis.

Disaggregation methods were validated by results from the four data sets (customer-level monthly/bi-monthly billing data, hourly AMI data, Supplier-level eAR data, and pilot End-Use study 10-second interval meter read data).

2.2.2 Customer-Level Data for Baseline Central Tendencies Analysis

Monthly billing data from the 18-Suppliers contained 896,000 residential accounts distributed across 699 census tracts (256 tracts were split between one or more Suppliers). The data set included customer-level billing data from January 2011 to June 2020, although not every study participant provided data for the full time period. Four Suppliers also provided hourly AMI data for 2019 from 290,000 residential accounts distributed across 336 census tracts. Additional hourly data from March 2020 was collected from two Suppliers to estimate the COVID-19 shelter-in-place orders’ effect on indoor residential water use. Customer-level meter service points were geocoded if this had not already been provided by the Supplier in order to match the billing data to census tracts.

The disaggregation analysis was conducted primarily on single-family residential accounts to avoid inherent difficulties with multifamily accounts. Ideally, billing data would be paired with household occupancy data to allow direct estimation of residential water use rates (R ¡-gpcd)[17] Therefore, it

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[17] In addition to incomplete coverage, the occupancy data provided by the few utilities that had it included default estimates for most households which limited its usefulness.

was necessary to estimate water use rates by dividing average water use per dwelling by estimates of average household occupancy derived from the Census data. This approach produces a biased estimate of water use rates. A bias correction was therefore applied to the final water use rate estimates. The magnitude of the correction varied by Census tract but was typically less than 1.0 gpcd. Details of the water use rates calculation and bias correction are provided in Appendix A - Monthly Analysis.

2.2.3 Use of Multi-Family Billing Data

Unlike single-family residential, multi-family data provided by the study participants was of poor quality because Suppliers' classification of multi-family accounts does not always align with Census definitions of multi-family housing and Suppliers do not often record the number of dwelling units in a multi-family complex. With single-family accounts, average water use per meter is equivalent to average water use per dwelling, which is used to estimate water use rates per person. Only about one-third of the study participants had sufficient information for estimating multi-family water use rates. However, if single- and multi-family R_i-gpcd are similar, the single-family R_i-gpcd estimates can be used as the statewide estimated R_i-gpcd.

2.2.4 Supplier-Level Data for Distribution Analysis

Data reported to the Water Board by Suppliers for 2017, 2018, and 2019 through the eAR were used for the Supplier-level R_i-gpcd distribution analysis. This included monthly reported total amount of potable water delivered to single-family residential customers, single-family residential service connections, and dedicated irrigation meter monthly water use (see Section 2.3.1, which explains the need for this data). Supplier single-family residential population was reported by Supplier's through the eAR.

The eAR Supplier-level data could only be checked for missing data and obvious reporting errors; but any errors associated with rolling up the data, classification of accounts as residential or non-residential, or small typographical errors in entering data could not be identified. Where data could be fixed (e.g., misreported gallons instead of millions of gallons), adjustments were made. Where data could not be fixed or explained, the Supplier was eliminated from the data set used in the analysis. Over one-half of the Suppliers did not have complete information to conduct the analysis.

2.2.5 Landscape Area and Weather Data

Two of the study's indoor residential water use estimation methods (see Section 2.3.1), Landscape Adjustment Method (LAM) and Rainfall Adjustment Method (RAM), require data on landscape area, rainfall, and air temperature. Landscape area data came from either the study participants or the Department's Residential Landscape Area Measurement Study. Weather data were collected from National Oceanic and Atmospheric Administration (NOAA) weather stations proximate to each service area. Further details on the landscape area and weather data sources are provided in Appendix A – Monthly Analysis.

2.2.6 Pilot End-Use Data

The Department, in collaboration with a Supplier in Northern California, performed a pilot End-Use study with 20 individual customers to verify the hourly and monthly indoor disaggregation methods. Customers' meters were fitted with a non-invasive Flume Smart Home Water Monitor device, which measured flow at 5-second increments for 30 continuous days during July and August 2020. Data collected by the Flume unit was disaggregated into individual end-uses by customer, including toilet flushes, faucet draws, shower, clothes washer cycle, leaks, and others.

The analyses and results from the 20-home sample do not represent the diversity of residential water use within California. The pilot end-use study was performed to prove the usefulness of End-Use analysis in combination with more readily available data sets for future indoor and outdoor water use studies.

2.2.7 Pandemic Effect Data

Before COVID-19, many people worked away from their residences and their work-hours water use are not included in the measured residential water use or in the Baseline Analysis. Additional customer-level data was collected to examine the pandemic Shelter-In-Place orders effect on indoor residential water use.

- Monthly billing data was collected from four of the Suppliers through June 2020 in three cases and through April 2020 in one.

- Hourly data was collected from two Suppliers from January 2020 through March 2020.

2.2.8 Population

Population is one of the most important numbers used in determining water use rates because water use is divided by population to determine the gallons per capita per day (gpcd); a population value that is too high will artificially lower the gpcd and a population value too low, will artificially increase the gpcd. The most defensible population estimates would be from the 2020 U.S. Census, which will not be available at the tract-level until later in 2021.

- **Study Participants and Baseline Central Tendencies Analysis.** The Department's tract estimate R_i-gpcd were calculated for each measured census tract fully within the 18-Suppliers' service areas using tract-level 5-year population estimates from the 2018 ACS. Tract-level 5-year population estimates from the ACS were also used for population-weighted strata, Supplier, and statewide averages.

- **Distribution Analysis.** The R_i-gpcd for informing the distribution was calculated by pairing the number of single-family accounts provided by Suppliers with the average persons per household (pph) from the Suppliers associated City or County 2019 California Department of Finance[18] data or from the U.S. Census' ACS if Department of Finance data was not available.

2.3 Disaggregation Methods

2.3.1 Disaggregation of Customer-level Data for Baseline Central Tendencies Analysis

Indoor residential water use is not directly metered and therefore must be inferred. The monthly data analysis used four different methods to disaggregate indoor from outdoor residential water use by adjusting winter water use for outdoor consumption. However, one was used just for

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[18] State of California, Department of Finance, 2011-2020 with 2010 Census Benchmark. Available at: https://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-5/

informational purposes. The details of each method described below are provided in Appendix A – Monthly Analysis. The analysis also included the simple Minimum-Month method for comparison purposes.

For all methods used, there are strengths and weakness, and situations or local conditions, where one or another will perform better, or where none are quite suitable. Nonetheless, as will be shown in the Results (Section 4.0 and 5.0), all methods provide a similar value for the central tendency indicating that any individual errors are averaged out when applied across a broad scale.

Minimum Winter Month Water Use Method (Minimum-Month or MMM)

Traditionally, the standard approach has been to assume that water use in the minimum winter consumption month is entirely indoor water use (Billings and Jones 2008). However, in California, winter irrigation is common, especially in non-coastal regions of California. Estimates of indoor residential water use based on the winter minimum consumption month will therefore be biased upward unless adjustments are made to remove outdoor water use. This method is not used in the Baseline Analysis and is provided for comparison purposes only.

Seasonal Adjustment Method

The Seasonal Adjustment Method (SAM) uses billing data from dedicated irrigation meters to infer residential winter irrigation water use. The key assumption used in this method is that, for a given location, the seasonality of residential and non-residential irrigation is broadly similar. This identifying assumption is used to infer winter residential irrigation, which is not directly observable, from non-residential irrigation served by dedicated irrigation meters, which is directly observable. Removing the inferred amount of winter irrigation from winter minimum-month consumption provides an estimate of indoor water use. For this analysis, the minimum winter water use month was assumed to be February and the maximum summer water use month was assumed to be August. This is a reasonable approach because monthly billing water use data is not necessarily confined to water used only during a particular month; it depends on when the meters are read. Use of February and August standardizes the dataset and analysis.

Landscape Adjustment Method

The Landscape Adjustment Method (LAM) uses household-level data on irrigated landscape area to infer residential winter irrigation water use. This method relies on the fact that winter irrigation, where it occurs, is directly related to landscape area: more landscape area requires increased winter irrigation and vice versa. A statistical model is used to estimate this relationship while controlling for other factors affecting winter water use. Once this relationship is determined, the statistical model is used to construct a counterfactual[19] prediction of winter water use assuming each household in the sample has zero irrigated landscape area. This counterfactual prediction provides an estimate of indoor water use.

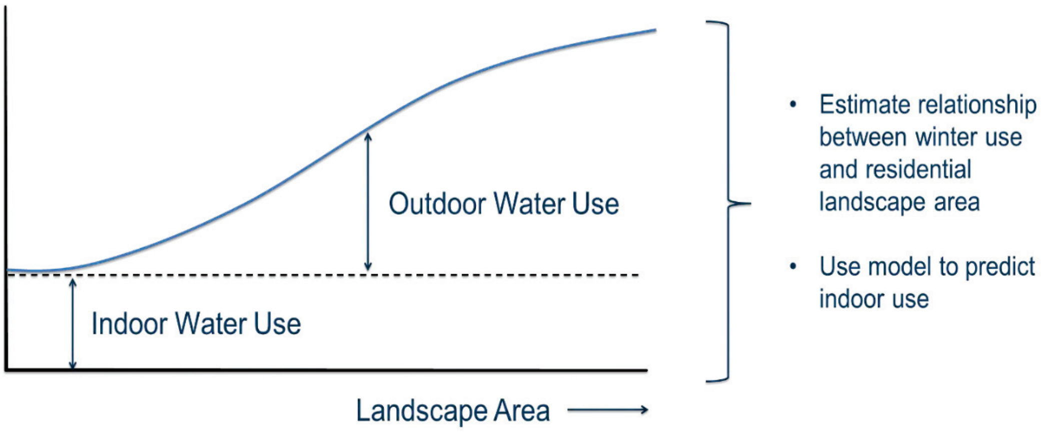

Figure 2.3-1. Description of LAM Indoor Water Use Estimation Strategy

Rainfall Adjustment Method

The Rainfall Adjustment Method (RAM) uses data on rainfall to infer residential winter irrigation water use. This method relies on the fact that winter irrigation is negatively related to rainfall; increases in rainfall reduce or eliminate the need for winter irrigation. A statistical model is used to estimate this relationship while controlling for other factors affecting winter water use. Once the relationship is determined, the statistical model is used to construct a counterfactual prediction of winter water use assuming rainfall

[19] A method of understanding the cause associated with observed result to what you would expect if the effect had not been implemented is known as the “counterfactual.” Estimation is performed with use of a statistical model, such as regression analysis, to answer the question; “If I didn’t have any landscape to irrigate, my total residential water use would be X.”

is at the upper end of its historical range when outdoor water use would be expected to be zero or very close to it. This counterfactual prediction provides an estimate of indoor water use.

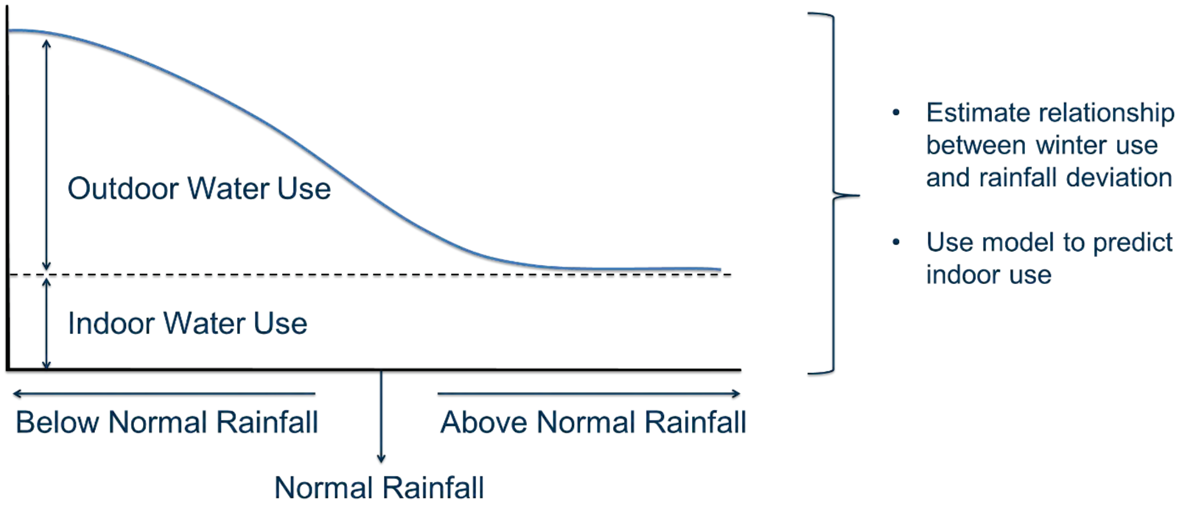

Figure 2.3-2. Description of RAM Indoor Water Use Estimation Strategy

Hourly Data Disaggregation

Four different approaches were used to calculate R_i-gpcd from hourly water consumption data for each single-family residence.

1. **Low Water Use Month: *February Averages.*** These approaches simulate the situation where higher resolution data is unavailable as is the case for Suppliers with only monthly or bi-monthly billing data. However, unlike monthly billing data, the hourly data set allows for exact determination of water use from the beginning of a month to the end of a month and for each day in the month. This method assumes February usage is entirely indoors.
2. **Entire Month of February Average (Month).**[20] The overall average daily usage for February is used as a benchmark for indoor use for all other months in the year after adjusting for the different number of days in each month. Total monthly usage above the adjusted February amount is treated as outdoor water use.

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[20] February is typically the lowest water-use month in California.

3. **Daily February Average (Daily).** Each total daily usage throughout the year is compared to the average daily usage during February. On days where use exceeds the average February daily usage, the portion of use above the threshold is considered outdoor use. This approach will treat some of water use in February as outdoor use (on days where total daily usage exceeds the average).

3. **Numerical Approach:** This approach is based on previous findings that even under congested household water use conditions (multiple appliances or water fixtures running within the same hour of the day), indoor residential water use seldom exceeds 100 gallons per hour (gph) (DeOreo et al 2011). More recent end-use evaluation of 20 efficient homes in the Sacramento Valley from July 2020 revealed a threshold of approximately 45 gph (see Section 3.2). Therefore, this analysis disaggregated indoor from outdoor usage by using a set of thresholds between 45 gph and 100 gph for the maximum indoor water use rate; all hourly water usage above the cutoff is considered outdoor use.

4. **Profile Approach:** In this approach, information at both hourly and daily levels are used, assuming customers will have sets of days where they use water in similar ways. An algorithm groups together each customer's daily usage patterns based on how much water is used at each hour of the day producing a "usage profile." Each usage profile is then assigned one of three labels: Indoor only, Indoor + Outdoor, or Outdoor only. The amount of water used during Indoor only days is then used to disaggregate indoor from outdoor on all other days.

Pilot End-Use Disaggregation

A pilot End-Use study on 20 Sacramento Valley households was conducted to assess the feasibility of deploying an End-Use study and to provide more detailed information to compare disaggregation results via other methods. Data was collected through a non-invasive strap-on meter in combination with machine-learning data analysis to determine specific indoor end uses (e.g., toilet flushing) by household. These high-resolution (5 to 10 second) meter reads are used to separate out water use from individual indoor appliances and fixtures, even with multiple indoor appliances concurrently running, from the total water use[21]. These data can help inform where household efficiency improvements could occur within a Supplier's service area. A discussion on the pilot study and its uses is included in Appendix C – Pilot End Use Analysis.

2.3.2 Disaggregation of Supplier-Level Data for Distribution Analysis

The Seasonal Adjustment Method (as described above in Section 2.3.1) was used to disaggregate total single-family residential water use and obtain the current R_i-gpcd estimate for each Supplier with sufficient data to run the analysis (see Appendix H for details on the analysis). The eAR Supplier-level data does not contain sufficient information to use either the LAM or RAM disaggregation approaches because those require customer-level data. However, for Suppliers that include dedicated irrigation meter account data in their eAR, the SAM method can be used.

Suppliers with data reported for dedicated irrigation meters and with values for 2017, 2018, and 2019 were included in the distribution analysis. Three variations of SAM were applied to the eAR data to estimate R_i-gpcd:

- Variation 1 uses the Single-Family minimum winter and maximum summer month total residential water use.
- Variation 2 uses the dedicated irrigation meters minimum winter month and maximum summer month water use.
- Variation 3 uses February and August as the fixed minimum winter and maximum summer water use months.

Because there is no preponderance of evidence to suggest that one variation is better than the other, the average of all the three variations, for each year (nine total values) was used to estimate baseline R_i-gpcd for each Supplier in the distribution analysis. For some Suppliers, one or more variations did not work and those Suppliers were excluded from the analysis. See Appendix H for more detail.

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[21]Water Research Foundation. 2016. Residential End Uses of Water, Version 2; Aquacraft. 2011. California Single Family Water Use Efficiency Study Final Report. Sponsored by DWR; Mayer, P, et al. 1999. Residential End Uses of Water. Sponsored by AWWA Research Foundation.

The distribution analysis also considered characteristics known to affect R_i-gpcd as identified in the baseline analysis (median household income, population over 65, and age of housing stock), along with hydrologic region and climate region that may affect R_i-gpcd but were not included in the baseline analysis factors.

2025 and 2030 Projected R_i-gpcd

Indoor residential water use was also estimated for 2025 and 2030, by Supplier, to provide a basis for evaluating longer-term indoor residential water use standards. An analysis prepared for the Department and Water Board (Mitchell, 2016) provided county-level estimates of the percent reduction in indoor residential water use based on implementation of current building and plumbing code requirements, housing stock sales, and new development (refer to the analysis report in Appendix F).

Current plumbing code requires use of water efficient shower heads, faucets, and toilets for all new development and for re-sale of existing housing stock. Additionally, all new fixtures and appliances must meet certain water efficient metrics in order to be sold in California.[22,23] As fixtures and appliances wear down and are replaced, they can be expected to be replaced with more water efficient ones.[24]

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[22] AB 715, enacted in 2007, requires that any toilet or urinal sold or installed in California on or after January 1, 2014 cannot have a flush rating exceeding 1.28 and 0.5 gallons per flush, respectively. On April 8, 2015, in response to the Governor's Emergency Drought Response Executive Order (EO B-29-15), the California Energy Commission approved new standards for urinals requiring that they not consume more than 0.125 gallons per flush, 75% less than the standard set by AB 715.

[23] Water use standards for residential and commercial clothes washers and dishwashers are established by the U.S. Department of Energy through its authority under the federal Energy Policy and Conservation Act.

[24] SB 407, enacted in 2009, mandates that all buildings in California come up to current State plumbing fixture standards within this decade. For single-family residential property, the compliance date is January 1, 2017. For multi-family and commercial property, it is January 1, 2019. This law establishes

3.0 STUDY PARTICIPANTS' RESULTS

The basis for the statewide central tendencies analyses is the results from the 18-Supplier customer-level data summarized in this section. Individual customer-level R_i-gpcd were averaged for each tract completely within the 18-Suppliers service areas. The determination of R_i-gpcd estimates assumed a set number of people per household (customer account) based on ACS 5-year population estimates; the best available population estimates are at the tract level. Household water use estimates are not shown because of the Non Disclosure Agreement (NDA) and the extreme variability in household population which directly affect gpcd estimates. Because of the extreme variability in individual household population over time, there is over- and under-counting of individual household population and consequently, over- and under-estimates of individual household water use. When water use of all the households are averaged at the tract level, the variability associated with household population is reduced. Based on this observation, the smallest representative unit of household water use that can be confidently reported is at the tract level and therefore tract level estimates are used to determine the baseline.

3.1 Monthly Data Analysis

R_i-gpcd results from the 18-Suppliers span the years 2011-2019. For comparison purposes, the results were binned into four water use condition periods[25]:

- Pre-Drought (2011-2013)

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requirements that residential and commercial property built and available for use on or before January 1, 1994 replace plumbing fixtures that are not water conserving, defined as "noncompliant plumbing fixtures" as follows:

- Any toilet manufactured to use more than 1.6 gallons of water per flush;
- Any urinal manufactured to use more than 1.0 gallon of water per flush;
- Any showerhead manufactured to have a flow capacity of more than 2.5 gallons of water per minute; and
- Any interior faucet that emits more than 2.2 gallons of water per minute.

[25] There is a lag-time between when the drought began and Suppliers' customer water-use response to the drought. Therefore, the pre-drought water use conditions extended into the first couple of drought years.

- Voluntary 20% Conservation Executive Order (2014)
- State Conservation Reduction (2015-2016)
- Post-Drought (2017-2019)

Table 3.1-1 provides summary statistics of the single-family results for each period. The Minimum-Month Method (MMM) results are included only for comparison because this method is often used to estimate indoor residential water use. The MMM results are not further used in the study analysis or discussion.

Three important points to note are:

1. These results are not the statewide estimates of indoor residential gpcd, which are presented in Section 4.0, but are presented as a comparison of the R_i-gpcd summary estimates for the sampled census tracts.
2. Not every one of the 18 Suppliers was able to provide billing data for the 2011-2016 period. The estimates for the earlier periods cover fewer census tracts and thus provide less geographic coverage than the estimates for the Post-Drought period.

The Post-Drought period (2017-2019) data was used for estimating current indoor residential water use because it is most proximate to the present day and it has the broadest geographic coverage without being confounded by the water use restrictions in place during the drought. Data from other periods informed the LAM and RAM analysis, which control for potential external factors.

Table 3.1-1. Study Participant's Single-Family R_i-gpcd Estimates by Method for 2011-2019 Time Period
†MMM results are presented for comparison only.

Time Period	***No. of Tracts *****	**MMM† Mean* *gpcd***	**MMM† Median *gpcd***	**SAM Mean* gpcd**	**SAM Median gpcd**	**LAM Mean* gpcd**	**LAM Median gpcd**	**RAM Mean* *gpcd***	**RAM Median *gpcd***
Pre-Drought (2011-2013)	*340*	79.0 (4.0)	73.9	54.0 (3.4)	49.0	64.9 (2.9)	62.1	63.2 (2.9)	57.9
Voluntary 20% Reduction (2014)	*401*	83.3 (4.6)	74.8	56.5 (4.3)	52.1	63.2 (2.6)	57.6	61.0 (2.6)	55.2
Required Reduction (2015-2016)	*508*	58.4 (4.8)	51.0	47.4 (5.2)	44.3	54.6 (3.3)	46.4	52.4 (3.1)	46.0
Post-Drought (2017-2019)	*699*	63.9 (4.5)	58.7	52.4 (3.8)	50.2	52.2 (3.2)	48.0	52.4 (3.1)	48.4
All Years Average (2011-2019)		71.8 (4.5)	66.3	52.7 (4.1)	49.9	55.7 (3.1)	50.5	55.1 (3.0)	49.9

*Value in parenthesis is the standard error associated with R_i-gpcd estimate average (mean)

Where MMM = Minimum-Month Method, SAM = Seasonal Adjustment Method, LAM = Landscape Adjustment Method, RAM = Rainfall Adjustment Method.

**Not all suppliers had data for all years

Because customer-level data was used, margins of error could be calculated for the tract-level averages and applied to the statewide averages. The details of the margin of error calculation (Table 3.1-1) are summarized in Appendix G. The margin of error indicates how much the estimate may differ from the true value. The magnitude of the margin of error varies by census tract, but typically is on the order of +/- 8 percent.[26]

There is substantial variation in tract-level R_i-gpcd, regardless of estimation method used. This variation is illustrated in Figure 3.1-1, which shows box and whisker plots of the estimated R_i-gpcd for the Post-Drought period (current conditions). The width of each box shows the range between the 25th and 75th percentile estimates, while the belt through the interior of each box shows the median (50th-percentile) estimate for sampled census tracts (also shown in Table 3.1-1)[27]. The whiskers on either side of each box show the full range of the results, excluding outliers. Roughly, this range is from 20 to 80 gpcd with approximately two-thirds of the estimates falling between 40 and 60 R_i-gpcd. The 18-Supplier estimate of R_i-gpcd centers on 52 gpcd.

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[26] The margin of error is based on a 90% level of statistical confidence, meaning that, under repeated sampling, the interval defined by the margin of error would be expected to contain the true population value 90% of the time. This is the same level of statistical confidence used by the Census Bureau for margins of error attached to published American Community Survey estimates.

[27] The 25th percentile means that 25% of the tract average R_i -gpcd fell below that value; the 50th percentile means that 50% of tract average R_i -gpcd are above that value and 50% are below that value; the 75th percentile means that 25% of tract average R_i -gpcd values are above that value.

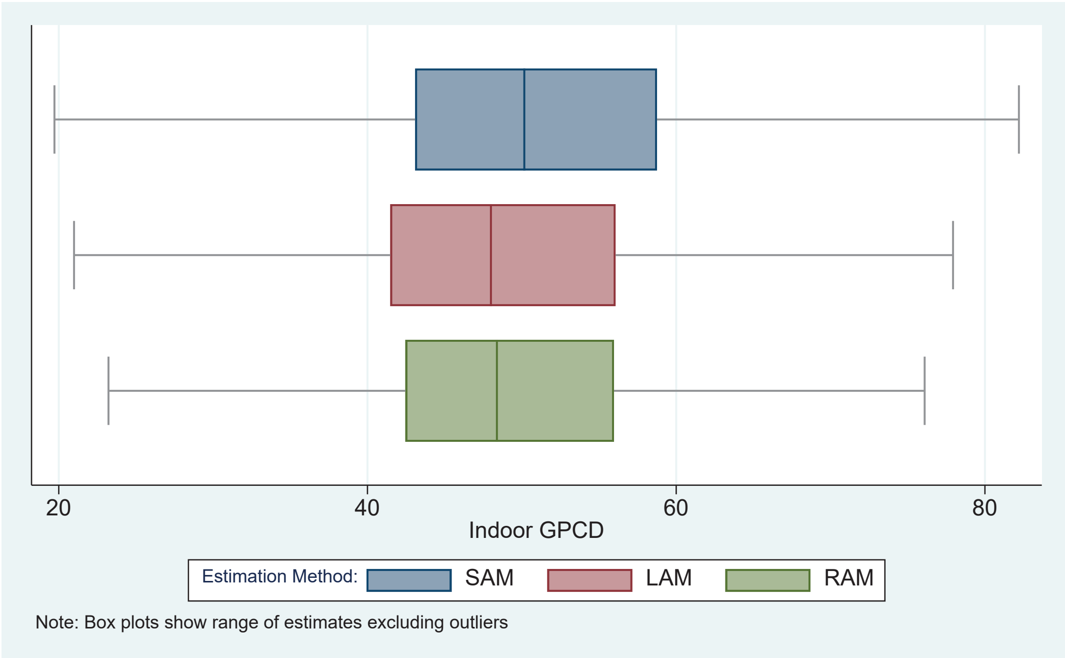

Figure 3.1-1. Distribution of 18-Supplier Tract Average Ri-gpcd

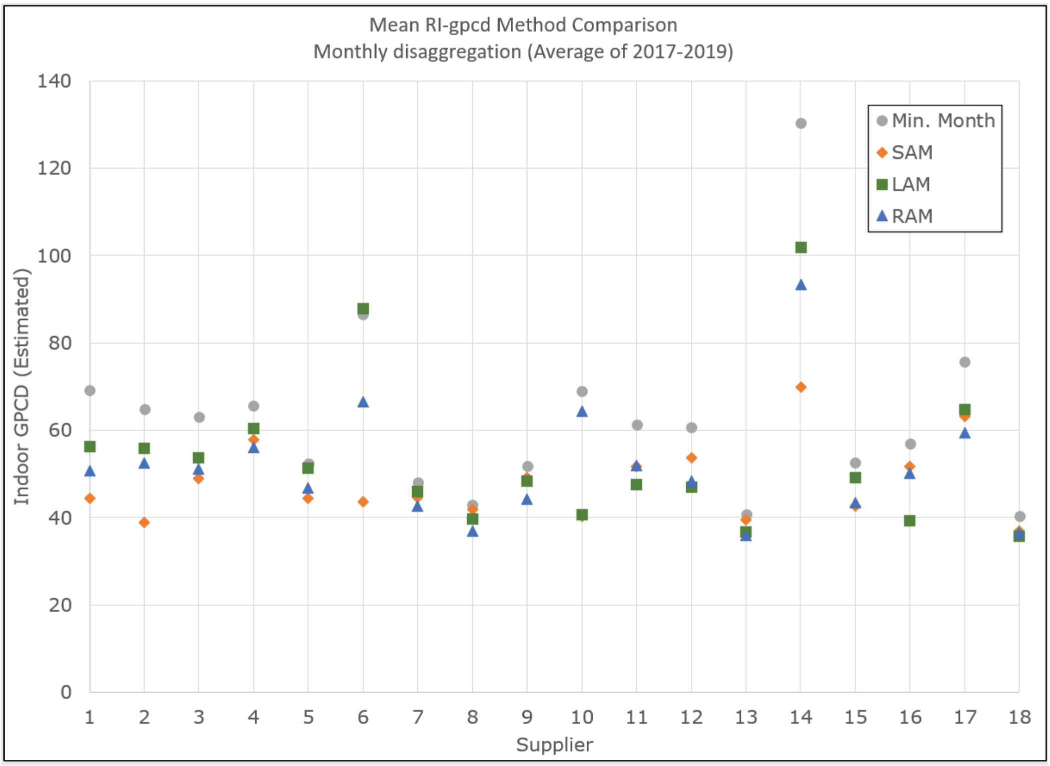

Figure 3.1-2. Study Participants' Results of All Monthly Disaggregation Analysis.

3.2 Hourly Data Analysis

A summary of hourly single-family R_i-gpcd estimates from 2019 is shown in Table 3.2-1. Suppliers participating in the hourly analysis were from geographically and demographically diverse locations. Results from single-family customers also indicate variation in indoor water usage between summer and winter in two of the communities studied, with more water being used during summer months. Potential explanations include unobserved increases in occupancy (e.g., children home from school) or behavioral factors (e.g., use of swamp coolers).

Table 3.2-1a. Hourly Data R_i-gpcd: Daily February Average and Month of February Average Approaches

Supplier	Daily February Average* gpcd	Month of February Average* gpcd
1	41.6 (5.5)	44.3 (6.4)
2	56.2 (5.0)	56.0 (5.5)
3	36.4 (6.1)	38.5 (6.3)
4	48.0 (8.4)	52.6 (9.6)

*Where value in parenthesis is the standard error

Table 3.2-1b. Hourly Data R_i-gpcd: Threshold Approaches

Supplier	45 gph* gpcd	75 gph* gpcd	100 gph* gpcd
1	34.8 (4.8)	43.8 (5.8)	47.5 (6.2)
2	44.9 (4.8)	56.5 (5.5)	62.1 (6.4)
3	35.7 (5.5)	41.7 (6.5)	44.3 (7.0)
4	43.8 (7.3)	54.5 (9.0)	59.0 (10.0)

*Where value in parenthesis is the standard error

Table 3.2-1c. Hourly Data R_i-gpcd: Profile Approaches

Supplier	No Leak Filter* gpcd	Leak Filter* gpcd
1	45.6 (5.9)	44.5 (5.6)
2	57.8 (5.8)	51.9 (5.3)
3	41.5 (6.4)	40.6 (6.0)
4	55.7 (9.2)	49.7 (7.2)

*Where value in parenthesis is the standard error

Except for Supplier 2, the Daily February Average method resulted in a lower estimate of R_i-gpcd compared to the Month of February Average method.

For all four Suppliers, the Month of February Average, 75 gph Threshold, and Profile (no leak filter) Approaches produced similar R_i-gpcd estimates. In principle, the 100 gph approach approximates an estimated upper-bound indoor residential water use (based on the sum of all indoor appliances and fixtures being in use at the same time) and the 45 gph estimate provides a lower bound estimate (based on our small sample observation of efficient homes from the Pilot End Use Study). The 75 gph reflects a more middle ground hourly cutoff. The estimate from the 75 gph lines up the best with the Threshold approaches that looks for structural breaks in the hourly data, indicating these service areas are likely an even mix of high and low Ri-gpcd households or that most households gpcd are "middle of the road".

3.3 Methods Comparison

Figure 3.3-1 and Table 3.3-1 show results from all customer-level data analyses. Monthly results are an average of 2017, 2018, and 2019; hourly results are from 2019; and the Pilot End-Use Study results are from 20 customers for the month of July and August 2020.

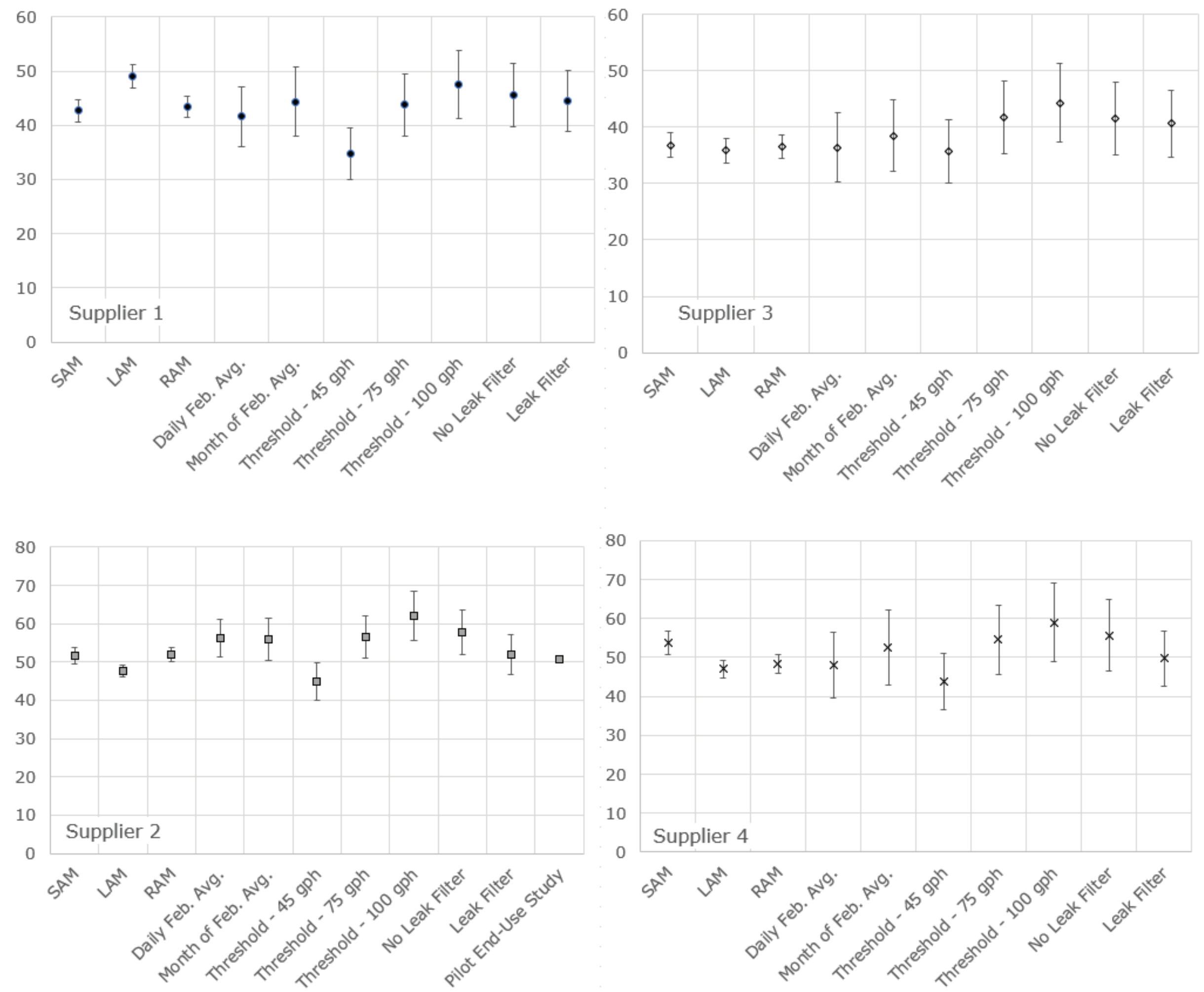

Figure 3.3-1. Comparison of Disaggregation Method R_i-gpcd Using 2017-2019 Tract Aggregated Customer-level Monthly Billing Data and Hourly AMI Data, and 20 Customer Pilot End Use Study Data.

Table 3.3-1. Comparison of Disaggregation Method R_i-gpcd Using 2017-2019 Tract Aggregated Customer-level Monthly Billing Data and Hourly AMI Data, and 20 Customer Pilot End Use Study Data.

Type of Data	Disaggregation Method	Supplier 1	Supplier 2	Supplier 3	Supplier 4
Monthly / Bi-Monthly	SAM[a]	51 (2.1)	39 (2.1)	48 (2.2)	60 (3.0)
Monthly/ Bi-Monthly	LAM[a]	47 (1.6)	42 (2.2)	43 (2.1)	64 (2.3)
Monthly / Bi-Monthly	RAM[a]	52 (1.8)	38 (2.0)	43 (2.2)	63 (2.4)
Hourly	Daily February Average[b]	41.6 (5.5)	56.2 (5.0)	36.4 (6.1)	48 (8.4)
Hourly	Month of February Average[b]	44.3 (6.4)	56 (5.5)	38.5 (6.3)	52.6 (9.6)
Hourly	Threshold - 45 gph[b]	34.8 (4.8)	44.9 (4.8)	35.7 (5.5)	43.8 (7.3)
Hourly	Threshold - 75 gph[b]	43.8 (5.5)	56.5 (5.5)	41.7 (6.5)	54.5 (9.0)
Hourly	Threshold - 100 gph[b]	47.5 (6.4)	62.1 (6.2)	44.3 (7.0)	59 (10.0)
Hourly	No Leak Filter[b]	45.6 (5.8)	57.8 (5.9)	41.5 (6.4)	55.7 (9.2)
Hourly	Leak Filter[b]	44.5 (5.3)	51.9 (5.6)	40.6 (6.0)	49.7 (7.2)
End Use	End Use Algorithms[c]	NA	50.8	NA	NA

a – average of 2017 to 2019, b – 2019 data only, c – July/August 2020, n=20 accounts; Value in parenthesis is Standard Error

Based on these limited results, the hourly disaggregation analyses may provide more reasonable values for Suppliers with high (Supplier 4) or low (Supplier 2) R_i-gpcd compared to using the monthly methods. However, the sample size is too limited and other factors such as geographic location or demographic characteristics may account for the differences.

3.4 Pandemic Effect Results

Table 3.4-1 shows the pandemic shelter-in-place order effects on indoor residential water use for six Suppliers. This approximately 3-5 gpcd increase in R_i-gpcd is roughly equivalent to about two to three extra toilet flushes per person. Extra toilet flushing may explain most of the observed increase in indoor residential water use. This is consistent with the pilot End-Use Study conducted during July and August 2020 that measured an average toilet flush rate of three more flushes per person per day than has been recorded in previous End-Use studies.[28]

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[28] See Mayer et al. (1998), Mayer et al. (2011), and Mayer et al. (2016).

Table 3.4-1. Increase in Single-Family Indoor Residential Water Use Following Pandemic Shelter-in-Place Orders

Supplier	**Analysis *Monthly or Hourly***	**Per Household *gpd***	**Per Person *Ri-gpcd***
Coachella Valley WD	Monthly	7.2 (1.1)	3.0
Eastern MWD	Monthly	11.1 (0.3)	2.9
CWS S. San Francisco	Monthly	12.6 (1.4)	3.7
CWS Livermore	Monthly	35.9 (2.9)	12.2
Redwood City	Hourly	8.8 (0.9)	3.1
City of Folsom	Hourly	13.3 (1.3)	4.5
Mean Effect	All	NA	*4.9*
Excluding Livermore	All	NA	3.4

*Standard error of estimate in parentheses

3.5 Multi-Family Residential

To inform whether the statewide R_i-gpcd could be represented by single-family residential (SFR) water use, the disaggregation analysis was performed for several Suppliers with sufficient multi-family residential (MFR) monthly and hourly customer-level data.

3.5.1 Monthly Analysis MFR R_i-gpcd

Table 3.5-1 demonstrates the variability and similarity between multi-family and single-family residential R_i-gpcd for all four disaggregation methods. In some cases multi-family residential R_i-gpcd is higher than single-family residential and in some cases it is lower, depending on the Supplier and on the method used. In general, though, the R_i-gpcd standard errors for the MFR were greater than those for SFR, which is to be expected because of the potential for greater variability in the MFR sector (e.g., with or without on-site laundry) and the difficulty in obtaining good data to disaggregate (e.g., number of occupied units).

In addition to incomplete MFR account information and data, the occupancy data provided by the few Suppliers that had MFR information included default estimates for most households which limited its usefulness. A comparative analysis of five Suppliers with sufficient data indicated an approximate equivalency in four of the five Suppliers for which both MFR and SFR estimates of R_i-gcpd could be developed.

For the overall multi-family sample, the mean estimate of indoor residential water use is 49 gpcd with the SAM and RAM methods and 50 gpcd with the LAM method. The median estimate is 48 gpcd with the SAM and LAM method and 46 gpcd with the RAM method.

- Multi-family **SAM** analysis showed weaker correlations than the SFR analysis but tell a story similar to SFR R_i-gpcd in terms of which factors are stronger predictors and which factors are weaker predictors of variation in R_i-gpcd (refer to section 2.1.1 for SFR R_i-gpcd factors). This indicates the reasonableness of using SFR as a proxy to describe all residential R_i-gpcd.

- The **RAM** analysis did not work well with MFR data because of the extreme variability in types of multi-family account: e.g., multifamily accounts can include small 2-4-unit master-metered properties as well as much larger master-metered properties.

- A **sensitivity analysis** confirmed the ability to use SFR R_i-gpcd as a surrogate for all residential R_i-gpcd. Assuming that multi-family R_i-gpcd is 10% higher than corresponding SFR R_i-gpcd in each tract, the statewide average would increase by 1.2 R_i-gpcd compared to assuming single-family and multifamily have the same R_i-gpcd. If MFR R_i-gpcd is 10% lower, the statewide average drops by 1.2 gpcd (Statewide baseline estimates are discussed in Section 4.0). This increase or decrease is close to the margins of errors associated with each estimation method.

Table 3.5-1. Monthly Data Analysis Average of 2017-2019 Multi-Family Residential (MFR) R_i-gpcd Compared to Single-Family Residential (SFR) for Five Suppliers

Supplier	**MMM MFR *gpcd***	**MMM SFR *gpcd***	**SAM MFR *gpcd***	**SAM SFR *gpcd***	**LAM MFR *gpcd***	**LAM SFR *gpcd***	**RAM MFR *gpcd***	**RAM SFR *gpcd***
Sac River	63 (5.9)	61 (3.3)	60 (5.6)	54 (3.0)	64 (5.0)	47 (2.3)	63 (4.9)	49 (2.4)
C. Coast	42 (3.9)	40 (2.5)	41 (3.7)	39 (1.0)	39 (3.1)	36 (0.9)	38 (3.1)	35 (1.0)
S. Coast	45 (5.8)	54 (2.4)	39 (6.1)	48 (2.1)	42 (2.1)	50 (2.2)	38 (2.0)	44 (2.0)
S. Coast	50 (3.4)	60 (2.7)	50 (3.5)	61 (2.5)	49 (2.9)	40 (1.8)	48 (2.9)	52 (2.4)
SF Bay	49 (6.7)	44 (2.4)	48 (6.8)	39 (2.2)	43 (3.3)	39 (2.1)	43 (3.3)	40 (2.2)
All	**54 (5.2)**	**56 (2.7)**	**50 (5.2)**	**48 (2.5)**	**53 (3.6)**	**45(2.1)**	**52 (3.6)**	**47 (2.2)**

* Value in parenthesis = standard error

3.5.2 Hourly Analysis MFR R_i-gpcd

The Month of February (Low Water Use Month) and Profile methods, described in Section 3.2, were used to disaggregate R_i-gpcd for multi-family residential. A summary of multi-family R_i-gpcd estimates are shown in Table 3.5-2 below.

Table 3.5-2. Hourly Data Analysis of 2019 Multi-Family Residential (MFR) R_i-gpcd* Compared to Single-Family Residential (SFR) For Three Suppliers.

Supplier	Average Day MFR, *gpcd*	Average Day SFR, *gpcd*	Calendar Month MFR, *gpcd*	Calendar Month SFR, *gpcd*	Profile No Leak Filter MFR, *gpcd*	Profile No Leak Filter SFR, *gpcd*
S. Coast	50.3 (30.5)	41.6 (5.5)	51.9 (32.5)	44.3 (6.4)	42.3 (35.4)	45.6 (5.9)
SF Bay	42.8 (10.2)	36.4 (6.1)	43.4 (11.9)	38.5 (6.3)	40.5 (18.0)	41.5 (6.4)
Sac River	60.3 (28.6)	48.0 (8.4)	62.4 (29.8)	52.6 (9.6)	43.6 (31.1)	55.7 (9.2)

*Values in parentheses are standard error

Each of these methods makes different assumptions to estimate indoor residential water use. All of the different hourly disaggregation methods for estimating indoor residential water use produces consistent, reasonable estimates for both MFR and SFR. This independently confirms the monthly disaggregation conclusion of inferring MFR R_i-gpcd with SFR R_i-gpcd.

4.0 BASELINE CENTRAL TENDENCIES RESULTS

The two analyses using the tract level estimates of R_i-gpcd were the Strata-Based and Correlation-Based analyses (refer to Section 2.1 for an explanation of these methods).

These analyses were conducted using only single-family residential customers data; as noted above, single-family and multi-family R_i-gpcd are comparable (see Section 3.5) and population estimates and water use data associated with single-family residential are more complete allowing for a better disaggregation and determination of R_i-gpcd.

Both the Strata-Based and Correlation-Based estimates produce good statewide averages and comparable results. The Strata-Based estimates may be more reliable because fewer assumptions are used. The Correlation-Based estimate is much more data-intensive and the results are limited by the constraints of the study scope. However, the Correlation-Based estimates confirm use of the factors classifying each strata.

Comparison between the Strata-Based and Correlation-Based Baseline central tendencies indicate agreement by all five analysis that are within the margins of error of each. The Correlation-Based confidence intervals are tighter than the Strata-Based statewide aggregation because more information is used to develop the Correlation-Based tract level predictions. The differences across approaches and methods are small, suggesting that current R_i-gpcd statewide average is within the range of 49-52 gpcd.

4.1 Strata-Based Estimates

Tract-level estimates were developed from SFR customer-level billing histories using the four monthly disaggregation methods. Statewide Baseline results in the Strata-Based Approach are presented in Table 4.1-1. These averages were developed from 453 census tracts wholly within the service areas of 18 Suppliers that were selected to represent the statewide diversity. Section 2.1.1 describes the methodology used for aggregating tract-level estimates up to the state level.

Strata-Based Analysis provides Tract-Level R_i-gpcd that can be rolled up to a statewide average. Strata-Based results and analysis presented in this report are for the tract-level aggregated R_i-gpcd that are further summarized on a statewide basis.

Table 4.1-1. Strata-Based Statewide Baseline: Tract-Level R_i-gpcd Estimates (Average of 2017-2019).

Method	Average R_i-gpcd	95% Confidence Interval
MMM	62.5	± 1.9
SAM	49.5	± 1.0
LAM	52.2	± 1.6
RAM	51.5	± 1.4

As noted in Section 3.1, the 2017-2019 years appear to be least affected by the 2012-2016 drought and are the most representative of California's current R_i-gpcd.

The MMM results are included for informational purposes only and will not be discussed further. It is included because the MMM is often used to estimate indoor residential water use, however the MMM analysis does not remove winter irrigation and can overestimate indoor water use, especially where winter irrigation is quite significant, such as in Southern California.

4.2. Correlation-Based Estimates

Correlation-Based estimates provide Tract-Level R_i-gpcd that can be aggregated at the Supplier or statewide levels. Correlation-Based results and analysis presented in this report are for the Supplier aggregated R_i-gpcd that are further summarized on a statewide basis.

Table 4.2-1 shows the Baseline statewide R_i-gpcd estimated using the Correlation-Based Approach. The SAM and RAM Correlation-Based R_i-gpcd estimates for 384 Suppliers does well predicting the central tendency of statewide average R_i-gpcd. The median R_i-gpcd using SAM disaggregation process is 50.1 gpcd and the median for the RAM disaggregation process is 49.8 gpcd. However, the distribution is tightly clustered for both with a standard deviation of 2.6 and 5.6 gpcd, respectively.

Table 4.2-1. Correlation-Based Statewide Baseline: Supplier Aggregated R_i-gpcd Estimates (Average of 2017 to 2019).

Method	Average R_i-gpcd	95% Confidence Interval
SAM	50.5	± 0.26
LAM	50.9	-
RAM	50.7	± 0.23

Table 4.2-1 does not show results for the Minimum Month Method as described before.

Correlation-Based Analysis comparison of disaggregation methods are:

- **SAM.** The SAM estimate has limited ability to explain the characteristics of indoor residential water use because SAM R_i-gpcd tract estimates tightly cluster near the mean. This means that SAM poorly represents the tails of the R_i-gpcd distribution. However, the Correlation-Based SAM estimate detected both a post-2000 housing effect and population over 65 years old effect. The tight R_i-gpcd clustering and the ability to detect only the post-2000 housing effect and population over 65 effect indicates that the Correlation-Based SAM estimate can explain some factors associated with indoor residential water use but has limitations.

- **LAM.** The LAM estimate produces the least desirable result because it does not detect a post-2000 housing effect or income effect. Additionally, the LAM estimate has the largest effect from total residential water use, compared to the other methods, which indicates LAM did not separate out the outdoor water use from total water use as well as the other methods.

- **RAM.** The RAM estimate performed the best (highest R-square, coefficients are reasonable and significant) of the three Correlation-

Based estimates. The RAM estimate detected significant effects for all three factors: population over 65, housing built after 2000, and median household income. Only under the RAM estimate does the impact of income appear statistically significant. The coefficient associated with the RAM estimate for household income suggests that for every $10,000 increase in tract household income, R_i-gpcd rises by 0.3 gpcd, a relatively weak but significant effect.

The SAM estimate produces reasonable and significant model/equation coefficients, but the model's explanatory power is lower when compared with the RAM estimate. Overall, the Correlation-Based SAM estimate is good for estimating a statewide average and the RAM estimate does a better job capturing the tails of the R_i-gpcd distribution.

However, none of the three Correlation-based estimates are able to robustly characterize the tails (high and low R_i-gpcd values) of the distribution and all demonstrated a low R-squared value. Only the SAM disaggregation could be used for the Distribution Analysis because of dataset limitations. Refer to Appendix G.

4.3 Factors Influencing Variation in R_i-gpcd Across Tracts

Regression models were used to explore which factors influence variation in R_i-gpcd across the 453 census tracts selected to represent California. Effects of tract characteristics, obtained from the Census (housing stock age, median household income, and tract population over-65 years in age), on tract-level R_i-gpcd was determined for the SAM and RAM disaggregated data from single-family residential accounts.

- **Population Over 65 Correlated With <u>Higher</u> R_i-gpcd.** The models detect a strong, significant effect of the percentage of over-65 population on R_i-gpcd. For every 10% increase in the over-65 population proportion, R_i-gpcd increases by approximately 3-5 gpcd. For example, tracts with 60% of the population over 65 can be expected to have 15-25 gpcd higher indoor per-capita use than tracts where only 10 percent of the population is over-65 years of age, with all other factors being equal.

- **Housing Built After 2000 Correlated With <u>Lower</u> R_i-gpcd.** Post-2000 households are expected to be associated with more efficient indoor use. Both the Correlation-Based SAM and RAM estimates confirm that hypotheses, while the LAM estimate does not, which reduced confidence in using the LAM estimate for current statewide R_i-gpcd.

The proportion of post-2000 housing in a tract is a statistically significant predictor of lower R_i-gpcd. However, no water use efficiency gradient is detectable within housing stock constructed prior to 2000.

- Tracts with all housing built after 2000 have an R_i-gpcd that is 5-6 gpcd below tracts, where all housing was constructed prior to year 2000, with all other constraints being equal.

- There is no statistically significant difference between homes built between 1980-1999 and those built prior to 1980. Older housing stock is subject to similar influences due to updates in plumbing codes, appliance efficiency standards, and agency-sponsored incentive programs starting from the early 1990s causing water use efficiency levels for households to increase at roughly the same rate.

- **Median Household Income Weak Correlation With Higher R_i-gpcd.** Median household income has a weak, but positive effect on R_i-gpcd. For every $10,000 increase in median household income, per-capita indoor water use increases by roughly 0.3 gpcd.

4.4 Multi-Family versus Single Family Tract Level Estimates using SAM and RAM

Multi-family estimates could only be generated from a smaller subset of tracts than the number of tracts used in the Single Family indoor residential estimates. Multi-family data was not used from the eAR data. Because of the limitations of multi-family data described in Section 3.5, there is limited utility in including multi-family R_i-gpcd estimates in the statewide indoor residential estimates. The limited multi-family data R_i-gpcd tract level estimates are approximately similar to single-family indoor residential tract level estimates with the SAM and RAM approaches as shown in Figure 4.4-1 and Figure 4.4-2.

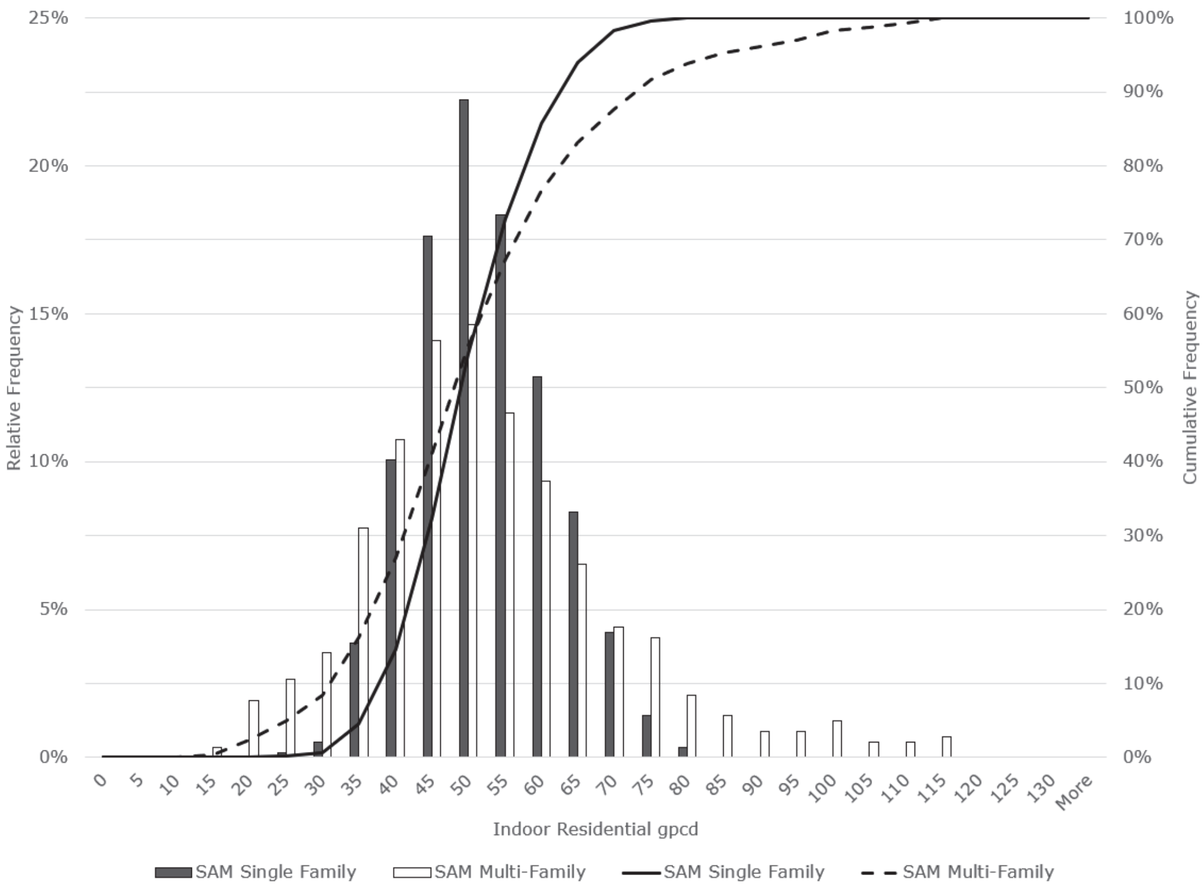

Figure 4.4-1. Single Family compared to Multi-Family: **SAM** Tract R_i-gpcd Estimates

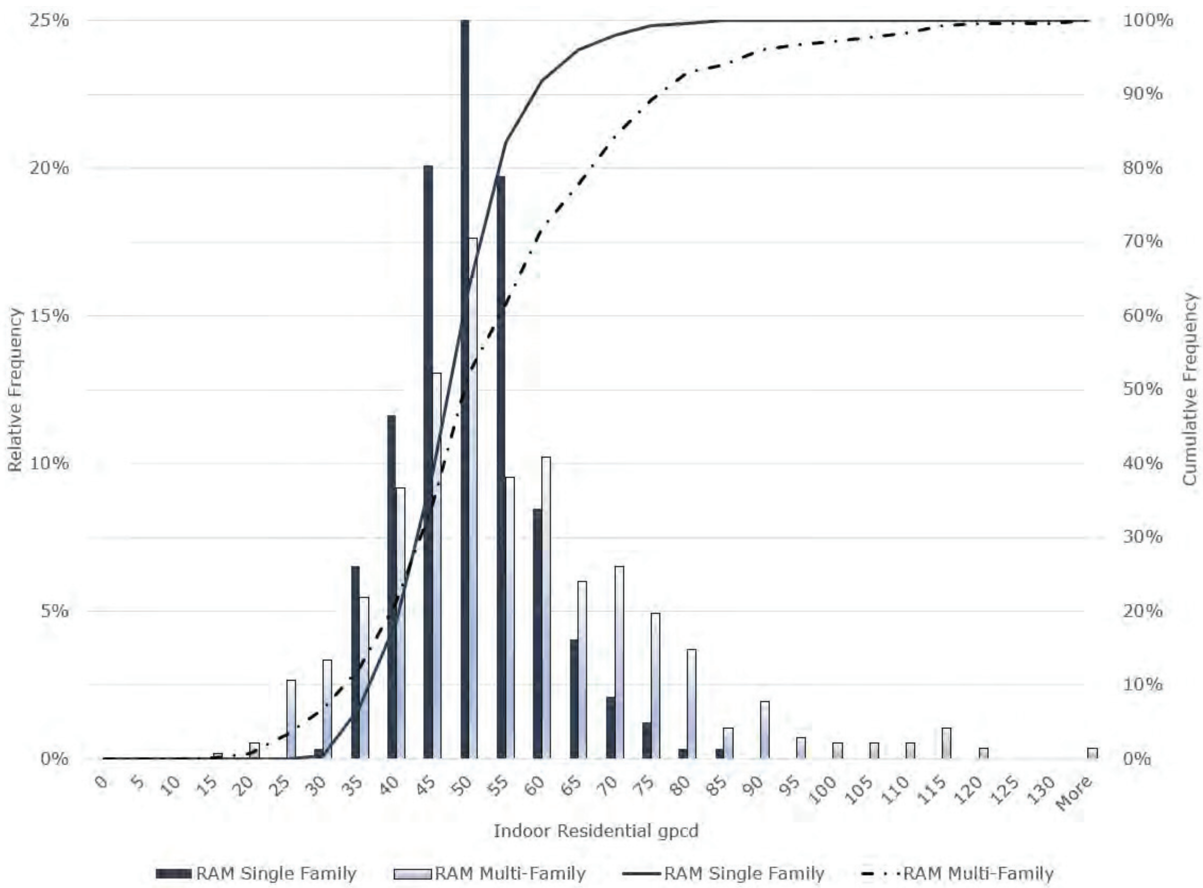

Figure 4.4-2. Single Family compared to Multi-Family: **RAM** Tract R_i-gpcd Estimates

Table 4.4-1. SAM and RAM Single-Family versus Multi-Family Tracts by R_i-gpcd

Hydrologic Region	**MMM MFR*** *(R_i-gpcd)*	**MMM SFR*** *(R_i-gpcd)*	**SAM MFR *** *(R_i-gpcd)*	**SAM SFR*** *(R_i-gpcd)*	**LAM MFR*** *(R_i-gpcd)*	**LAM SFR*** *(R_i-gpcd)*	**RAM MFR*** *(R_i-gpcd)*	**RAM SFR*** *(R_i-gpcd)*
Sac River	63 (5.9)	61 (3.3)	60 (5.6)	54 (3.0)	64 (5.0)	47 (2.3)	63 (4.9)	49 (2.4)
C. Coast	42 (3.9)	40 (2.5)	41 (3.7)	39 (1.0)	39 (3.1)	36 (0.9)	38 (3.1)	35 (1.0)
S. Coast	45 (5.8)	54 (2.4)	39 (6.1)	48 (2.1)	42 (2.1)	50 (2.2)	38 (2.0)	44 (2.0)
S. Coast	50 (3.4)	60 (2.7)	50 (3.5)	61 (2.5)	49 (2.9)	40 (1.8)	48 (2.9)	52 (2.4)
SF Bay	49 (6.7)	44 (2.4)	48 (6.8)	39 (2.2)	43 (3.3)	39 (2.1)	43 (3.3)	40 (2.2)
Average	**54 (5.2)**	**56 (2.7)**	**50 (5.2)**	**48 (2.5)**	**53 (3.6)**	**45(2.1)**	**52 (3.6)**	**47 (2.2)**

*Standard Error in parenthesis, values are average of 2017 to 2019 data

5.0 DISTRIBUTION ANALYSIS RESULTS

The current condition distribution of Supplier R_i-gpcd in California is represented by the 157 Suppliers in this study and shown in Figure 5-1. These values represent an average of 2017, 2018, and 2019 SAM analysis of Supplier-level (eAR) data. The distribution is slightly skewed to the lower end with some Suppliers showing extreme values. Extreme values may be artifacts of the analysis, data, or indicate unique water use that may be subject to variance[29] conditions.

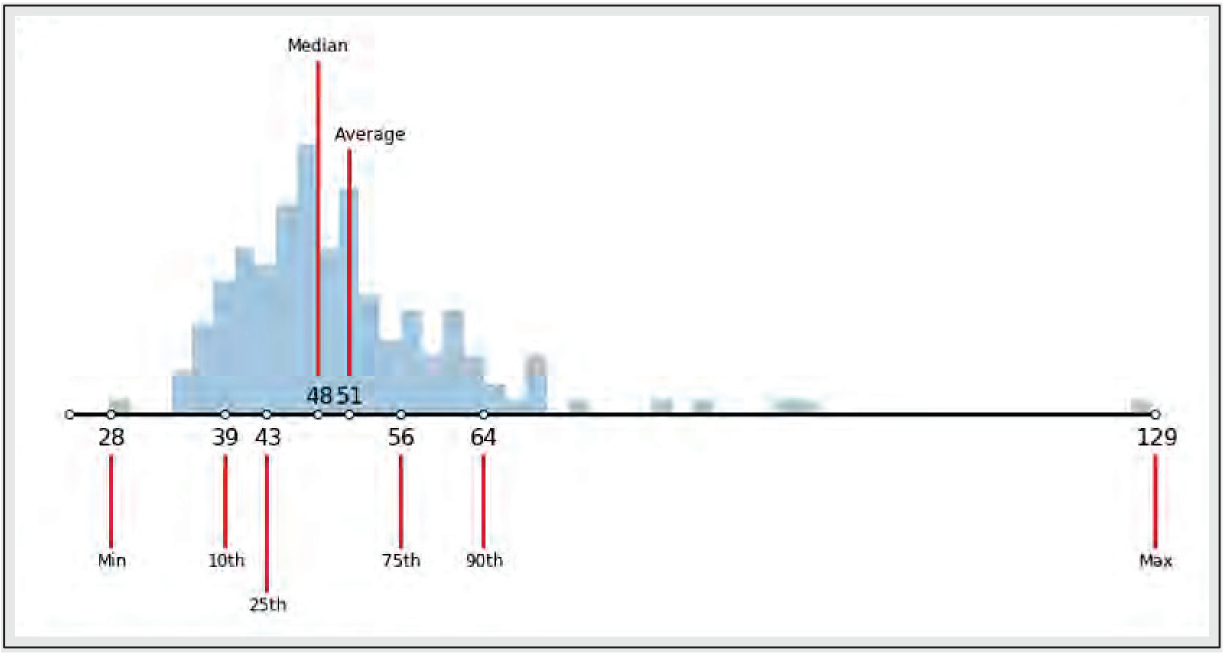

Figure 5.1 Current Conditions Distribution Analysis Results for 157 Suppliers (Where Ri-gpcd values are along the horizontal axis and frequency of occurrence for histogram bars is on the vertical axis. Distribution statistics along the horizontal axis are included for reference.)

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[29] Variances are additions to the water use objective that can be claimed for Suppliers with unique uses of water in their service area that has a material effect on their water use objective. The variances are currently under study and development but include uses such as large population of horses and other livestock, seasonal populations, use of evaporative coolers, large areas of commercial and non-commercial agriculture, to name a few.

From the analysis in Appendix J, a non-wasteful household without efficient fixtures and appliances can expect an R_i-gpcd of about 55 gpcd. Based on this study's analysis, the lower R_i-gpcd does appear to suggest that residential customers in California, on average, are currently achieving some measure of efficient indoor residential water use that demonstrates efforts Suppliers and customers have already put towards water conservation.

5.1 Distribution Analysis Results Comparison to Central Tendencies

R_i-gpcd estimates from the monthly and hourly customer-level Baseline Analysis validates the Supplier-level dataset (eAR) SAM analysis to represent the Statewide R_i-gpcd distribution (variability) of Suppliers. Table 5.1-1a and 5.1-1b show how closely the average between all the analyses agree.

Table 5.1-1a. Strata-Based Approach Summary From Tract Aggregated Ri-gpcd for Baseline Analysis SAM, LAM, and RAM and Aggregate Supplier-Level Estimated Ri-gpcd For Distribution Analysis SAM.

Statistic	**Distribution Supplier-Level Data (eAR) SAM** *(R_i-gpcd)*	**Baseline SAM** *(R_i-gpcd)*	**Baseline LAM** *(R_i-gpcd)*	**Baseline RAM** *(R_i-gpcd)*
Average	**51.1**	**49.5**	**52.2**	**51.5**
95% Confidence	NA	±1.0	±1.6	±1.4

Table 5.1-1b. Correlation-Based Approach Summary Statistics From Supplier-Aggregated R_i-gpcd.

Statistic	Supplier-Level Data (eAR) SAM (*R_i-gpcd*)	Correlation-Based Baseline SAM (*R_i-gpcd*)	Correlation-Based Baseline LAM (*R_i-gpcd*)	Correlation-Based Baseline RAM (*R_i-gpcd*)
Number of Suppliers	157	384	384	384
Average	**51.1**	**50.5**	**50.9**	**50.7**
95% Confidence	NA	±0.3	NA	±0.2
Minimum	27.8	44.2	39.3	39.3
Maximum	128.7	63.4	84.8	82.2
Median	**48.3**	**50.1**	**50.0**	**49.8**
Std. Dev.	12.7	2.6	5.9	5.6
Standard Error	-	0.141*	0.166*	0.138*
10^{th} Percentile	39.3	47.8	44.6	44.7
25^{th} Percentile	43.7	48.8	46.9	47.0
75^{th} Percentile	56.1	51.5	53.7	53.4
90^{th} Percentile	63.5	53.6	58.3	57.6

*Standard Error (of the mean) is calculated by Supplier based on tract-level estimates. Standard error cannot be calculated using Supplier-Level eAR data. Standard error estimates how well the sample data represents the whole population; with aggregated Supplier data, not enough information is available to estimate how good R_i-gpcd SAM eAR data estimates represent tracts or individual households within that Supplier.

However, as Table 5.1-1 shows, the range of R_i-gpcd distribution is greater for the Distribution Analysis because the Baseline Analysis, by nature, will tend to produce less variable results. Agreement on the averages indicates that use of the Supplier-level data disaggregated using the SAM method can be useful for informing the statewide variability in R_i-gpcd at the Supplier-level and effects of changing the R_i-gpcd standard.

Figure 5.1-1 shows the range and spread of the various analysis. LAM relative and cumulative frequency distributions are shown only for comparison because this analysis was generally found to produce less defensible results.

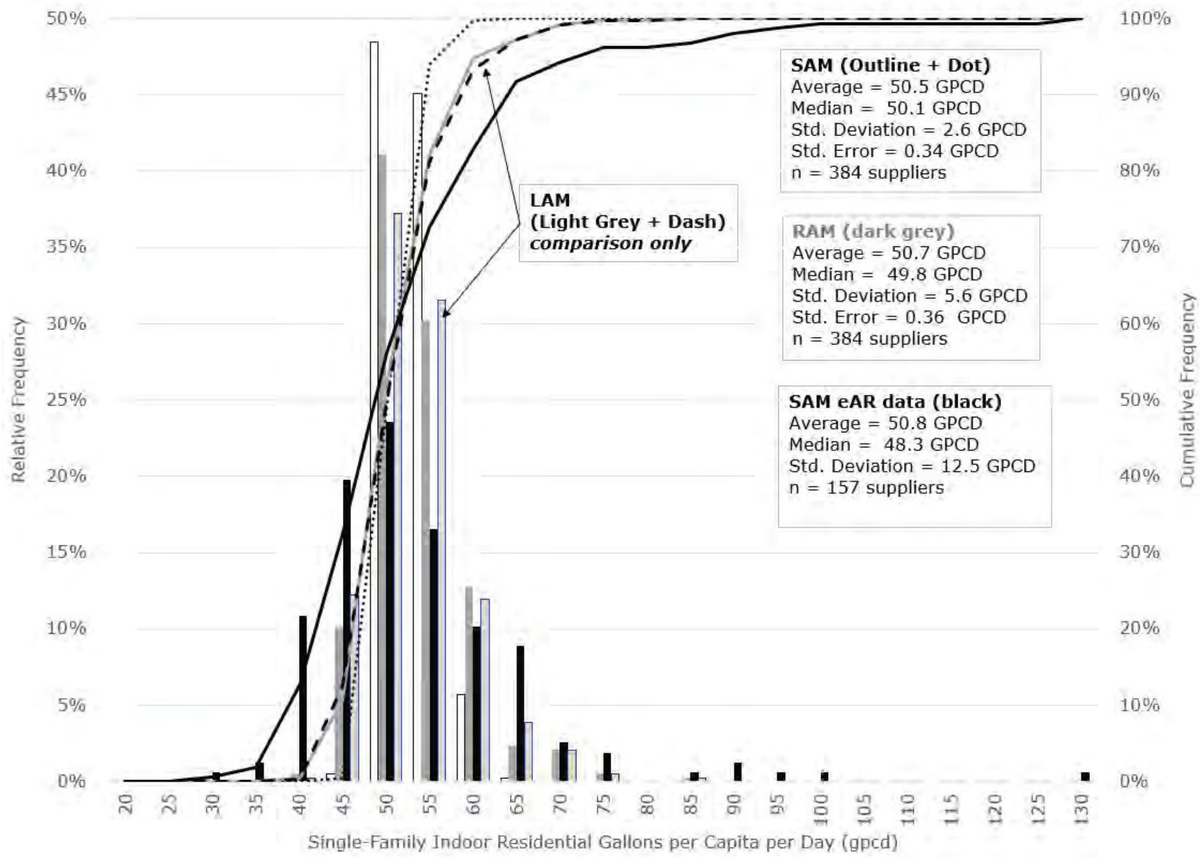

Figure 5.1-1. California Indoor Residential gpcd Distribution with SAM, RAM, and LAM*
Correlation-Based Supplier Estimates, and SAM Supplier-level data using an Average of 2017-2019.

5.2 Current and Future Projected R_i-gpcd Distribution

The indoor residential water use standard in statute reduces from 55 to 52.5 gpcd in 2025 and reduces from 52.5 to 50 gpcd in 2030. Therefore, it was important to understand what the projected R_i-gpcd distribution would be.

R_i-gpcd can be expected to decline ‘naturally’ because of plumbing code effects, appliance and fixture turnover, and new housing (passive conservation). It can also decline because of conservation programs and efforts (active conservation), which will be locally variable and depend upon the individual programs, customer response to programs, and the level of 'saturation' (e.g., how close the service area is to having all toilets replaced with efficient toilets). Because the Department has no ability to assess the likely effect of active conservation, the Department estimated projected R_i-gpcd for 2025 and 2030 based on current R_i-gpcd for the 157 Suppliers, along with county estimates for passive conservation from Mitchell (2016) (refer to Appendix F).

Figure 5.2-1 and 5.2-2 show the projected distributions for 2025 and 2030, respectively. This analysis indicates that the average and median R_i-gpcd is projected to decline, due to passive conservation, by about four gpcd by 2030 without any active conservation efforts or any standard in effect.

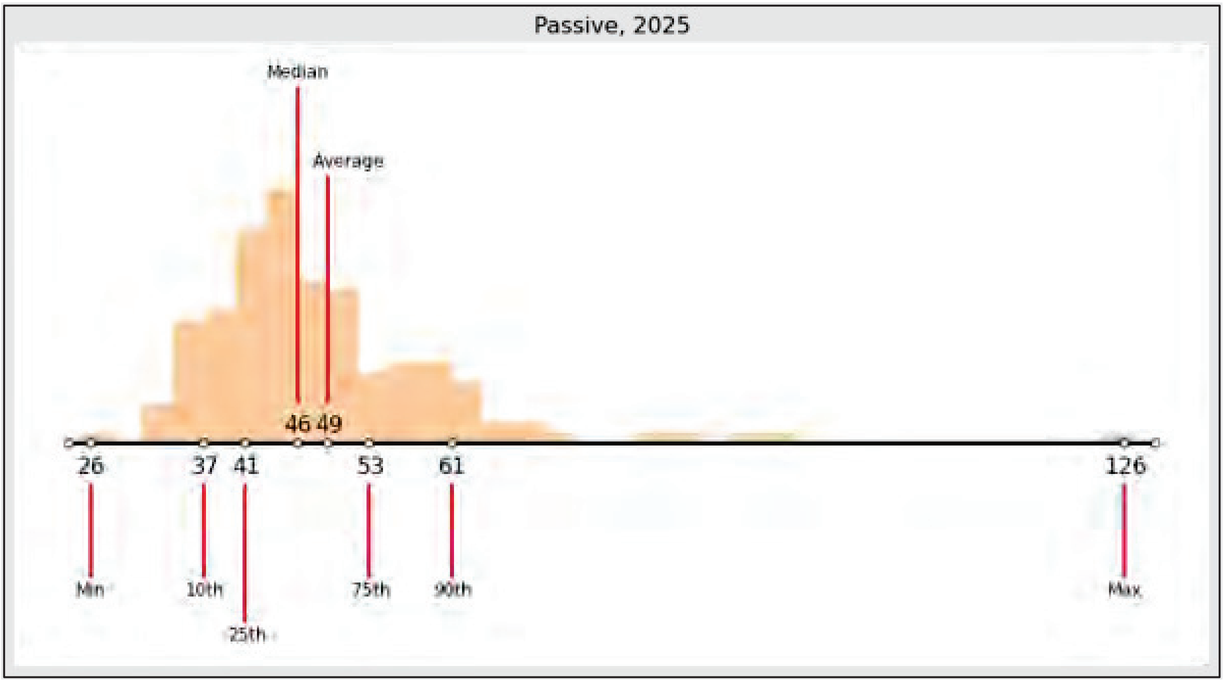

Figure 5.2-1. 2025 Projected Distribution Analysis Results for 157 Suppliers (Where Ri-gpcd values are along the horizontal axis and frequency of occurrence for histogram bars is on the vertical axis. Distribution statistics along the horizontal axis are included for reference.)

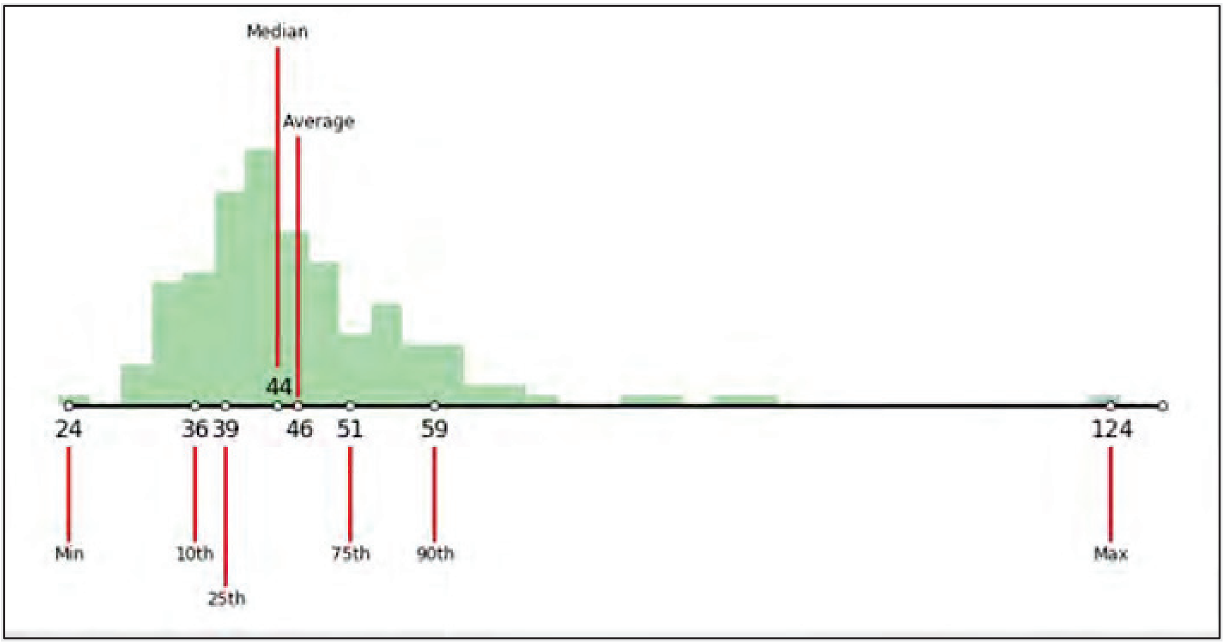

Figure 5.2-1. 2030 Projected Distribution Analysis Results for 157 Suppliers (Where Ri-gpcd values are along the horizontal axis and frequency of occurrence for histogram bars is on the vertical axis. Distribution statistics along the horizontal axis are included for reference.)

5.3 Standards Effects

In order to provide a study that informs any recommendations, potential effects of any standard were estimated using a Decision Support System (DSS) tool to examine how many Suppliers and the population that would be affected by a recommended standard and what the magnitude of effect would be. This tool incorporated information from the Distribution Analysis Supplier R_i-gpcd, Supplier population, and high poverty status based on Census tract data.

There are three main assumptions that need to be considered when looking at the analysis:

1. Suppliers with estimated service area R_i-gpcd above the standard are assumed to drop down to the standard. This assumption means that estimated effects may be high because:
   - Suppliers do not have to meet individual standards; they may accommodate an exceedance of any standard by being sufficiently

under one of the other standards so long as their overall water use does not exceed the water use objective.

- It is very possible that a variance is applicable for Suppliers with high R_i-gpcd. If a variance is granted, water use may not decrease.
- High R_i-gpcd in the dataset may have occurred because of incomplete separation of indoor from outdoor residential water use.

2. Urban retail Suppliers with estimated service area R_i-gpcd below the standard remain the same. This assumption means that estimated effects may be high because:
   - Similar to the above situation, a Supplier may use their lower R_i-gpcd to accommodate exceedance of one of the other standards, so long as their overall water use does not exceed the water use objective.
   - Low R_i-gpcd in the dataset may have occurred because the model underestimated the amount of outdoor water use.
3. Population remained the same in 2025 and 2030. This assumption means that estimated 2025 and 2030 effects may be low because averages and quantities were population-weighted.

Figures 5.3-1a to 5.3-1c show examples of the DSS tool using 157 Supplier R_i-gpcd values for each assessment year (2020, 2025, or 2030), derived from the Distribution Analysis, along with the current Water Code standard for that year. Red bars highlight Suppliers that are predicted to be above the standard, with blue highlighting those below the standard. Darker shaded bars denote Suppliers with high poverty levels compared to the rest of the Suppliers (75 percent of Suppliers have lower levels of poverty compared to the Suppliers with shaded bars). The reasonably even distribution indicates any standard will not be biased towards Suppliers with high poverty levels, however, it also indicates that any standard will affect some Suppliers with high poverty levels. The DSS tool allowed for selection of any standard and computed summary information, some of which is presented in the following tables.

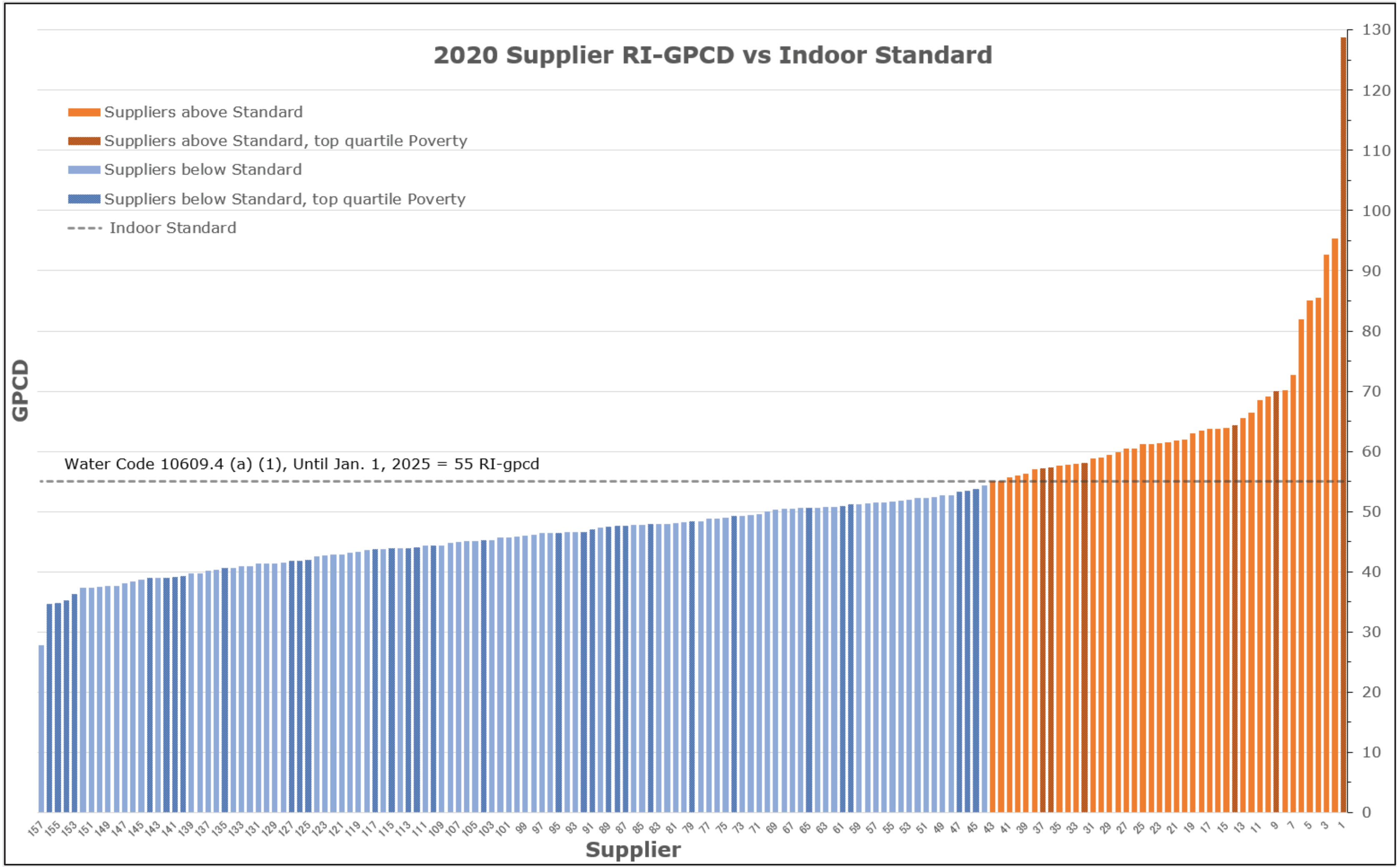

Figure 5.3-1a. Estimated 2020 Supplier R_i-gpcd (eAR Data) With Water Code 2020 Indoor Standard

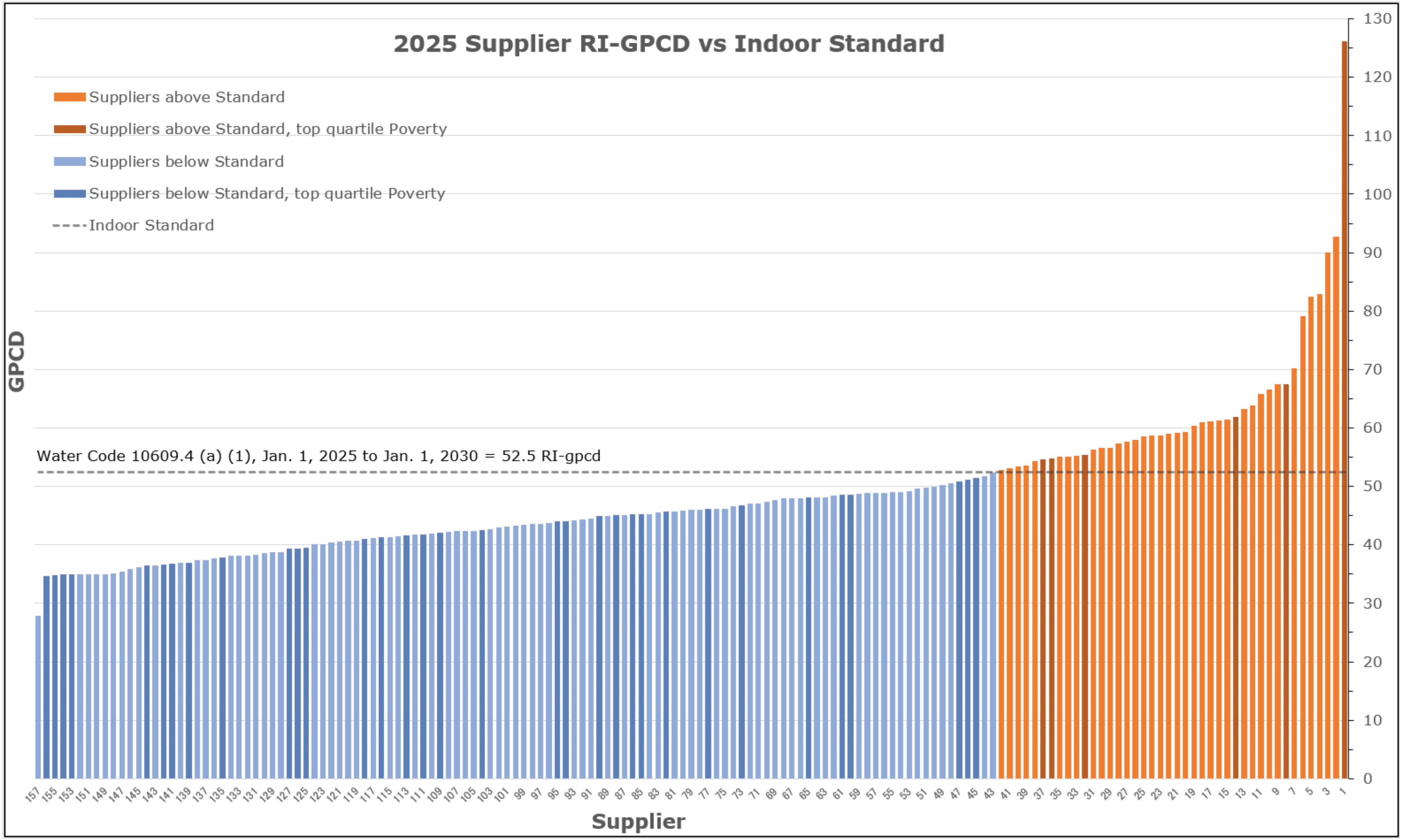

Figure 5.3-1b. Projected 2025 Supplier Ri-gpcd (eAR Data) With Water Code 2025 Indoor Standard

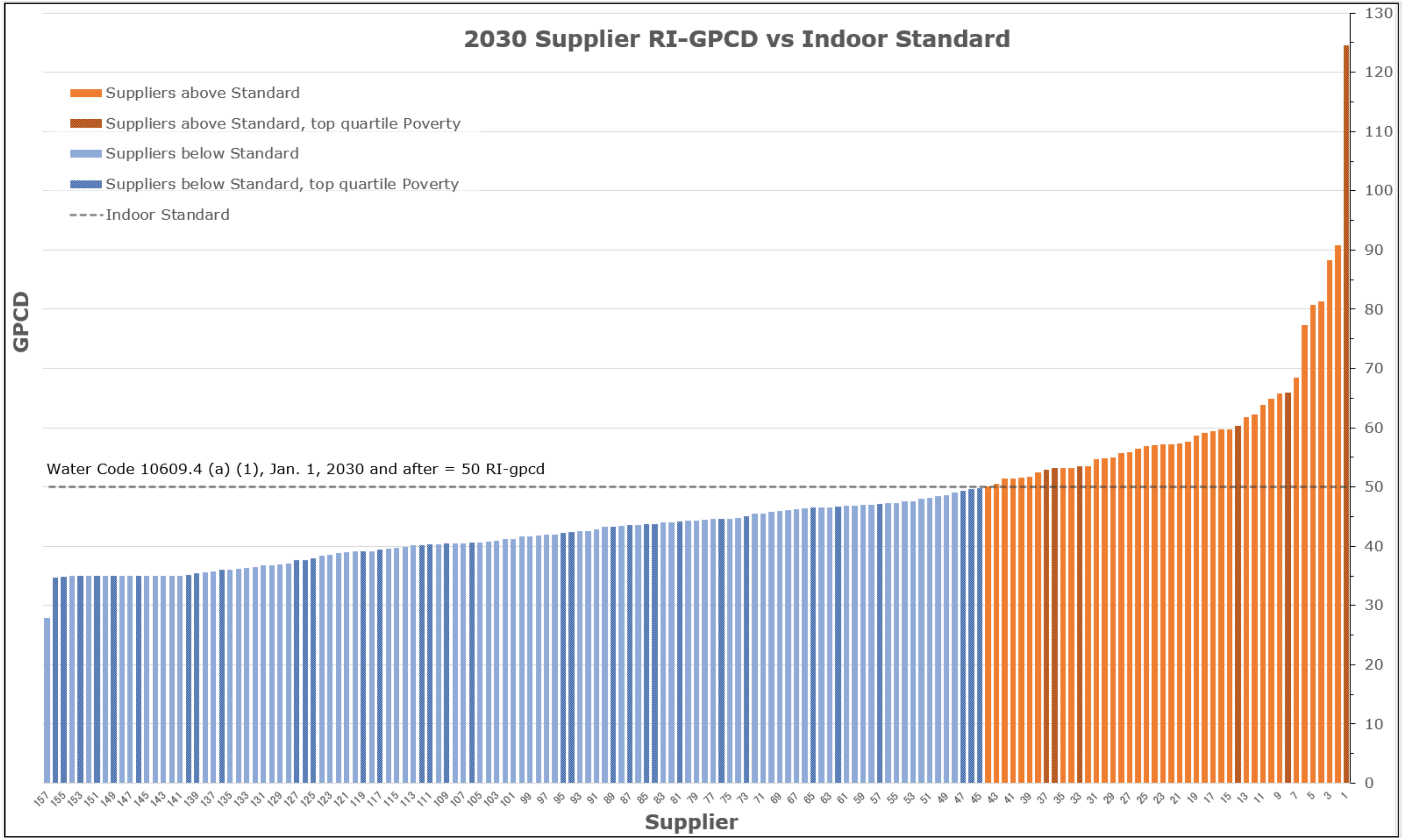

Figure 5.3-1c. Projected 2030 Supplier R_i-gpcd (eAR Data) With Water Code 2030 Indoor Standard

Tables 5.3-1a to 5.3-1c summarize potential effects of the statutory standard and standards that could affect approximately 25-percent, 50-percent, and 75-percent of Suppliers on estimated Statewide average R_i-gpcd, water savings, and associated populations. The SAM analysis of Supplier-Level data (eAR), Values for one gpcd increments are included in Appendix H - Distribution Analysis (eAR Data) and values for two gpcd increments are included in the April 22, 2021 Working Group meeting PowerPoint presentation slides.

Compared to the expected Statewide R_i-gpcd averages, implementation of the Water Code standard could reduce the expected Statewide 2020-2025 average R_i-gpcd (50.8 gpcd) by 2.2 gpcd resulting in a potential water savings of 89,883 acre-feet per year (AFY) compared to no-standard. For 2025-2030, the Water Code standard could reduce the expected Statewide average R_i-gpcd (48.2 gpcd) by 2.2 gpcd, with a potential water savings of 89,522 AFY compared to no-standard. For 2030 and onward, the Water Code standard could reduce the expected Statewide R_i-gpcd average (46.6 gpcd) by 2.3 gpcd, with a potential water savings of 97,166 AFY compared to no-standard.

Table 5.3-1a Potential Estimated Effects of Standards For 2020-2025

Standard Tested, *gpcd*	New Average R_i-gpcd	Water Savings, *acre-feet/ year*	Suppliers Above Standard, *%*	Suppliers > 5 gpcd Above Standard, *%*	Population Above the Standard, *%*
56	48.8	81,231	25	16	21
55	48.6	89,883	27	17	23
48.5	46.2	189,005	49	29	58
43	42.3	352,435	76	52	81

Table 5.3-1b Potential Estimated Effects of Standards For 2025-2030

Standard Tested, *gpcd*	New Average R_i-gpcd	Water Savings, *acre-feet/ year*	Suppliers Above Standard, *%*	Suppliers > 5 gpcd Above Standard, *%*	Population Above the Standard, *%*
53.5	46.2	80,634	25	16	20
52.5	46.0	89,522	27	17	23
46	43.7	186,134	50	29	58
41	40.2	331,227	75	50	78

Table 5.3-1c Potential Estimated Effects of Standards For 2030+

Standard Tested, *gpcd*	New Average R_i-gpcd	Water Savings, *acre-feet/ year*	Suppliers Above Standard, *%*	Suppliers > 5 gpcd Above Standard, *%*	Population Above the Standard, *%*
51.5	44.6	83,078	25	16	21
50	44.3	97,166	28	18	23
44.5	42.2	181,299	50	29	57
39	38.4	340,515	76	52	80

6.0 BENEFITS AND IMPACTS SUMMARY

A qualitative analysis of the benefits and impacts on water supply, wastewater, and recycled water systems was conducted through case study interviews with four utilities and prior assessments by the California Urban Water Agencies (CUWA) in 2017 (Adapting to Change; Utility Systems and Declining Flows). These utilities represent a diverse set of experiences and reflect variations in geography, source supplies, service area size, and topography, all of which may affect benefits and impacts from changing R_i-gpcd. [Refer to Appendix I - Benefits and Impacts of Changing R_i-gpcd, for details on this study. Benefits are further discussed in Appendix I Section 2 and adverse impacts are presented in Section 3.]

Water and wastewater systems are interconnected; any standard's effect on R_i-gpcd may alter hydraulics in these systems: total volumes and velocities may be affected along with water and wastewater quality, energy use, operation and maintenance requirements, and planning and design.

Whether or not a benefit or impact will occur depends on local conditions and how much a changing standard may affect a Supplier's water use. If a Supplier service area R_i-gpcd is at or below the standard, the standard will have little to no effect on the related systems. If the Supplier service area R_i-gpcd is higher than the standard, effects will depend on the magnitude of exceedance, along with locally-specific characteristics of the system.

For an area where the existing R_i-gpcd is higher than the standard, the benefits of reduced R_i-gpcd are similar for water and wastewater systems because reduction in total volumes allows for reduced treatment costs and energy use, and for excess capacity to support growth or defer capital investment for expansion. However, adverse impacts vary greatly, reflecting the differences in water and wastewater system infrastructure needs and expectations.

The acknowledgment of adverse impacts under this situation is not to imply that emphasis on conservation and water use efficiency should be relaxed, or that potable water use remains the same or should increase to avoid impacts. Rather, it is to acknowledge the interconnections between water use, wastewater generation, and recycled water production, and how changes within the cycle will have implications.

Though indoor residential water use is a factor in water and wastewater flows and recycled water systems, impacts on utilities are also a function of the following factors:

- **Diverse utility characteristics and conditions**. Multiple characteristics influence a utility's vulnerability to adverse impacts, such as population served, age and condition of existing infrastructure, materials of construction, and utility rate structures.

- **Magnitude of effect**. If indoor residential water use is already low, overall effects of a changing standard may be minimal. Alternatively, a significant decrease in indoor residential water use to meet a changing standard may have more substantial adverse impacts.
- **Other water use sectors**. The COVID-19 pandemic has driven measurable increases in residential water use, along with a concurrent decrease in commercial, industrial, and institutional (CII) water use. The overall net effect for many utilities has been reduced system flows, even with increasing residential water use. During drought conditions, water use reductions are experienced in most water use sectors, which can further compound effects.

Because this study was a qualitative assessment and not intended to arrive at quantifiable thresholds for the R_i-gpcd, future studies to inform a new standard will need to take site-specific factors and unique characteristics into consideration. Summaries of this qualitative assessment on benefits and adverse impacts on water and wastewater utilities and impacts on recycled water projects from reduced R_i-gpcd are listed below in Tables 6-1, 6-2 a-c, and 6-3 a-c.

Public utilities across California have demonstrated their ability to adapt to adverse impacts of a changing R_i-gpcd through a variety of mitigation strategies. However, these adaptations require time and money, the extent of which will depend on utility-specific characteristics.

Existing literature and utility experience demonstrate real benefits from reduced per capita indoor residential water use, as well as significant adverse impacts to water, wastewater, and recycled water systems. These benefits and adverse impacts are summarized in Appendix I Tables 5.0a and ES-2 through ES-4, respectively.

Based on the research and case study interviews, specific utility characteristics can either increase a utility's resiliency or exacerbate adverse impacts from reduced R_i-gpcd. This is summarized in Appendix I Table ES-5 and discussed further in Section 5 of Appendix I. The utility characteristics described do not represent an exhaustive list, but rather a starting point for future research and quantifiable data collection.

The findings of this qualitative assessment are consistent with the quantitative analysis of impacts to wastewater and recycled water systems provided in the Nature Sustainability article, “Unintended consequences of water conservation on the use of treated municipal wastewater” (Shwabe et al., 2020). This Nature study found significant effects of conservation policies in 2015, 2016, and 2017 on wastewater flow and salinity, even when wastewater treatment plant characteristics, seasonal, monthly, or year-specific impacts are factored out. As expected, the magnitude of impact to the 34 southern California wastewater treatment plants analyzed was highly variable.

Table 6-1 Potential Benefits for Water and Wastewater Utilities from reduced R_i-gpcd

Effect	Description	Benefit to Utility
Adaptations to the effects of climate change	Enables existing supplies to support potential population growth without an immediate need for water treatment plant expansion or investments in supplemental supplies	Improved regional self-reliance, water service reliability, and cost savings
Decreased water treatment and pumping costs	Lower water demand decreases treatment chemical uses and associated costs to produce drinking water, and lowers energy required to pump water in distribution systems	Cost savings for water utilities through reduced chemical purchase and energy usage
Deferred capital investment	Remaining capacity can allow for deferral of capital investment costs to expand existing water or wastewater treatment plant	Deferred capital spent for water or wastewater utilities
Reduced energy usage for wastewater systems	Reduced water demand and wastewater production results in lower energy usage associated with reduced pumping and treatment process needs	Cost savings from reduced energy usage for pumping

Table 6-2.a Potential Adverse Impacts for Water Utilities from reduced R_i-gpcd

Effect	Description	Potential Adaptation Strategies & Impact on Utility
Deterioration of water quality	Increased retention time in the water distribution system creates treatment and potential public health and safety implications from increases in disinfectant by-product (DBP) formation, microbial activity, and change in aesthetic characteristics such as taste and odor	Increased operational costs from flushing, additional chemical usage or O&M, or possible increased risk to health and safety[1]
Stranded assets and stagnation in storage facilities	Reduced water demand may result in stranded assets such as underused water treatment plants or unused capacity in distribution systems and storage facilities	Economic impact from unused assets as well as operations and maintenance (O&M) labor and costs to continue maintaining underused infrastructure[1]
Reductions in revenue from reduced water sales	Reduced water demand can result in lower total water sales, which makes it challenging for utilities to cover baseline O&M costs	Economic impact from reduced revenue and need to increase customer rates to compensate

[1] *Increased retention time results from systems oversized for current conditions. Utilities are updating demand projections, but there are considerations in water system sizing (e.g., peak hour, maximum day, and fire flows) that may limit a utility's ability to adapt through downsizing to match reduced water demand.*

Table 6-2.b Potential Adverse Impacts for Wastewater Utilities from reduced R_i-gpcd

Effect	Description	Potential Adaptation Strategies & Impact on Utility
Increased sewer gas production	Increasing sewer gas production such as hydrogen sulfide (H_2S) concentrations can create public health and safety impacts from increase in odor production and build-up of noxious gasses	Increased costs from increased purchase of odor mitigation materials and associated O&M
Accelerated rate of corrosion in sewer pipes and manholes	Higher H_2S concentrations accelerate the rate of corrosion in sewer pipes, especially concrete, leading to faster rate of failure	Increased costs from additional O&M and accelerated need for capital improvement program (CIP) projects for infrastructure rehabilitation or replacement
Increased occurrence of sewer blockages and overflows	Increased solids concentrations exacerbate blockages in sewers, resulting in clogged pipes, loss of sewer serviceability, sanitary sewer overflows	Increased costs for additional O&M and public health & safety impacts if unaddressed
Degradation of wastewater influent quality	Increasing contaminant concentrations in wastewater influent such as higher ammonia, biological oxygen demand (BOD), and total suspended solids (TSS) can stress loading-based treatment processes and increase concentrations in wastewater effluent	Reduced treatment capacity and increased treatment costs to continue meeting discharge requirements

Table 6-2.c Potential Adverse Impacts for Recycled Water Projects from reduced R_i-gpcd

Effect	Description	Potential Adaptation Strategies & Impact on Utility
Reductions in recycled water quantity	Reductions in wastewater influent subsequently reduce the volumes of recycled water that can be produced, limiting a utility's ability to offset potable reuse with recycled water	Increased reliance on potable water instead of recycled water, reducing regional self-reliance
Deterioration of recycled water quality	Changes in wastewater effluent quality adversely affect recycled water quality, which has downstream impacts on recycled water users with specific water quality criteria	Increased costs of recycled water, particularly if supply needs to be supplemented with potable water or if additional pretreatment is needed

Table 6-3.a Water Utility Characteristics that can Contribute to Adverse Impacts from reduced R_i-gpcd

Adverse Impact	Utility Characteristics
Deterioration of water quality due to increased retention time in distribution system	• **Age of infrastructure.** Systems appropriately designed for higher historical flow rates can become oversized, resulting in longer retention times and higher water age. Design criteria that support higher flow rates (e.g., flat slopes, turns and pumping) may not work well for lower flow conditions and can exacerbate water quality. Older systems may also experience more corrosion and deterioration. In such systems, any changes in flow conditions may lead to water quality deterioration, including contaminant leaching. **Topography, size, and density of service area.** Systems that serve large, flat, and low-density areas require water to travel longer, increasing the potential for longer distribution system retention times. • **Infrastructure material.** Systems with pipes made of iron, lead, copper and other metals may be more susceptible to problematic metal release from increased retention time.
Stranded assets and stagnation challenges from reduced water quantity	• **Magnitude of change from initial design parameters.** Similar to the above, water treatment plants and storage facilities sized for historically greater water demands may become oversized, resulting in water stagnation or excess infrastructure that could exist as stranded assets.

Reductions in revenue from reduced water sales	• **Rate structure.** Utilities with rate structures tied to volumetric use may experience more financial volatility as customers reduce water use.

Table 6-3.b Wastewater Utility Characteristics that can Contribute to Adverse Impacts from reduced R_i-gpcd

Adverse Impact	Utility Characteristics
Increase in odors and accelerated corrosion from higher sewer gas concentrations	• **Age of infrastructure.** Utilities with older infrastructure may be more susceptible to odor, leakage, and accelerated corrosion as pipelines have deteriorated and corroded over time. • **Topography, size, and density of service area.** Long stretches of flat pipeline provide more time for H_2S production, exacerbating odor production and corrosion. • **Infrastructure material.** Sewer systems constructed of materials sensitive to corrosion, such as concrete, will experience adverse effects of accelerated corrosion most heavily.
Increase occurrence of sewer blockages and overflows	• **Pipeline diameters.** Pipelines with smaller diameters are more easily clogged and thus more susceptible to sanitary sewer blockages and associated overflows. • **Conveyance system design parameters.** Pipelines with more flow constraint conditions (turns, material roughness, use of lift stations, and other features) may be more susceptible to blockages.

Impacts on wastewater effluent quality and increased chemical use from degradation of wastewater influent quality	• **Customer demographic.** Utilities with large percentages of residential customers will experience larger changes in both wastewater quality and quantity. • **Wastewater Treatment Plant (WWTP) treatment process.** WWTPs that use treatment processes that have loading limitations, such as activated sludge, nutrient removal, and biosolids handling, will be more sensitive to increasing loads in influent wastewater. • **National Pollutant Discharge Elimination System (NPDES) permit requirements and discharge point.** WWTPs that discharge into sensitive water bodies with strict NPDES discharge limits may require more operational adjustments and may struggle to maintain margins of safety that enable consistent compliance with effluent requirements.

Table 6-3.c Recycled Water Utility Characteristics that can Contribute to Adverse Impacts

Adverse Impact	Utility Characteristics
Deterioration in recycled water quality from worsened wastewater effluent quality	• **Customer demographic and end-uses.** Systems that serve customers that require high water quality (e.g., industrial processes, golf courses, or potable reuse) could be more susceptible to the impacts of increasing concentrations in wastewater effluent. • **Existing or planned investments.** Changes in wastewater quality will more greatly impact projects that are actively in design or construction phases.
Limiting the offset of potable use from reductions in recycled water production volumes	• **Water supply source.** Utilities that use recycled water to supplement a sensitive or scarce source supply will be more impacted by reductions in recycled water production. • **Discharge requirements.** Production of recycled water could be limited where WWTP's must continue to discharge a minimum flow to the receiving water body.

7.0 KEY ANALYSIS CONSIDERATIONS AND LIMITATIONS

The scope of the study and analysis was limited by data availability and provides a best estimate of R_i-gpcd. In calculating R_i-gpcd, disaggregating indoor water use from total residential water use has many challenges, some of which are discussed below.

7.1 Data Limitations

7.1.1 Population Data

The indoor residential water use standard is developed on a per-person basis, meaning accurate population counts are essential for determining a more accurate R_i-gpcd. The most defensible population estimates would have come from the 2020 census; however, that data was not available until March 31, 2021 and is not included in the scope of this study.

7.1.2 Data Quality and Quantity

R_i-gpcd is inferred based on models which include: monthly customer-level data used to develop the Central Tendencies Analysis results and aggregate monthly data used to develop the Distribution Analysis results. Aggregate monthly data was gathered from 157 of the 408 Suppliers from the annual eAR data submitted to the State Water Board.

- Monthly data disaggregation methods used to infer indoor residential water use from monthly billing data work best where winter outdoor water use is minimal; that is not the case for many Suppliers.
- Estimated R_i-gpcd using monthly aggregated data for an entire service area does not produce as accurate an estimate as does using customer-level data.
- A prerequisite to using the LAM and RAM methods are acquiring customer-level billing data and parcel-level measurements of landscape areas. These methods also require the ability to work with large, customer-level datasets. Only the least robust disaggregation

method, SAM, can be used with eAR Supplier-level monthly data; while the results are informative, they are imprecise.

- There are known input errors with the eAR data. While obvious errors can be resolved, unobvious errors cannot. After careful screening, 157 of the 408 Suppliers (38% of all Suppliers) reporting eAR data could be used in the Distribution Analysis.

- R_i-gpcd error and confidence intervals can only be developed from customer-level data. These intervals are unknown for the Distribution Analysis estimates.

- Projected 2030 R_i-gpcd estimates are based on assumptions of turnover and development at the county-level and may not reflect individual service area conditions.

- The analysis of multi-family R_i-gpcd estimates are limited because of the unknown number of dwelling units associated with each connection. Multi-family R_i-gpcd cannot be inferred from the eAR data because of populations in group quarters, residences served by commercial meters, and because meter misclassification may result in inaccurate residential water use volumes.

- Additional service areas for the customer-level analysis is warranted to characterize the diversity of Supplier service areas within California.

7.2 Unknown Efficiency and Efficiency Improvement Capability

Low or high estimates of R_i-gpcd derived from hourly, monthly, or aggregate Supplier data cannot be associated with efficient or inefficient household water use without a comprehensive End-Use study. Without knowing why a household’s water use is low or high, it cannot be conclusively stated that indoor residential water use is efficient or inefficient. Reasoning for this can range from issues with the data provided, the analysis method not being suitable to the Supplier’s situation, or other factors that may warrant a variance.

7.3 Potential Sector Water Use Shift

The majority of this study was conducted using pre-pandemic data but some water use data were collected during 2020. It is recognized that the increase in population at home due to stay-at-home orders may affect indoor residential water use. Several studies from across the globe have reported changes in residential water use that have resulted from increased work-at-home.[30]

During the statewide shelter-in-place orders in March 2020, indoor residential water use increased by approximately 3.0 to 12.2 gpcd from the limited analysis of six Suppliers in the Department's study. An analysis presented by Flume in early 2021 showed the dramatic impact of COVID-19 on water use by comparing indoor gpcd for every day of the year in 2019 to 2020. While not a representative sample of all California, this analysis shows how much indoor residential water use veered from a typical year versus 2020.[31] Significantly, the lingering impacts of COVID-19 are not known.

This increase in indoor residential water use due to COVID-19 is important because there is no CII indoor water use standard. When water use shifts from a sector for which there is no standard (CII) to a sector where there is a standard (indoor residential), this could affect a Supplier's ability to meet their water use objective even if their overall water use declines. The persistence of this increase and associated effects on CII and overall water use objectives is currently unknown.

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[30] "The average US home used nearly 729 additional gallons of water in April than it did in February, according to a new study from water-monitoring company Phyn". https://www.techrepublic.com/article/us-home-water-use-up-21-daily-during-covid-19-crisis/?mc_cid=203b67e30d&mc_eid=c3757b1ab4; Abu-Bakar, H. et. Al. 2021. Quantifying the impact of the COVID-19 lockdown on household water consumption patterns in England. npj Clean Water (2021) 4:13; https://doi.org/10.1038/s41545-021-00103-8

[31] Flume. 2021. Diving Deep Into Water Use Trends in 2020. Webcast - https://youtu.be/GqJrfP45w5Q

7.4 Unknown Effect on Affordability of Water and Human Right to Water

The studies did not analyze potential economic impacts. Implementation of programs to accelerate water conservation will cost money, which comes from the State (taxpayers) or customers (rate-payers). Some Suppliers are already struggling with lost revenue because of unrecoverable customer bills exacerbated by economic conditions arising from the pandemic. However, water use efficiency is often less expensive than developing new water supplies and may help to ensure equitable and affordable access to water.

7.5 Benefits and Impacts on Other Water Sectors

Water supply, wastewater, and recycled water systems could all be affected by changes to indoor residential water use standards. Public utilities can and will adapt to changing standards. However, planning and investments for changes in infrastructure and facilities take time and money. Quantification of specific benefits and impacts will depend on magnitude of change, utility of specific conditions and characteristics, and how the COVID-19 pandemic shifts where and how water is used. Quantitative benefit and impact analyses were not conducted for this study.

7.6 Implementation of Best Practices

Locally cost-effective programs still require initial investment for implementation which takes time. Suppliers may be limited in what more they can do or achieve and how quickly they can implement programs (see Section 6.2, above). For example, leaks cannot be completely eliminated, and appliances and fixtures can be efficient, but over time they may lose efficiency. Furthermore, many conservation practices are implemented by customers and there may be behavioral, cultural, or financial barriers to implementation.

For example, Metropolitan Water District of Southern California has continued to promote indoor incentives for its member agencies' residential customers through rebate programs. Since the drought ended in 2016, the uptake of rebates by residential customers has dramatically declined (Figure 7.6-1). It is unknown whether this reduction is because of reduced interest, saturation of the area with efficient appliances, economic conditions that limit the ability of customers to contribute their cost-share, reduction in education and outreach programs by member agencies, or other factors. It is also unknown whether or not uptake can be increased to accommodate a changing standard.

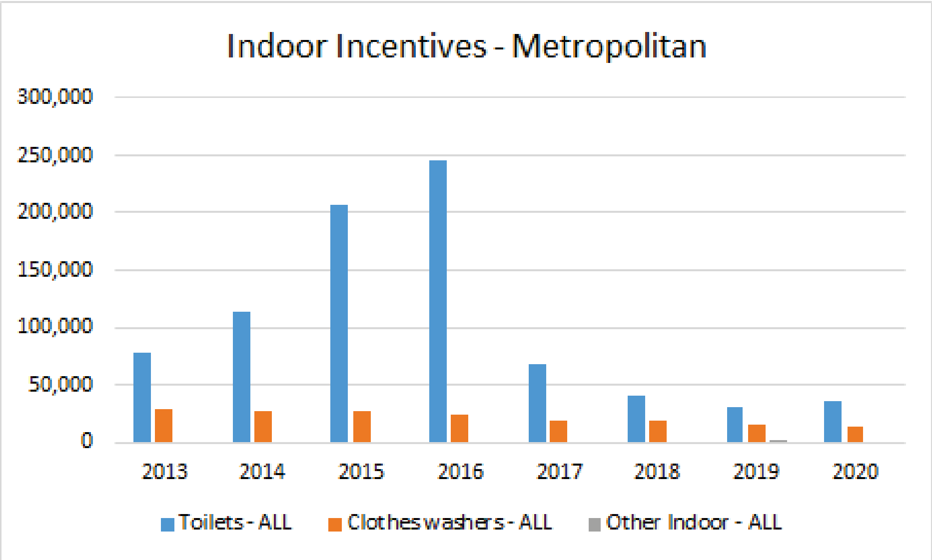

Figure 7.6-1. Data for the Metropolitan Water District Incentive Program, Residential Installed Units (as of 12/14/2020)

8.0 RECOMMENDATIONS

The proposed joint recommendations for the indoor residential water use standards were presented at the April 22, 2021 Water Use Studies Working Group meeting for consideration and feedback from stakeholders. Table 8-1 lists the current standards in statute, the proposed standards in Assembly Bill 1434 (AB 1434, Freidman, as of April 26, 2021) for context, and the Department and State Water Board proposed joint recommendations.

Table 8-1. Comparison of Indoor Residential Water Use Standards (gpcd)

Starting Year	Current Statute	AB 1434	Joint DWR and Water Board Proposed Recommendation
2020	55	48	55
2025	52.5	45	47
2030	50	40	42

Rationale for Selecting the Proposed Joint Recommendations

Based on available information, the Department and State Water Board jointly believe the proposed recommendations reflect:

- That Californians have become more efficient over time. The current median water use of 48 gpcd is well below the 2020 standard in statute.[32]
- Efficient use.[33]
- Best practices.[34]
- That water use efficiency is often less expensive than developing new water supplies and may help to ensure equitable and affordable access to water.[35]

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[32] The Department and the State Water Board's joint recommendations draw from the most robust analysis of indoor residential water use in California to date. See Appendix H.
[33] See the discussion of efficient indoor residential water use in Appendix J.
[34] See the discussion of best practices Section 1.8 and Appendix J.
[35] Water conservation programs have been shown to mitigate rate increases (Lee et al., 2011; Feinglas et al., 2013; Chesnutt et al., 2018). In some cases rate increases have disproportionately impacted lower income households (Mini et al., 2014 a,b).

- That water use efficiency reduces greenhouse gas emissions[36] and improves the resilience of urban areas to future water supply challenges.
- The need for a reasonable path to a feasible and impactful 2030 standard.
    - This standard recognizes the efforts, investments, and conservation achievements already made by California suppliers and their customers.
    - The overall water use objective is calculated by combining the indoor residential standard, the outdoor residential standard, the large landscape areas (CII) standard, the water loss standard, variances,[37] and a bonus incentive.[38] Suppliers retain discretion for how they will meet their overall water use objective.
    - Half of suppliers are on track to be at or below 44 gpcd by 2030 with passive conservation only. Estimates of Supplier water use are expected to be even lower when including active conservation.
    - Suppliers have time to plan, develop partnerships and programs, and support conservation as a way of life.

The Department and State Water Board recognize there are many factors affecting residents, suppliers, and related water utilities (wastewater and recycled water).

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[36] During the last drought, water conservation saved as much energy as all the energy efficiency initiatives offered by the state’s major investor-owned utilities (Spang et al., 2018)
[37] Those suppliers that struggle to meet their objective specifically because of a unique circumstance that materially affects indoor residential water use rates (e.g., extensive use of evaporative coolers) may request a variance.
[38] For the amount of potable recycled water used the previous year.

2020: 55 gpcd (No Change in the Current Statute)

Our agencies do not recommend changing the 2020 standard. This is because a 2020 standard would be in effect for only one year (2024). In addition, this reflects our recognition of the financial strain the pandemic has created for many suppliers.

2025: 47 gpcd (5.5 gpcd Less than the Current Statute)

To assess the suitability of standards, it is important to estimate what water use will be in the future. When estimating future water use, it is informative to consider trends in water use over time. The main trend has been declining indoor residential water use at a rate of approximately 0.4 to 0.9 percent per year[39]. The lower end of this range reflects passive conservation and the higher end of this range reflect both active and passive conservation, where:

- “Active” conservation measures such as education and outreach, residential and commercial water audits, and rebates.
- “Passive” water use reductions such as those driven by plumbing codes, SB 407, and turnover given the expected lifetime of fixtures and appliances.

By 2025, 54 percent of Suppliers would be below the recommended standard of 47 gpcd considering only passive conservation. If indoor residential water use continues dropping with active conservation efforts, the number of suppliers below the 2025 recommended standard of 47 gpcd could be even higher. As noted above, suppliers retain discretion for how they will meet their overall water use objective. They may also be eligible for the bonus incentive or to pursue variances.

2030: 42 gpcd (8 gpcd Less than the Current Statute)

From 2030 onward, the Department and the State Water Board recommend an indoor residential standard of 42 gpcd. As with the recommendation for

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[39]Refer to Appendix F and the Residential End Use in United States, Version 2, which shows that indoor residential use decreased 15% between 1999 and 2016, suggesting a 0.9% per year decline (De Oreo et al., 2016).

the 2025 standard, the 2030 recommendation takes into consideration future use.

By 2030, 39 percent of Suppliers would be below the recommended standard of 42 gpcd considering only passive conservation. If indoor residential water use continues dropping with active conservation efforts, the number of suppliers below the 2030 recommended standard of 42 gpcd could be even higher. As noted above, suppliers retain discretion for how they will meet their overall water use objective. They may also be eligible for the bonus incentive or to pursue variances.

Stakeholder Suggestions for More Successful Local Implementation

During public engagement, stakeholders suggested State policies, assistance, and investments that could facilitate improved local implementation of indoor residential water use efficiency programs and support the State's achievement of its water conservation goals. In general, the Department supports these suggestions – summarized below – and urges the Legislature to consider them when adopting new indoor water use efficiency standards.

Financial Assistance

Some suppliers indicated that reducing indoor residential water use beyond current levels will require investment in incentive programs, leak repairs, and other strategies beyond their financial capacity. Employing these strategies to improve indoor efficiency in disadvantage or underserved populations or smaller urban retail water suppliers with limited capacity may be especially challenging. State financial incentives intended to leverage local – and in some cases Federal – funds would help achieve water efficiency objectives.

Enforcement of Plumbing Code Indoor Residential Efficiency Requirements (SB 407)

State mechanisms to encourage enforcement of indoor residential water use efficiency requirements such as providing funding to support local programs that incentivizes the plumbing fixture replacements or requiring local agencies to inspect the properties at the time of property transfer, in the plumbing code (SB 407) would help water suppliers achieve more efficient water use. SB 407 requires all residences and commercial properties to have efficient showerheads, faucets, and toilets, but enforcement is variable at best.

Statewide Messaging

Consistent public messaging on the importance of and, in many cases, ease of water use efficiency practices is critical to broad adoption. Strong public messaging is also an essential element in local water rate decision-making (e.g. Proposition 218 elections). Consistent and robust statewide messaging on the importance and value of water use efficiency would help augment the impact of local informational campaigns.

End Use Studies

Customer-level end-use studies would provide valuable information to local suppliers and wastewater and recycled water managers. Such studies would build upon the information gathered and assessed by the Department and would provide further insights into where investments would result in the biggest efficiency gains (new appliances vs leak detection, for example). Such studies would also help wastewater and recycled water managers make more informed long-term planning decisions in subsequent phases of facility improvements and distribution infrastructure.

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ATTACHMENT 1-5:
A.23-08-010 - Sam Lam - Report on General Office Expenses Budget, Conservation Program Budget, SR2 and SR3 [PUBLIC]

Table 1-2: District Breakdown of Recorded Conservation Program Expenses (2018 – 2022)

District	2018	2019	2020	2021	2022	Average
Arden Cordova	$ 40,332.00	$ 158,384.00	$ 115,466.00	$ 48,614.00	$ 113,666.00	$ 95,292.40
Baypoint	$ 10,887.00	$ 10,217.00	$ 342.00	$ 26,198.00	$ 4,387.00	$ 10,406.20
Clearlake	$ (1,173.00)	$ 313.00	$ 316.00	$ 11,800.00	$ 2,183.00	$ 2,687.80
Los Osos	$ 10,572.00	$ 2,728.00	$ 1,259.00	$ 22,905.00	$ 3,921.00	$ 8,277.00
Santa Maria	$ 17,390.00	$ 36,361.00	$ 3,619.00	$ 103,510.00	$ 36,556.00	$ 39,487.20
Simi Valley	$ 32,428.00	$ 3,459.00	$ 15,435.00	$ 122,248.00	$ 29,209.00	$ 40,555.80
Region 2	$ 554,082.00	$ 140,585.00	$ 212,450.00	$ 815,498.00	$ 290,340.00	$ 402,591.00
Region 3	$ 361,783.00	$ 651,140.00	$ 430,562.00	$ 250,160.00	$ 346,762.00	$ 408,081.40
Total	$ 1,026,301.00	$ 1,003,187.00	$ 779,449.00	$ 1,400,933.00	$ 827,024.00	$ 1,007,378.80

GSWC's TY 2025 conservation program expense budget request is $1,116,189. The budget request is an 11% increase over the average spent in the last recorded five-years. The proposed increase to the budget maintains similar level of conservation program expenditures as approved in GSWC's 2020 GRC and should assist ratepayers to comply with ongoing conservation legislation in this GRC cycle.[8]

Cal Advocates support cost-effective water conservation measures that improve water-use efficiency to advance the state's policy to make water conservation a way of life. Cal Advocates agrees with GSWC in reducing the budget allocated towards rebates and to increase the direct install budget allocation.[9] GSWC identified that some of the residential rebate applications for water-efficient appliances were for remodeling purposes.[10] For example, rebates would be offered to program applicants who would have purchased a water-efficient toilet regardless of whether a rebate was offered, thereby reducing the program's cost-effectiveness. Thus, the rebate program's budget should be reduced and allocated towards more valuable conservation measures.

It is necessary to reduce the budget GSWC allocates to conservation workshops. Conservation workshops are educational and do not have industry expectations that it will

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[8] Testimony of Edwin DeLeon at 7.

[9] Testimony of Edwin DeLeon at 11.

[10] Testimony of Edwin DeLeon at 23.

produce any measurable water savings.[11] While conservation workshops and messaging may be positive conservation measures, allocating more budget to conservation measures that are more likely to result in greater water-use efficiency increases the program's cost effectiveness.

Conservation program expenses should reflect a maximum allocation of 20% of the total budget towards conservation messaging and workshop related measures. The remaining 80% (or more) of the budget should be allocated to measurable conservation measures like the (1) residential audit program, (2) CII audits, (3) outdoor incentives, and (4) the direct install program. A customer's participation in water use audits and installation of water-efficient appliances can produce a measurable change in water use.

GSWC anticipates increasing spending on direct installs for California Alternate Rates for Water (CARW) customers.[12] GSWC should begin to track the percentage of conservation program participants that are CARW customers. This information is vital to ensure equal access and participation for all customers. At this moment, GSWC does not track whether a program participant is a CARW customer or not.[13] Under the direct install program, GSWC installs water-efficient products for residential and Commercial, Industrial, and Institutional (CII) customers and can bring forth measurable customer usage changes.[14 15]

Lastly, GSWC should begin to track and collect the usage data from customers participating in the water audits, outdoor incentives, and direct install programs. It is important to understand the water conservation potential that is possible from each of the

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[11] Response to DR SLM-007 (Conservation Expense), Question 13. Attachment 1-1.

[12] Testimony of Edwin DeLeon at 11.

[13] Response to DR SLM-007 (Conservation Expense), Question 6, 12, 16, and 17. Attachment 1-1.

[14] Testimony of Edwin DeLeon at 21.

[15] CII customers are Commercial, Industrial, and Institutional customers.

ATTACHMENT 1-6:
California Water Service Response to DR SLM-005, Attachment #6.

RESPONSE TO DATA REQUEST

2024 GENERAL RATE CASE, A.24-07-003

To: **Public Advocates Office**

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From: **California Water Service**

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Melody Singh Manager, Revenue	(916) 329-1856 msingh@calwater.com

Date: **October 31, 2024** Re: **SLM-005** Subj: **Sales, Rate Design, Conservation Program**	Request Received from CPUC: **October 21, 2024** Requested Due Date: **October 28, 2024** **Extension for Q8 requested to: October 31,2024**

Comments:

- **Partial Response #2 (LAST) attached. Items that have changed from the prior response are noted in blue font.**
- **Response provided by Rates and M. Cubed.**
- **Does not contain confidential information.**
- **This response refers to the following attachments included separately:**

- **SLM-005 *Attachment #1 – Sales by customer***
- ***SLM-005 Attachment #2 – Persons per SFR Household***
- ***SLM-005 Attachment #3 – Sales per tier block***
- ***SLM-005 Attachment #4 – 90th percentile***
- ***SLM-005 Attachment #5 – Chico CMP***
- ***SLM-005 Attachment #6 – Analysis of Bathroom Retrofit Water and Energy Savings***
- **SLM-005 *Attachment #7 - Conservation Program CAP Participation***

Data Requests and Responses

Sales

Please refer to Cal Water's response to DR SLM-001 (Recorded Sales).

1. Provide an update to Cal Water's response to DR SLM-001 (Recorded Sales) to include the latest available data (between July 2024 – September 2024), utilizing the same Excel files and format Cal Water submitted in its response to DR SLM-001.
Response: The updated dataset is included as *SLM-005 Attachment #1 – Sales by customer*.

Rate Design

2. For each of Cal Water's ratemaking areas, please provide Cal Water's estimate of the number of persons per single-family residential household and provide supporting justification, if available.
Response: *SLM-005 Attachment #2 – Persons per SFR Household* contains the data that we use for estimating the estimated number of persons per single-family residential household. This data came from DWR's data population tool and is included in our Urban Water Management Plans.

Please refer to the RO Model,

Workpaper: Y_CH04_REV_SD_Rec Sales

Worksheet: Tier Block Ratio % WS-95

3. Provide the supporting data and analysis for the values in Column AS.
Response: *SLM-005 Attachment 3 – Sales per tier block* contains this data. Each excel file refers to a single ratemaking area. Sheet 1 of each workbook contains the 2022 SFR billing records used to calculate the tier sales percentages. Sheet 2 contains the calculation of the percentages.

   A stata log file showing respective code used to create excel workbooks is included in the attachment.

4. Explain what years "Year 1" , "Year 2" , and "Year 3" represent in Columns AQ, AR, and AS, respectively.
Response: Year 1 and 2 refer to sales per tier under our three tier system, which was in effect during the 2021 and 2022 time period, respectively. Year 3 refers to the 2022 sales, which is reallocated based on tier break points authorized in the 2021 GRC Decision.

5. For each ratemaking area, please provide an estimate of the 90th percentile of monthly residential consumption with the data used in calculating the values in Column AS, in CCF,

along with the data used to support the estimate and explanation of how Cal Water made the estimate.
Response: Please refer to *SLM-005 Attachment #4 - 90th percentile*.

Conservation Programs
Please refer to Cal Water's Testimony Book #2 – Attachment H.

6. Provide all relevant reports, contracts/scope of work, communications with consultants, and invoices relating to Cal Water's outside consulting services related to "conservation program development and measurement and verification of program performance."[1]
Response: The primary report associated with Cal Water's conservation program development is the Conservation Master Plan (CMP). As stated in the CMP:

The main purposes of this Conservation Master Plan are to:
- **Serve as a broad guidance document that helps inform annual conservation activities, such as program levels, staffing, and budget needs both internally and for stakeholders.**
- **Summarize the mix of conservation measures that Cal Water plans to implement going forward, including the estimated water savings, costs, and effects on water demand.**
- **Explain the evaluation process and factors considered in selecting conservation measures.**
- **Provide an update to the 2016-20 Conservation Master Plan as part of a five-year review cycle to assess program performance and identify the need for any adjustments; and**
- **Ensure Cal Water districts are positioned to comply with the state's Making Water Conservation a California Way of Life regulations.**

Each district-specific CMP is included as Appendix I of the districts Urban Water Management Plan (UWMP). The Chico District CMP is included with this response (*SLM-005 Attachment #5*) and all other CMPs can be found at www.calwater.com/conservation/uwmp2020/.

The "California Water Service Conservation Budget Report" that was provided with the 2024 General Rate Case filing is supplemental to, and builds on, the CMP. As stated in this report, "This report outlines California Water Service's proposed staffing and budgets for water conservation programs as part of the 2024 General Rate Case (GRC). The staffing and budget proposals detailed herein are designed to mee the unique challenges and comply with the regulatory requirements introduced by recent legislation and environmental pressures."

Please see the response to Question 9 of this data request for information pertaining to the measurement and verification of program performance

7. Cal Water claims that its existing level of staffing has "restricted Cal Water's ability to launch and expand conservation initiatives effectively."[2] Please provide documentation, examples, or other evidence to support this claim.
Response: Cal Water provides conservation programs to 25 separate districts located all across California. It currently has 9 FTE positions to support the development, implementation, monitoring, and reporting of conservation programs in these regions. This translates to 0.36 FTE per service area, or roughly 4.5 FTE per million people served. Documentation, examples, and other evidence that this level of staff support is inadequate includes the following:

[1] California Water Service Conservation Budget Report at 37.
[2] California Water Service Conservation Budget Report at 34.

- **The Memorandum of Understanding Regarding Urban Water Conservation in California as amended January 4, 2016, specifies that each urban water utility shall designate a conservation program coordinator responsible for the management, tracking, planning, and reporting of conservation programs in its service area. This requirement implies designation of 25 conservation program coordinators to oversee the conservation programs operated in Cal Water's 25 geographically disparate service areas. Currently, Cal Water has three regional conservation coordinator positions and is proposing to increase this to five regional coordinator positions.**

- **Cal Water's districts are geographically disparate, spanning 45,000 square miles of the state. The 25 service districts within this area are of different sizes, geographies, climates, economies, and demographics. Providing effective conservation programming requires localized knowledge and understanding of the unique conditions and opportunities that characterize each region in which Cal Water operates, which in turn requires regionally deployed staffing. Supporting and servicing customers requires knowing and understanding the localized context in which customers utilize their service. Cal Water understands it needs to regionalize its conservation program deployment, which is why it is proposing to establish five program deployment regions, each overseen by a dedicated conservation coordinator.**

- **The service areas of California's 400 urban retail water suppliers cover approximately 13,460 square miles according to service area boundary files compiled by DWR. Assuming a minimum of one conservation coordinator per urban retail water supplier, this implies a minimum coverage of 34 square miles per FTE position. Cal Water's districts cover more than 473 square miles, and it currently has three regional conservation coordinators, resulting in a coverage ratio of 158 square miles per FTE position. Thus, each Cal Water conservation coordinator must cover almost five times the area covered by the average retail urban water supplier conservation coordinator. Increasing the number of regional conservation coordinators to five FTE, as Cal Water is proposing, would result in a coverage ratio of 95 square miles per FTE coordinator position compared to an average of 34 square miles per coordinator position for all urban retail water suppliers. Note that this calculation is ignoring the large areas that separate each Cal Water district.**

As stated in Cal Water's current filing, the average conservation program staffing level for larger urban water supply agencies is 12 FTE positions per million people served. Cal Water serves approximately 2 million people, and its current staffing level is 9 FTE, or 4.5 FTE per million people being served, about one-third the average staffing level for other large urban water supply agencies. Cal Water is proposing to increase its conservation program staffing level to 15 FTE, or 7.5 FTE per million people served, which would increase its staffing level to about two-thirds the average staffing level per million people served for larger urban water supply agencies.

8. For each ratemaking district, what is the annual percentage of customers participating in Cal Water's conservation programs have also been customers in the Customer Assistance Program (CAP) from 2018 to 2023? Please provide the data and any supporting documents used to calculate the percentages.
   Response: ~~**2018-2020 information is not in Cal Water's current billing system and would take a considerable amount of time to prepare manually. As such, Cal Advocates and Cal Water agree to amend the request to include the time period 2020-**~~

~~**2024. Cal Water has requested and Cal Advocates agrees to an extension to provide this data in a subsequent response by October 31st.**~~

Response #2: Please reference 'SLM-005 Attachment #7 - Conservation CAP Participation' for the requested data. The data provided is for the years 2020 – 2024 (YTD) given that older data included in Cal Water's billing system is archived and not readily available.

The methodology used to calculate the provided data is as follows:

- **Customers were identified as CAP customers based on their CAP status in December of the program participation year, except for 2024 which used September for this purpose.**
- **Customers that participated in a conservation program and were no longer a customer in the month used to identify CAP customers would not be included as a CAP customer in the data provided.**
- **Customers who participated in multiple conservation programs each year are only counted once for that year. The result is that the number of program participants included for a given year should be viewed as the number of unique program participants for that year.**

9. Please describe the categories of data Cal Water collects from customers to evaluate the outcome and effectiveness of conservation programs.

   a. Does Cal Water track the water usage of individual customers before and after the customer's participation in a conservation program?
   Response: Yes, Cal Water records the water usage of all metered customers on a monthly basis. Consequently, it has records of water usage of customers before and after their participation in a program. The only exception would be participation by unmetered customers prior to their conversion to metered water service.

   b. If so, please provide all supporting documents and analysis for each ratemaking district.
   Response: Simple before-after comparisons of water usage are generally inadequate for assessing conservation program water savings because there are a multitude of other factors, such as differences in weather, changes in the economy, or coincident conservation orders or drought restrictions, that confound such comparisons. In general, it is necessary to develop sophisticated statistical models of water use that control for potential confounders in order to develop robust estimates of program water savings.

   Cal Water has conducted several such studies, most recently to evaluate the water savings of its bathroom retrofit direct installation programs. The two reports documenting these conservation program water savings evaluations are provided as *SLM-005 Attachment #6* to this response:

   Statistical Analysis of Bathroom Retrofit Water and Energy Savings: California Water Service Dominguez and East Los Angeles Districts

Statistical Analysis of Bathroom Retrofit Water and Energy Savings: California Water Service Bakersfield District

More generally, Cal Water bases its conservation program water savings estimates on empirically derived estimates of average savings for different types of conservation programs (e.g., toilet, shower, and washer replacements, turf removal, audits and home water reports, etc.) that have been compiled by the Alliance for Water Use Efficiency and are contained in the Alliance's Water Conservation Tracking Tool.

[Note 1: An overview of the Alliance's Water Conservation Tracking Tool can be found here: https://www.allianceforwaterefficiency.org/resources/topic/water-conservation-tracking-tool#.]

END RESPONSE

STATISTICAL ANALYSIS OF BATHROOM RETROFIT WATER AND ENERGY SAVINGS

California Water Service

Dominguez and East Los Angeles Districts

DWR Grant Agreement No. 4600011093

Prepared by

M.Cubed & A & N Technical Services

POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS

M.CUBED

May 2018

CONTENTS

1 INTRODUCTION

This report presents a statistical analysis of water and energy savings and associated reduction in greenhouse gas emissions from the retrofit of residential bathrooms with high-efficiency toilets, showerheads, and faucet aerators in California Water Service's Dominguez and East Los Angeles Districts. The bathroom retrofits were co-funded by the Department of Water Resources (DWR) Water-Energy Grant Program (DWR Grant Agreement No. 4600011093), which provides funds through a competitive grant process to implement water efficiency projects to reduce water and energy use.

The bathroom retrofit program installed new high-efficiency plumbing fixtures in 1,599 bathrooms across 673 single-family, multi-family, and non-residential sites, including the replacement of 1,678 toilets, 262 showerheads, and 128 faucet aerators. The retrofits took place between November 2016 and December 2017.

Water savings are estimated with a statistical model of pre- and post-retrofit water use of participant and control group customers. The retrofit sites form the participant group. Residential sites that did not participate in the retrofit program form the control group. Water savings are estimated as the difference in post-retrofit mean water use between the two groups, after controlling for seasonality, weather, and customer fixed effects.

Energy savings are derived from the estimated water savings using energy use factors for the different water end uses (e.g. toilet, shower, and faucet). Energy savings from the avoided production, treatment, and distribution of water are incorporated into the energy savings estimate. The reduction in greenhouse gas emissions is derived from the estimated energy savings using emission factors appropriate to the power suppliers serving the study region. The same energy and emission factors used in the grant proposal to estimate the reductions in energy use and greenhouse gas emissions are used in this report.

The remainder of this report is organized as follows:

- Section 2 describes the bathroom retrofit program and provides retrofit summary statistics
- Section 3 explains the statistical model used to estimate water savings
- Section 4 documents the data used to implement the statistical model of water savings
- Section 5 presents model estimation results and estimated water savings
- Section 6 presents the energy savings and greenhouse gas reduction analysis
- Section 7 provides a summary of findings

2 DESCRIPTION OF BATHROOM RETROFIT PROGRAM

The objective of the bathroom retrofit program was to replace qualified toilets with high-efficiency toilets, and retrofit qualified showerheads and bathroom faucet aerators when needed. These fixtures were directly installed by a contractor on customers' premises. California Water Service has been shifting its focus toward such direct installation programs for a number of reasons, including:

- Direct installation ensures that the most efficient and effective devices are used, are actually installed, and are installed properly.
- Past rebate and kit distribution programs, as well as ongoing natural replacement of these fixtures, have, to a large extent, “picked the low-hanging fruit,” i.e., the customers that required smaller incentives, financial and otherwise, to participate. There is still a significant inventory of high-consuming fixtures; their owners are less likely to respond to rebate and kit distribution approaches. In particular, low income customers have proven difficult to reach with rebates and kit distribution approaches. It is much easier to target these customers with a direct installation program.
- An inherent difficulty of rebate programs is the phenomenon of “free ridership.” A free rider is a customer who receives a rebate to install a fixture that they were going to install in any event. Studies differ on precisely how severe this problem is, but all agree that it is a factor that dilutes the cost-effectiveness of rebate programs. Direct install programs are much less subject to free ridership.

The bathroom retrofit program provided to qualified customers:

- Installation of high-efficiency toilets, low-flow showerheads, and bathroom faucet aerators;
- Recycling of the replaced devices as practicable; and
- Follow-up customer service and product warranty for a minimum of one year after the installation date.

These services were provided to the customer at no cost. All installations were performed by a state-licensed plumber. The bathroom retrofit program was based on a similar program California Water Service operated in its Bakersfield, Selma, Stockton, and Visalia Districts between 2009 and 2011.

Table 1 shows the fixture specifications that the direct installations were required to meet.

Table 1. Water Use Efficiency of Replaced and Installed Fixtures

Fixture	Water Efficiency of Replaced Units	Water Efficiency of Installed Units
Toilet: Residential	At least 1.6 gpf	No more than 1.0 gpf
Toilet: Non-Residential	At least 1.6 gpf	No more than 1.28 gpf
Showerhead	At least 2.5 gpm	No more than 1.5 gpm
Aerator	At least 1.0 gpm	No more than 0.5 gpm

The program was marketed to residential and non-residential customers by both California Water Service and the outside contractor selected to do the retrofits. Single-family marketing started with a direct mailing that specifically targeted low-income customers in disadvantaged communities as well as customers that had previously expressed interest in participating in previous retrofit programs. California Water Service also directed customer service representatives to inform customers about the program when appropriate and customers could apply for a bathroom retrofit via an online application on Cal

Water's website. Marketing to multi-family customers was primarily done by canvassing of the service area by the outside contractor. California Water Service supplemented the contractor canvassing with direct mailings and phone calls to eligible multi-family sites. Potential non-residential participants were identified through Cal Water's commercial water use evaluation program.

The program successfully targeted customers in disadvantaged communities (DAC). As shown in Table 2, 88% of the single-family participants and 100% of the multi-family and non-residential participants were located in a DAC.

Table 2. Count of Sites by DAC Status

Located in DAC	Multi-Family	Single-Family	Non-Residential
No	0	82	0
Yes	3	585	3

Bathroom retrofits began in April 2017 and ended in December 2017. Figure 1 shows the number sites retrofitted by date. Figure 2 shows the number of bathrooms receiving at least one new fixture by retrofit date. Figure 3 shows the number of fixtures installed by date. Table 3 summarizes the number of bathroom retrofits and fixture installations for single-family, multi-family, and non-residential sites.

Figure 1. Number of Sites Retrofitted by Date

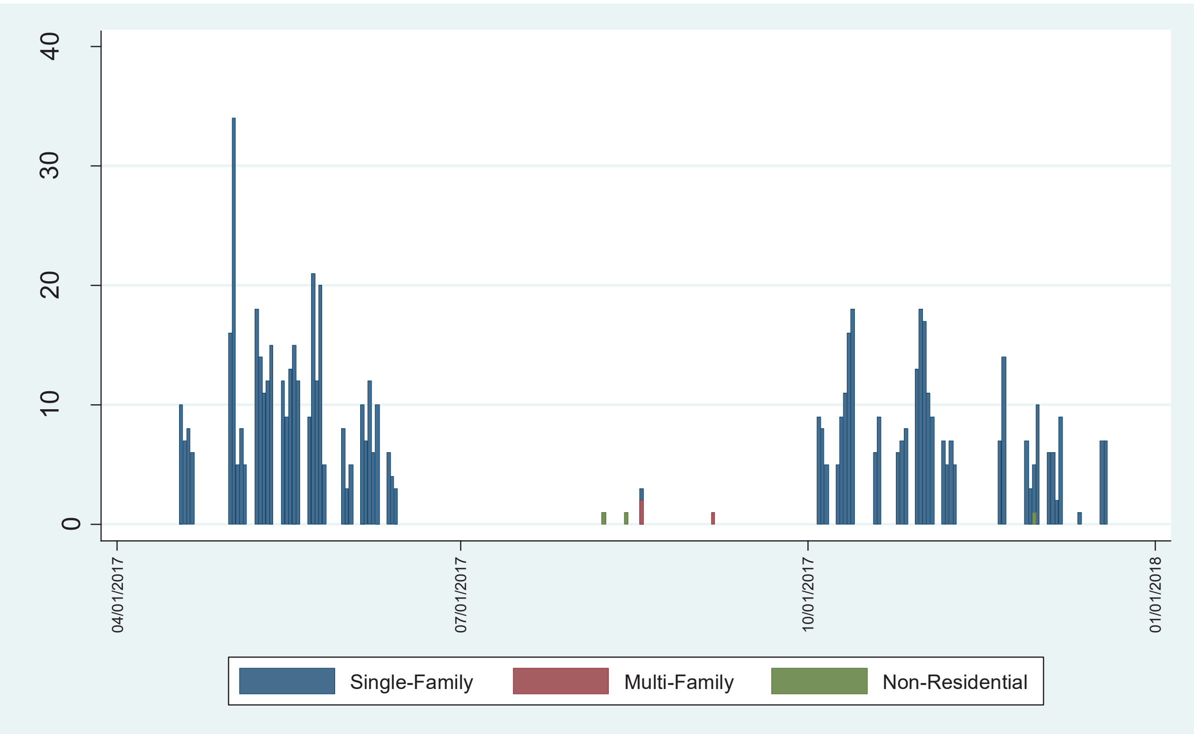

Figure 2. Number of Bathrooms Receiving At Least One New Fixture by Date

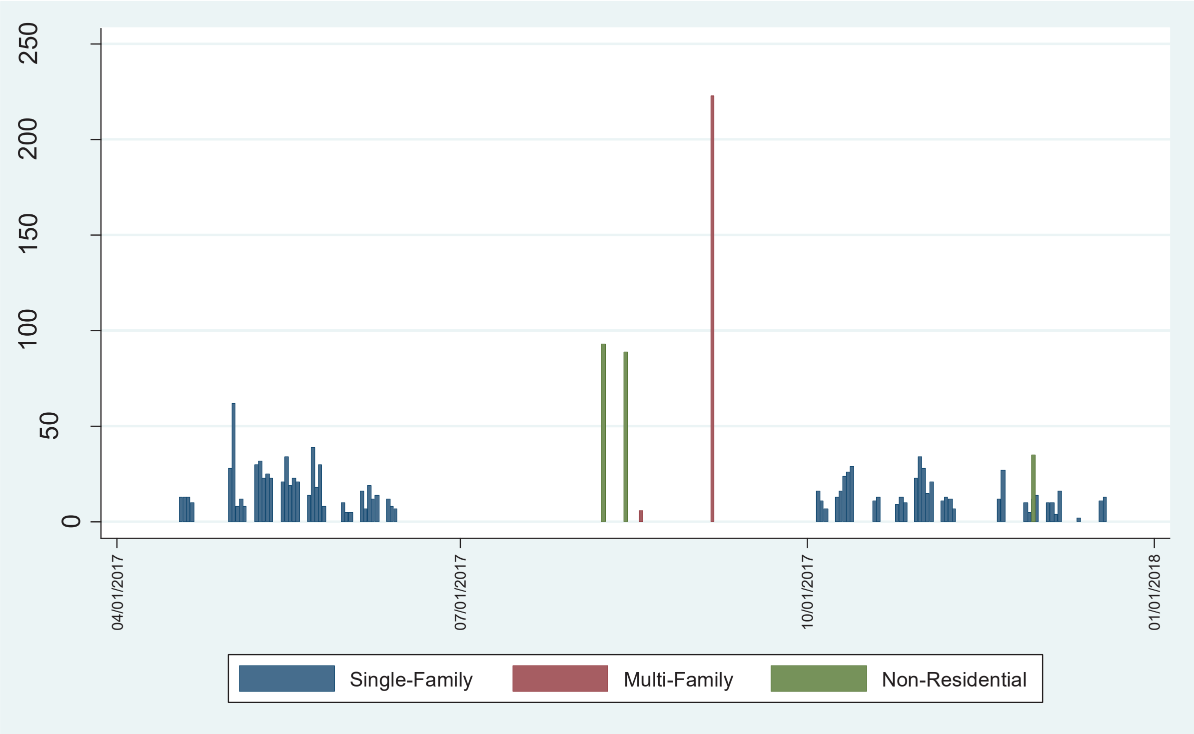

Figure 3. Number of Fixtures Installed by Date

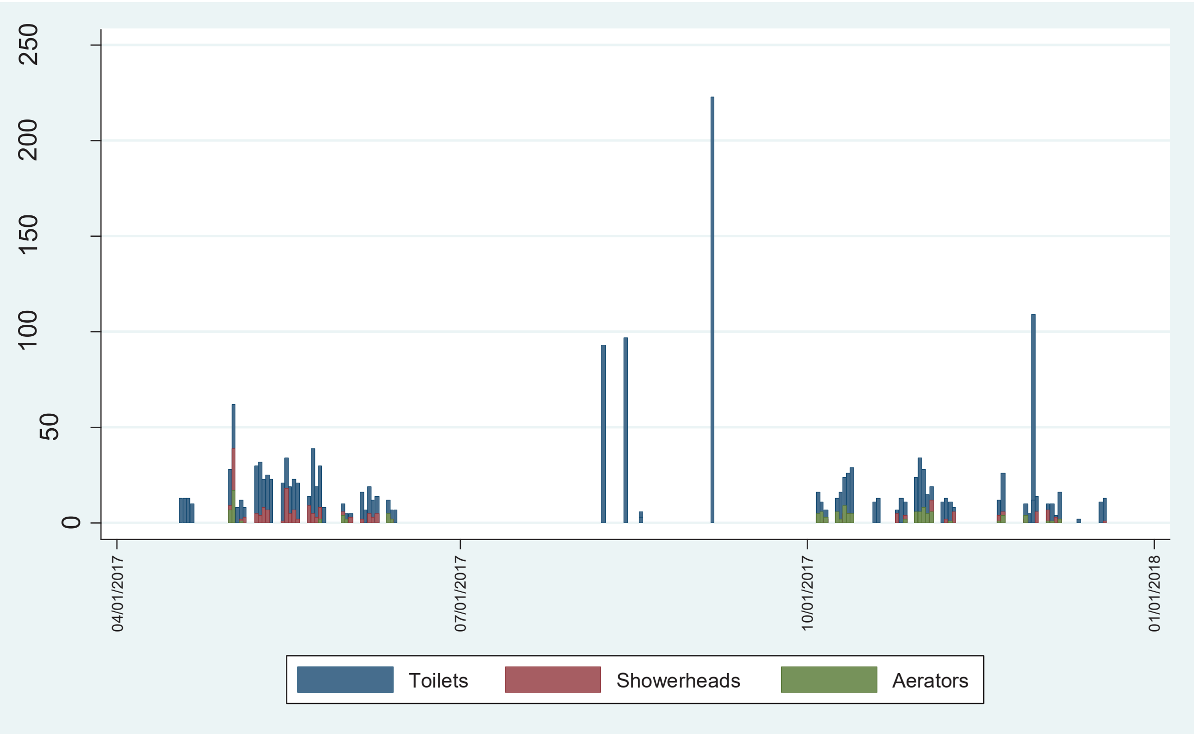

Table 3. Count of Bathrooms Retrofitted and Fixtures Installed

Class	Total Sites	Total Bathrooms	Retrofitted Bathrooms	Installed Toilets	Installed Showerheads	Installed Aerators
Single-Family	667	1,402	1,153	1,150	262	128
Multi-Family	3	236	229	229	0	0
Non-Res	3	229	217	299	0	0
Total	673	1,867	1,599	1,678	262	128

The number of retrofitted toilets as a fraction of all toilets at a site is summarized in Tables 4. The program achieved a high percentage of toilet replacements at most sites.

Table 4. Count of Retrofit Sites by Percentage of Toilets Replaced

Class	0-33%	34-50%	51-99%	100%	Unknown	Total Sites
Single-Family	38	128	35	466	0	667
Multi-Family	0	1	2	0	0	3
Non-Res	0	0	0	1	2	3

2.1 COMPARISON TO PROJECTED IMPLEMENTATION

Actual bathroom fixture installations were significantly different from projected implementation in the grant proposal, as summarized in Table 5. There were two main reasons for this. The most important being that prevailing wage regulatory requirements caused unit replacement costs for multi-family and non-residential bathroom retrofits to be 30-40% greater than assumed in the proposal.[1] DWR waived the prevailing wage regulatory requirement for single-family bathroom retrofits. This made single-family retrofits more cost-effective to complete than multi-family and non-residential retrofits, resulting in a decision to do more single-family retrofits and fewer multi-family and non-residential retrofits than originally proposed.[2] Whereas the grant proposal assumed a fairly uniform distribution of retrofits between single-family, multi-family, and non-residential sites, actual single-family retrofits were 64% greater than the proposed level while multi-family and non-residential retrofits each fell short of projected levels by more than 50%. Overall, the program retrofitted 24% fewer toilets than projected in the grant proposal and these retrofits skewed strongly toward single-family participants.

The second reason for the difference between proposed and actual fixture installations concerned the replacement of showerheads and aerators. The grant proposal assumed one showerhead and one aerator

[1] The grant proposal based bathroom retrofit unit costs on Cal Water's earlier bathroom retrofit programs, which were not subject to prevailing wage regulatory requirements.
[2] The ex-ante water savings estimate for single-family bathroom retrofits was 17-18% less than for multi-family bathroom retrofits, while retrofit costs were 30-40% less. This meant that single-family retrofits, on an ex-ante basis, were significantly more cost-effective per unit of expected water savings than multi-family retrofits.

replacement in each single- and multi-family bathroom retrofit.[3] However, these fixtures were replaced by the plumbing contractor only if they were (1) present in the bathroom and (2) not already low-flow. These two conditions were not met in most of the participating bathrooms. Overall, the program installed 83% fewer showerheads and 91% fewer aerators than projected in the grant proposal.

As discussed later in the report, the differences between proposed and actual fixture installations significantly impacts the water and energy savings realized by the program. For example, the grant proposal assumed that showerhead and aerator replacements would account for 15% of projected water savings and more than 15% of projected energy savings (due to hot water savings). The lower than expected number of showerhead and aerator replacements, however, resulted in significantly less water and energy savings from these fixtures than projected.

Table 5. Projected versus Actual Bathroom Fixture Replacement

	Single-Family	Multi-Family	Non-Residential	Total
Toilets				
Grant Proposal	700	800	700	2,200
Actual	1,150	229	299	1,678
Difference	450	-571	-401	-522
% Difference	64%	-71%	-57%	-24%
Showerheads				
Grant Proposal	700	800	0	1,500
Actual	262	0	0	262
Difference	-438	-800	0	-1,238
% Difference	-63%	-100%	0%	-83%
Aerators				
Grant Proposal	700	800	0	1,500
Actual	128	0	0	128
Difference	-572	-800	0	-1,372
% Difference	-82%	-100%	0%	-91%

3 STATISTICAL MODEL OF WATER SAVINGS

In this section we describe the statistical methodology used to estimate program water savings. Panel data regression using a fixed- or random-effects statistical estimator is the preferred method for estimating water and energy savings from conservation program interventions (Chesnutt and McSpadden, 1991; Sergi and Faruqui, 2011). Sergi and Faruqui (2011) list the primary advantages of panel data regression methods to be:

[3] The grant proposal assumed only toilet replacement for non-residential retrofits.

- Repeated measurements on the participant and control group data are usually readily available using the utility's legacy metering and billing systems, which makes panel data regression methods feasible and cost-effective to implement.
- The availability of repeated measurements of pre- and post-retrofit data for both participant and control groups allows for more precise estimates of savings at smaller sample sizes than other estimation approaches, such as simple difference in means and difference-in-differences techniques.
- It is possible to explicitly incorporate weather variables into the panel data regression framework to control for weather effects on customer water use. This removes a potentially significant source of bias in the measurement of water savings using simpler methods.
- It is possible to account for the effect of time-invariant unobservable factors on water use, such as household characteristics or attitudes towards conservation. Failure to control for differences in unobservable factors across study subjects can also lead to biased estimates of water savings (Angrist and Pischke, 2009).

The general form of the panel regression model used in this study is:

$$y_{it} = S_t + W_t + P_{it} + u_{it} \qquad (1)$$

The left-hand-side variable y_{it} is the metered water use of subject i read on date t, expressed in gallons per day.[4] The right-hand-side variables explain y_{it} in terms of systematic and stochastic determinants of water use. The systematic component is designed to capture the effects of season, weather, and program participation on observed water use. The stochastic component captures the effects of unobserved subject characteristics and other idiosyncratic random factors affecting observed water use. u_{it} is the model's stochastic component while the other right-hand-side variables comprise the systematic component. The construction of each of these model components is described below.

<u>Systematic Model Component</u>

There are three subcomponents to the systematic model component:

- Because residential water use has a pronounced seasonal pattern, the model is constructed to account for the effects of seasonality on water use. Failure to control for seasonality can significantly bias estimated savings.
- W_t is then constructed to capture the effects of weather on water use when it departs from normal conditions. For example, W_t captures the effects that above or below normal rainfall or air temperature have on water use.
- P_{it} is constructed to measure the effect of participation in the bathroom retrofit program on water use.

Seasonal Subcomponent: The cyclical pattern of seasonal water use can be represented with a Fourier series of sines and cosines. The approach dates back to Hannan (1960) and was extended by Jorgenson

[4] For example, if subject i's meter read on date t is 10 ccf and covers 30 days of consumption, then $y_{it} = 10 * 748/30$=249.3 gallons, since there are 748 gallons per ccf.

(1964) to include estimation of both trend and seasonality. The first step is to construct twelve daily harmonic variables as given in equations 2 and 3.

$$sin_{jd} = sin\left(\frac{2\pi \cdot j \cdot d}{365}\right) \; for\; j = 1,2,\ldots,6 \; and \; d = 1,2,\ldots,365 \tag{2}$$

$$cos_{jd} = cos\left(\frac{2\pi \cdot j \cdot d}{365}\right) \; for\; j = 1,2,\ldots,6 \; and \; d = 1,2,\ldots,365 \tag{3}$$

The daily harmonics are then formed into n-term averages, where n is the number of days of water consumption in the meter read. Thus, for meter read date t, the following averages are formed:

$$\overline{sin}_{jt} = \frac{1}{n}\sum_{k=t-n+1}^{t} sin_{jk} \;\; for\; j = 1,2,\ldots,6 \tag{4}$$

$$\overline{cos}_{jt} = \frac{1}{n}\sum_{k=t-n+1}^{t} cos_{jk} \;\; for\; j = 1,2,\ldots,6 \tag{5}$$

The seasonal subcomponent is then given by equation 6:

$$S_t = \sum_{j=1}^{6} \beta_{sinj} \cdot \overline{sin}_{jt} + \sum_{j=1}^{6} \beta_{cosj} \cdot \overline{cos}_{jt} \tag{6}$$

where β_{sinj} and β_{cosj} are parameters that are estimated. The lower frequency harmonic terms usually explain most of the seasonal variation in water use and it is often the case that the higher frequency terms can be omitted from the model with little predictive loss.

Weather Subcomponent: The seasonal subcomponent is constructed to capture the effects of normal weather on water use. The weather subcomponent is designed to capture the effects of departures from normal weather on water use. The variables are constructed in two steps. In the case of precipitation, the first step is to calculate n-period sums of daily precipitation for each date in the weather time-series. As before n is the number of days of consumption in a meter read. These sums are then log-transformed. One is added to the sum prior to log transformation to deal with the case of zero precipitation for a period.

$$ppt_t = ln\left(1 + \sum_{k=t-n+1}^{t} ppt_k\right) \tag{7}$$

In the second step ppt_t is regressed on the $\overline{sin}_{jt}$ and $\overline{cos}_{jt}$ variables. The predicted values from this regression are the expected or normal n-period cumulative precipitation for each date t and the residuals of the regression are the deviations between actual and normal cumulative precipitation. Thus

$$dppt_t = ppt_t - \sum_{j=1}^{6} \hat{A}_{sinj} \cdot \overline{sin}_{jt} - \sum_{j=1}^{6} \hat{A}_{cosj} \cdot \overline{cos}_{jt} - \hat{A}_0 \quad (8)$$

where $\hat{A}_{sinj}$, $\hat{A}_{cosj}$, and $\hat{A}_0$ are the estimated parameters of the regression model given in equation (9):

$$ppt_t = A_0 + \sum_{j=1}^{6} A_{sinj} \cdot \overline{sin}_{jt} - \sum_{j=1}^{6} A_{cosj} \cdot \overline{cos}_{jt} + \varepsilon_t \quad (9)$$

The temperature variable is constructed in a similar way except that in the first step n-period averages rather than sums are formed and there is no need to add one prior to log transformation since the average temperature in the study area is never zero.

$$tmax_t = ln\left(\frac{1}{n} \sum_{k=t-n+1}^{t} tmax_k\right) \quad (10)$$

In the second step $tmax_t$ is regressed on the $\overline{sin}_{jt}$ and $\overline{cos}_{jt}$ and $dppt_t$ variables. Precipitation is included in the regression to account for its effect on air temperature. The regression residuals then yield the deviations between actual and normal temperature. Thus

$$dtmax_t = tmax_t - \sum_{j=1}^{6} \hat{B}_{sinj} \cdot \overline{sin}_{jt} - \sum_{j=1}^{6} \hat{B}_{cosj} \cdot \overline{cos}_{jt} - \hat{B}_1 \cdot dppt_t - \hat{B}_0 \quad (11)$$

where $\hat{B}_{sinj}$, $\hat{B}_{sinj}$, $\hat{B}_1$, and $\hat{B}_0$ are the estimated parameters of the regression model given in equation (12):

$$tmax_t = B_0 + B_1 \cdot dppt_t + \sum_{j=1}^{6} B_{sinj} \cdot \overline{sin}_{jt} - \sum_{j=1}^{6} B_{cosj} \cdot \overline{cos}_{jt} + \varepsilon_t \quad (12)$$

To account for the seasonality of weather effects on water use, the precipitation sums and temperature averages are interacted with the seasonal harmonics.[5] The interacted weather variables are then regressed on the seasonal harmonics in the same way as before and the regression residuals provide the seasonal interaction terms of the weather subcomponent.

Lagged values of the precipitation and temperature variables also can be incorporated into the model.

[5] For example, it is commonly observed that water use in the spring season is more sensitive to deviations in precipitation than in other seasons, most likely because higher than normal precipitation in the spring delays the start of the irrigation season while lower than normal amounts advance it.

The weather subcomponent is shown in equation 13:

$$W_t = \beta_{precip1} \cdot dppt_t + \beta_{precip2} \cdot dppt_{t-n} + \beta_{precip3} \cdot dppt\_sin1_t + \beta_{precip4} \cdot dppt\_cos1_t + \beta_{temp1} \cdot dtmax_t + +\beta_{tmax2} \cdot dtmax\_sin1_t + \beta_{tmax3} \cdot dtmax\_cos1_t \quad (13)$$

Program Participation Subcomponent: For this analysis, two alternative specifications of the participation subcomponent are implemented. The first is designed to estimate the average savings of a bathroom retrofit. The second is designed to estimate fixture-level savings.

The first specification is given by equation (14).

$$P_{it} = \beta_{bathroom} \cdot Bathrooms_{it} \quad (14)$$

where $Bathrooms_{it}$ equals the cumulative number of bathrooms retrofitted for customer i in period t. For some participants, retrofits were done over a span of months and the $Bathrooms_{it}$ variable is constructed in such a way to account for this fact.

The second specification is given by equation (15).

$$P_{it} = \beta_{toilet} \cdot Toilets_{it} + \beta_{showerhead} \cdot Showerheads_{it} + \beta_{aerator} \cdot Aerators_{it} \quad (15)$$

where the fixture variables equal the cumulative number of toilets, showerheads, and aerators retrofitted for customer i in period t.

The parameter $\beta_{bathroom}$ measures the average water savings of a bathroom retrofit. Similarly, the parameters β_{toilet} and $\beta_{showerhead}$ and $\beta_{aerator}$ measure the average water savings of replacing individual fixtures. If the model is estimated in levels,[6] the parameter estimates translate directly to the expected daily water savings in gallons per day per retrofit. If the model is instead estimated in logs, the parameters measure the average percentage change in water use per retrofit. A Box-Cox model specification test is used to inform the decision to estimate the model in levels or logs.

Stochastic Model Component

The stochastic component of the model is assumed to have the error structure given in equation 16.

$$u_{it} = \alpha_i + \sigma_{Bathrooms} + \varepsilon_{it} \quad (16)$$

Under this formulation, α_i represents variation in water use due to unmeasured and time-invariant household characteristics while ε_{it} represents variation in water use due to idiosyncratic error. This idiosyncratic error ε_{it} is allowed to covary with α_i and the number of bathrooms retrofit.

[6] Meaning the left-hand-side variable is not log-transformed prior to model estimation.

Choice of Model Estimator

Given this error structure, a random- or fixed-effects estimator is the appropriate choice for model estimation. Which estimator to use depends on whether it is reasonable to assume the α_i are uncorrelated with the other regressors. If so, both estimators are consistent but the random-effects estimator is more efficient and therefore should be preferred.[7] If not, the random-effects estimator is inconsistent and the fixed-effects estimator should be used. A Hausman specification test can help inform the choice.

Allowing correlation between the idiosyncratic equation error and the customer specific intercept and the number of bathrooms retrofit is a form of "random effects" model. This multi-level model is estimated using a Bayesian multilevel modeling approach. Known as Gibbs sampling [a Markov Chain Monte Carlo (MCMC) algorithm] it estimates the posteriori model coefficients and variance components. For the Program Participation specification defined by equation 14—the expected effect of a bathroom retrofit—non-informative Bayesian priors are used. For the Program Participation specification defined by equation 15—the expected effect of fixture retrofits—informative Bayesian priors are used.

Development of Empirical Bayesian Priors for Plumbing fixtures

To develop the Bayesian priors for toilet savings we use the toilet savings extrapolation equation from the Alliance for Water Efficiency's Water Conservation Tracking Tool. The extrapolation equation is based on previous field evaluations of single-family toilet retrofit programs and estimates toilet savings based on number of household residents. This results in a Bayesian prior for single-family toilet savings of 26.6 gpd.[8] A standard error of 4 gpd is attached to these priors.[9]

In the case of showerheads, shower use statistics from the 2016 Residential End Uses of Water Study (REUWS) (Water Research Foundation 2016) are used. This study reported an average shower flow rate of 2.1 gpm, an average shower duration of 7.8 minutes, and an average shower frequency of 0.69 showers per person per day. In the Dominguez and East Los Angeles retrofit programs, average household size is 4.2 persons in households that had new 1.5 gpm showerheads installed. Based on the REUWS showering statistics, the expected efficient showerhead water savings for these households would be 12.7 gallons per day.[10] A standard error of 3 gpd is assumed.

The faucet aerator estimate also can be compared against theoretical savings based on faucet use statistics from REUWS. REUWS reported an average faucet use volume of 0.5 gallons per use and an

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[7] In statistics, a consistent estimator is one that produces parameter estimates that get closer and closer to the true values of the parameters as sample size tends to infinity. One estimator is said to be more efficient than another if, given equal sample sizes, it has lower variance – i.e. it generates more precise estimates of the underlying true parameter.

[8] The extrapolation equation is single-family toilet savings in gpd = 7.826 + 6.693 x PPH – 0.529 x PPH^2, where PPH is the average number of persons per household. PPH for program participants is 4.2.

[9] See CUWCC (2005) BMP Costs & Savings Study for a review of prior field evaluations of single-family toilet replacement program water savings.

[10] (2.1 gal/min – 1.5 gal/min) x 7.8 min x 0.69 showers/person x 3.92 persons/household = 12.7 gallons.

average use duration of 30 seconds, implying an average flow rate of 1 gallon per minute. Switching a bathroom faucet aerator to 0.5 gpm would be expected to reduce faucet water use by half a gallon per minute of use. REUWS also reported that faucet usage averages 20 uses per person per day, implying 84 uses per day, on average, in households participating in the Dominguez and East Los Angeles bathroom retrofit programs. If it is assumed retrofitted faucets account for one-sixth of total uses, the expected daily aerator savings would be 3.0 gpd.[11] A standard error of 3 gpd is assumed.

The Bayesian Panel model will arrive at a combination of this prior estimate with those estimated by the data—that is, a posteriori distribution of fixture water savings for the three end uses.

4 DATA USED TO IMPLEMENT THE STATISTICAL MODEL OF WATER SAVINGS

In this section, we describe the data sources and construction of the data sets that were used to estimate the statistical models. Data issues complicating the estimation of water savings also are discussed.

4.1 DATA SOURCES

Weather Data: Daily estimates of precipitation (in inches) and maximum air temperature (in Farenheit) for January 1, 1987 to March 31, 2018 were downloaded from PRISM for latitude 33.839 and longitude -118.2705 and latitude 34.0219 and longitude -118.162, which are respectively the centroids of the Dominguez and East Los Angeles service areas.[12] The daily weather data were used to construct the weather variables described in the previous section.

Customer Water Use Data: California Water Service provided monthly water use for its residential and non-residential customers for each district for the period January 1, 2013 to March 31, 2018. Metered water use, which is reported in hundred cubic feet (ccf), was converted to gallons of water use per day by dividing the reported quantity in ccf by the number of days in the billing cycle and multiplying the result be 748, the number of gallons per ccf. Meter read dates were used to match the consumption records with their corresponding seasonal and weather variables.

Program Participation Data: California Water Service provided data on each program participant which included:

- Customer account number
- Premise identification number
- Number of full and partial bathroom retrofits
- Number of toilets installed
- Number of showerheads installed
- Number of aerators installed
- Dates of installation

[11] If retrofitted faucets account for one-sixth of household faucet use, then expected savings would be (1.0 gal/min – 0.5 gal/min) x 0.5 min/use x 71.4/6 uses/day = 2.975.
[12] The PRISM Climate Group (http://prism.oregonstate.edu/explorer/).

Account and premise identification numbers were used to match program particpant records to the customer water use data. The installation dates and counts of bathroom retrofits and toilet and showerhead installations were used to construct the program participation variables described in Section 3. If a customer was not a program participant, they were flagged for inclusion in the control group.

4.2 DATA ISSUES

The limited number of retrofit sites made it infeasible to reliably estimate water savings for the multi-family and non-residential sites. Recall from Table 3 that the program retrofitted only three multi-family three non-residential sites. However, California Water Service has previously evaluated water savings for multi-family bathroom retrofit programs implemented in its Bakersfield, Selma, Stockton, and Visalia districts between 2009 and 2011 (A&N Technical Services 2013).[13] The results from this prior evaluation are used to estimate the water savings for the multi-family retrofits. In the case of the non-residential sites, there was no remedy and the savings estimate from the grant proposal is used.

Another data issue concerned the amount elapsed time following the bathroom retrofits. It is generally recommended that at least one year of post-retrofit consumption data be used to estimate savings of water and energy efficiency programs (Sergici and Faruqui, 2011). The original program schedule was developed with this in mind, with retrofits to be completed in 2016 and the savings evaluation to be completed in late 2017. However, delays in the start of the program resulted in most retrofits being completed in 2017 rather than 2016, leaving insufficient time to complete the water savings analysis before the end of the grant agreement. As a consequence, DWR extended the grant agreement an additional six months. With the grant extension, an average of eight months of post-retrofit consumption data was able to be collected. This proved sufficient to estimate bathroom retrofit water savings for single-family program participants with good statistical precision.

5 ESTIMATED WATER SAVINGS

In this section we present the results of the statistical analysis of water savings. We then compare these estimates to the water savings assumptions used in the grant proposal. We conclude the section with an estimate of total program water savings.

5.1 SINGLE-FAMILY WATER SAVINGS

Tables 6 shows the estimation results for the Dominguez and East Los Angeles single-family bathroom retrofit intervention models. The Dominquez model is estimated using water consumption data for 308 single-family customers and 19,361 monthly observations of customer-level water use spanning the period January 2013 to March 2017. The East Los Angeles model is estimated using data for 223 single-family customers and 13,997 monthly observation of water use. Estimated model parameters have the expected signs and magnitudes and most are statistically significant at greater than a 99% level of confidence.

[13] A&N Technical Services (2013) used a statistical methodology similar to the one described in Section 3.

The average water savings for a single-family bathroom retrofit is 25.8 gallons per day in the Dominguez District and 35.5 gallons per day in the East Los Angeles District. Both estimates are more than six standard errors from zero, implying the null hypothesis of no discernable savings can be rejected at a very high level of statistical confidence.

A similar model was estimated for single-family bathroom retrofit programs operated in California Water Service's Bakersfield district over the same period as part of a separate Water-Energy grant. Table 7 compares estimated bathroom retrofit savings across the three districts. The estimates are similar, ranging between 25.8 and 35.5 gallons per day. The null hypothesis of no discernable savings is strongly rejected in each district.

To compute energy savings, it is necessary to estimate the fraction of water savings generated by showerhead and aerator replacements so that hot water savings can be estimated. Unfortunately, we were not able to get statistically reliable estimates of showerhead and aerator savings using the Dominguez and East Los Angeles data due to the low number of showerhead and aerator retrofits. We had better success with the Bakersfield data. For the Bakersfield program, we estimated average savings of 12.6 and 3.0 gpd for showerheads and aerators, respectively.[14] We use these fixture savings rates to calculate hot water and energy savings.

The final fixture savings values used to estimate energy savings in Section 6 are computed as follows. Showerhead and aerator savings are assumed to equal 12.6 and 3.0 gpd, respectively. The value for toilet savings is then selected so that average bathroom retrofit savings is equal to the average savings per bathroom retrofit given in Table 6. This results in the single-family bathroom fixture retrofit savings shown in Table 8.

Note that summing the individual fixture savings in Table 8 will result in a total bathroom savings that is greater than what is shown on the last line of the table for the average bathroom retrofit. This is because showerheads and aerators were not installed in the majority of the bathroom retrofits. In the Dominguez District, the program replaced, on average, 1 toilet, 0.13 showerheads, and 0.10 aerators per bathroom. In the East Los Angeles District, average replacement rates were 1 toilet, 0.36 showerheads, and 0.12 aerators per bathroom. The average bathroom savings in Dominguez is therefore 23.9 x 1 + 12.6 x 0.13 + 3.0 x 0.10 = 25.8 gpd, as shown in Table 8. Similarly, the average bathroom savings in East Los Angeles is 30.7 x 1 + 12.6 x 0.36 + 3.0 x 0.12 = 35.5.

[14] See M.Cubed and A & N Technical Services (2018). Statistical Analysis of Bathroom Retrofit Water and Energy Savings, California Water Service Bakersfield District, DWR Grant Agreement No. 4600011092. Prepared for California Water Service.

Table 6. Single-Family Bathroom Retrofit Intervention Model Estimation Results

Dependent Variable: Monthly water use in gpd/acct	**Dominguez District** Parameter Estimate	Std Dev	**East LA District** Parameter Estimate	Std Dev
Sin1	-20.4	1.7	-21.6	2.255
Cos1	-39.7	1.319	-28.1	1.761
Sin2	3.7	1.407	2.0	1.969
Cos2	4.2	1.368	6.4	1.855
Sin3	2.5	1.355	6.1	1.895
Cos3	4.5	1.371	9.1	1.921
Sin4	-0.9	1.484	0.9	2.036
Cos4	-0.3	1.510	-1.3	2.114
Sin5	-0.5	1.701	-3.3	2.367
Cos5	0.6	1.642	-3.1	2.251
Sin6	6.2	2.120	11.6	2.887
Cos6	3.4	1.926	11.5	2.680
Precipitation	-60.7	4.676	-56.8	5.557
Prior month precipitation	-22.6	2.670	-16.2	3.365
Precipitation x Sin1	4.2	5.023	-4.8	6.033
Precipitation x Cos1	48.0	5.632	46.7	6.730
Temperature	57.4	12.695	64.1	13.303
Temperature x Sin1	63.3	36.130	8.8	49.753
Temperature x Cos1	-127.6	35.348	-76.6	44.159
Retrofitted bathrooms	**-25.8**	**1.499**	**-35.5**	**5.420**
Constant	269.7	7.378	335.7	10.247
No. Observations	19,361		13,997	
No. of Customer Clusters	308		223	
sigma_u	127.5		146.1	
sigma_Bathrooms	2.6		58.7	
sigma_e	119.2		138.3	
Intra-cluster Correlation	0.730		0.697	

Table 7. Comparison of Single-Family Bathroom Retrofit Savings across Three Cal Water Districts

Dependent Variable: Monthly water use in gpd/acct	**Bakersfield District** Parameter Estimate	Std Dev	**Dominguez District** Parameter Estimate	Std Dev	**East LA District** Parameter Estimate	Std Dev
Sin1	-63.1	2.644	-20.4	1.7	-21.6	2.255
Cos1	-157.9	2.781	-39.7	1.319	-28.1	1.761
Sin2	13.1	2.523	3.7	1.407	2.0	1.969
Cos2	11.4	2.541	4.2	1.368	6.4	1.855
Sin3	9.5	2.613	2.5	1.355	6.1	1.895
Cos3	6.8	2.583	4.5	1.371	9.1	1.921
Sin4	-1.1	2.779	-0.9	1.484	0.9	2.036
Cos4	8.4	2.836	-0.3	1.510	-1.3	2.114
Sin5	1.6	3.208	-0.5	1.701	-3.3	2.367
Cos5	-2.1	3.036	0.6	1.642	-3.1	2.251
Sin6	17.6	3.350	6.2	2.120	11.6	2.887
Cos6	-1.9	3.966	3.4	1.926	11.5	2.680
Precipitation	-133.7	9.939	-60.7	4.676	-56.8	5.557
Prior month precipitation	-72.9	6.589	-22.6	2.670	-16.2	3.365
Precipitation x Sin1	-9.7	10.619	4.2	5.023	-4.8	6.033
Precipitation x Cos1	80.8	12.612	48.0	5.632	46.7	6.730
Temperature	326.4	61.418	57.4	12.695	64.1	13.303
Temperature x Sin1	211.7	66.208	63.3	36.130	8.8	49.753
Temperature x Cos1	-211.0	74.712	-127.6	35.348	-76.6	44.159
Retrofitted bathrooms	**-32.2**	**3.336**	**-25.8**	**1.499**	**-35.5**	**5.420**
Constant	404.3	10.714	269.7	7.378	335.7	10.247
No. Observations	17,592		19,361		13,997	
No. of Customer Clusters	287		308		223	
sigma_u	162.0		127.5		146.1	
sigma_Bathrooms	21.9		2.6		58.7	
sigma_e	275.1		119.2		138.3	
Intra-cluster Correlation	0.506		0.730		0.697	

Table 8. Estimated Single-Family Toilet, Showerhead, and Aerator Savings in Gallons per Day

	Dominguez District		**East Los Angeles District**	
Fixture	Average # Replaced per Bathroom	Unit Savings gpd	Average # Replaced per Bathroom	Unit Savings gpd
Toilet	1.00	23.9	1.00	30.7
Showerhead	0.13	12.6	0.36	12.6
Aerator	0.10	3.0	0.12	3.0
Average Bathroom Retrofit		25.8		35.5

5.2 MULTI-FAMILY WATER SAVINGS

As discussed in Section 4.2, the limited number of retrofit sites made it infeasible to reliably estimate water savings for the multi-family sector. However, California Water Service has previously evaluated water savings for multi-family bathroom retrofit programs implemented in its Bakersfield, Selma, Stockton, and Visalia districts between 2009 and 2011 (A&N Technical Services 2013). The estimation results for Bakersfield from this prior study are shown in Table 9. The model is estimated using water consumption data for more than 1,200 multi-family customers and more than 70,000 monthly observations of customer-level water use spanning the period January 2009 to November 2012. All estimated model parameters have the expected signs and magnitudes and are statistically significant at a high level of statistical confidence.

The average water savings for a multi-family bathroom retrofit is 52.6 gallons per day. The estimated effect is more than four standard errors from zero, implying the null hypothesis of no discernable savings can be rejected at very high levels of statistical confidence.

The estimated bathroom retrofit savings are roughly double what was estimated for single-family. In part this is because nearly all the multi-family bathroom retrofits upon which the results in Table 9 are based were complete retrofits – replacing toilet, showerhead, and faucet aerator -- which was not the case for the single-family retrofits. In many of the single-family retrofits only the toilet was replaced.

Even if single- and multi-family bathrooms received the same level of treatment, we would nonetheless expect multi-family savings to be higher for other reasons. First, multi-family households tend to have fewer bathroom fixtures per occupant, resulting in higher fixture usage rates and therefore greater water savings per fixture. Second, older toilets that use more water tend to be more common in multi-family housing, where remodel rates are lower. Third, toilet leaks may be more prevalent in multi-family housing where common metering provides less incentive for occupants to fix toilet leaks. Previous toilet savings evaluations have consistently found multi-family sites to have higher savings than single-family sites.[15]

[15] See CUWCC (2005) for a review of previous single- and multi-family bathroom fixture savings evaluations.

Table 9. Multi-Family Bathroom Retrofit Intervention Model Estimation Results from A&N Technical Services' 2013 Program Evaluation

Dependent Variable: Monthly water use in gpd/acct	**Parameter Estimate**	**Standard Error of Estimate**
Sin1	-764.2	56.4
Cos1	-73.7	19.7
Sin2	54.3	9.7
Cos2	-61.2	9.9
Precipitation	-78.4	24.2
April-May ETo	555.9	138.8
Retrofitted bathrooms	**-52.6**	**11.5**
Post Retrofit Control	-99.5	43.4
Constant	3117.1	164.2
Observations	70,494	
N_clust	1,232	
sigma_u	5,388.8	
sigma_e	2,468.6	
Time period of model	Jan 2009 – Nov 2012	

The evaluation of the 2009-2011 multi-family retrofit program did not parse the mean bathroom savings between toilets, showerheads, and aerators. While previous studies have found significant differences in toilet water savings between single- and multi-family sites, the same has not been true for showerheads and faucets. For the calculation of energy savings presented in Section 6, the single-family showerhead and aerator savings are therefore used for both the single- and multi-family retrofits. The value for toilet savings is then selected so that average bathroom retrofit savings matches the estimate from Table 9 of 52.6 gpd. This results in estimated water savings of 38.6 gpd for multi-family toilets, as shown Table 10.[16]

Table 10. Estimated Multi-Family Toilet, Showerhead, and Aerator Savings in Gallons per Day

Fixture	**Average # Replaced per Bathroom***	**Unit Savings gpd**
Toilet	1.00	38.6
Showerhead	0.88	12.6
Aerator	0.95	3.0
Average Bathroom Retrofit		52.6

* Installation frequencies from 2009-12 bathroom retrofit program.

Using the fixture unit savings estimates from Table 10, the average savings of 38.6 gpd per multi-family bathroom retrofit for the retrofits completed in 2016-17 is calculated in Table 11.

[16] This is based on the retrofit of 483 multi-family bathrooms and the replacement of 483 toilets, 427 showerheads, and 457 faucet aerators.

Table 11. Derivation of Average Savings per Multi-Family Bathroom Retrofit

Fixture	Average # Replaced per Bathroom	Unit Savings gpd
Toilet	1.00	38.6
Showerhead	0.00	12.6
Aerator	0.00	3.0
Average Bathroom Retrofit		38.6

5.3 NON-RESIDENTIAL WATER SAVINGS

As discussed in Section 4.2, non-residential toilet savings could not be estimated due to inadequate sample size. For the calculation of energy savings presented in Section 6, the estimates from the grant proposal are used. These are 20.6 gpd for the Dominguez District and 21.5 gpd for the East Los Angeles District.

5.4 COMPARISON TO GRANT PROPOSAL FIXTURE WATER SAVINGS ASSUMPTIONS

Table 12 compares the bathroom and fixture unit water savings estimates to the values in the grant proposal. The total savings for complete single- and multi-family bathroom retrofits differ by less than 10% between the grant proposal and the program evaluation. As noted in the previous section, it was not possible to estimate non-residential toilet savings and therefore the estimate from the proposal is used in the water and energy savings analysis.

The unit savings for individual fixtures are significantly different between the grant proposal and the program evaluation. The grant proposal assumed higher toilet and lower showerhead and aerator unit savings than was found in the program evaluation. The difference is due to the grant proposal's assumption that 15% of total program water savings would come from the single- and multi-family showerhead and aerator retrofits. This assumption implies showerhead and aerator daily unit savings of 8.6 gpd for the Dominguez District and 8.8 gpd for the East Los Angeles District, or about 8.7 gpd when averaged across both districts.[17] This is almost certainly too low given the program evaluation estimated daily unit savings that are almost twice this amount for showerheads and aerators.

[17] 31.8 x 10^6 gal/year total savings x 0.15 x 1 year/365 days x 1/1500 units = 8.7 gpd/unit

Table 12. Summary of Bathroom Fixture Water Savings Estimates in Gallons per Day

	Grant Proposal			Program Evaluation		
Class	Toilet	Showerhead & Aerator	Total	Toilet	Showerhead & Aerator	Total
Dominguez District						
Single-Family	34.3	8.6	43.0	23.9	15.6	39.5
Multi-Family	43.9	8.6	52.6	38.6	15.6	54.2
Non-Residential*	20.6	NA	20.6	20.6	NA	20.6
East Los Angeles District						
Single-Family	34.8	8.8	43.6	30.7	15.6	46.3
Multi-Family	43.7	8.8	52.6	38.6	15.6	54.2
Non-Residential*	21.5	NA	21.5	21.5	NA	21.5

* Non-residential toilet savings could not be estimated due to an insufficient number of retrofits. Therefore the estimate from the grant proposal is used to calculate non-residential toilet savings.

5.5 PROGRAM WATER SAVINGS

5.5.1 POTABLE WATER SAVINGS

The program evaluation's estimates of annual and lifetime water savings are summarized in Table 13. Lifetime savings are based on a 25-year project life, per the grant proposal. Annual water savings are 18.2 MG/yr and lifetime savings are 454 MG.

Table 14 compares the estimates in Table 13 to the levels projected in the grant proposal. Overall, estimated water savings are 43% less than projected in the proposal. The shortfall is caused by the installation of fewer fixtures than projected as well as disproportionate participation of single-family households, which have lower unit toilet savings than multi-family households. Indeed, given the unit savings from the program evaluation, had the proposed fixture retrofits been fully realized, the difference in projected and actual water savings would have been insignificant, as shown in Table 15.

Table 13. Estimated Annual and Lifetime Program Water Savings

	Single-Family	Multi-Family	Non-Residential	Total
Number of Retrofits				
Toilets	1,150	229	299	1,678
Showerheads	262	0	0	262
Aerators	128	0	0	128
Savings per Retrofit (GPD)*				
Toilets	26.8	38.6	21.5	
Showerheads	12.6	12.6	12.6	
Aerators	3.0	3.0	3.0	
Annual Savings (MG/yr)				
Toilets	11.2	3.2	2.4	16.8
Showerheads	1.2	0.0	0.0	1.2
Aerators	0.1	0.0	0.0	0.1
Total	12.6	3.2	2.4	18.2
Lifetime Savings (MG)**				
Toilets	280.8	80.7	58.8	420.3
Showerheads	30.1	0.0	0.0	30.1
Aerators	3.5	0.0	0.0	3.5
Total	314.5	80.7	58.8	454.0

* Savings per retrofit are the weighted average for Dominguez and East Los Angeles.
**Lifetime savings based on 25-year project life. In the table, lifetime savings do not precisely correspond to annual savings due to independent rounding.

Table 14. Difference in Annual and Lifetime Water Savings between Grant Proposal and Program Evaluation at Actual Fixture Replacement Levels

	Grant Proposal	Program Evaluation	Difference	% Difference
Number of Retrofits				
Toilets	2,200	1,678	-522	-24%
Showerheads	1,500	262	-1,238	-83%
Aerators	1,500	128	-1,372	-91%
Annual Savings (MG/yr)				
Toilets	27.0	16.8	-10.2	-38%
Showerheads & Aerators	4.8	1.3	-3.4	-72%
Total	31.8	18.2	-13.6	-43%
Lifetime Savings (MG)*				
Toilets	675.1	420.3	-254.7	-38%
Showerheads & Aerators	119.1	33.6	-85.5	-72%
Total	794.2	454.0	-340.2	-43%

*Lifetime savings based on 25-year project life. In the table, lifetime savings do not precisely correspond to annual savings due to independent rounding.

Table 15. Difference in Annual and Lifetime Water Savings between Grant Proposal and Program Evaluation at Grant Proposal Projected Fixture Replacement Levels

	Grant Proposal	Program Evaluation*	Difference	% Difference
Number of Retrofits				
Toilets	2,200	2,200	0	0%
Showerheads	1,500	1,500	0	0%
Aerators	1,500	1,500	0	0%
Annual Savings (MG/yr)				
Toilets	27.0	23.6	-3.4	-13%
Showerheads & Aerators	4.8	8.5	3.8	79%
Total	31.8	32.2	0.4	1%
Lifetime Savings (MG)**				
Toilets	675.1	590.5	-84.6	-13%
Showerheads & Aerators	119.1	213.5	94.4	79%
Total	794.2	804.0	9.8	1%

* Assuming grant proposal projected fixture replacement levels.
**Lifetime savings based on 25-year project life. In the table, lifetime savings do not precisely correspond to annual savings due to independent rounding.

5.5.2 HOT WATER SAVINGS

Program energy savings derive from reduction in water system transmission, treatment, and distribution of water and reduction in program participant use of hot water. In the grant proposal, it was assumed that hot water comprised 79% of showerhead and faucet water use. However, results of data logging of shower and faucet water use reported in the 2016 Residential End Uses of Water Study (WRF 2016) suggest this estimate is too high. It found that hot water comprised 66% of shower and 57% of faucet water use. We use these percentages to calculate the program hot water savings shown in Table 16.

Table 17 compares the hot water savings estimates in Table 16 to the levels assumed in the grant proposal. Estimated hot water savings are 77% less than projected in the proposal. All of the shortfall can be attributed to the installation of fewer showerhead and aerator replacements than projected.

Table 16. Estimated Annual and Lifetime Program Hot Water Savings

	Single-Family	Multi-Family	Total
Annual Water Savings (MG/yr)			
Showerheads	1.20	0.00	1.20
Aerators	0.14	0.00	0.14
Total	1.35	0.00	1.35
Annual Hot Water Savings (MG/yr)			
Showerheads	0.80	0.00	0.80
Aerators	0.08	0.00	0.08
Total	0.88	0.00	0.88
Lifetime Hot Water Savings (MG/yr)*			
Showerheads	19.9	0.0	19.9
Aerators	2.0	0.0	2.0
Total	21.9	0.0	21.9
*Lifetime savings based on 25-year project life.			

Table 17. Difference in Annual and Lifetime Hot Water Savings between Grant Proposal and Program Evaluation

	Grant Proposal	Program Evaluation	Difference	% Difference
Number of Retrofits				
Showerheads	1,500	262	-1,238	-83%
Aerators	1,500	128	-1,372	-91%
Annual Savings (MG/yr)				
Showerheads & Aerators	3.76	0.88	-2.89	-77%
Lifetime Savings (MG)*				
Showerheads & Aerators	94.3	21.9	-72.4	-77%
*Lifetime savings based on 25-year project life. In the table, lifetime savings do not precisely correspond to annual savings due to independent rounding.				

6 ESTIMATED ENERGY AND GREENHOUSE GAS SAVINGS

Estimates of energy and greenhouse gas (GHG) savings based on the results of the program water savings evaluation are compared to grant proposal projections in Table 18. Both sets of estimates use the same energy intensity and GHG emission factors that were used in the grant proposal. Any differences are therefore because of differences in the estimated water and hot water savings between the grant proposal and the program evaluation, as presented in Section 5 of the report.

Table 18. Summary of Estimated Water, Energy, and GHG Savings

Water Savings		Grant Proposal	Program Evaluation	% Diff	Units
1)	Annual volume of water savings within System	31.8	18.2	-43%	MG/year
2)	Annual volume of imported water savings	31.8	18.2	-43%	MG/year
3)	Annual volume of hot water heating system savings	3.8	0.9	-77%	MG/year
4)	Lifetime volume of water savings within System	794.2	454.0	-43%	MG
5)	Lifetime volume of imported water savings	794.2	454.0	-43%	MG
6)	Lifetime volume of hot water heating system savings	94.3	21.9	-77%	MG
Energy Savings		Grant Proposal	Program Evaluation	% Diff	Units
1)	Annual energy savings within System	10,519	6,012	-43%	kWh/year
2)	Annual energy savings from imported water	309,205	176,736	-43%	kWh/year
3)	Annual energy savings from electric hot water heating system	50,949	0	-100%	kWh/year
4)	Annual energy savings from natural gas hot water heating system (used to calculate total energy saving)	806,555	202,279	-75%	kWh/year
5)	Total annual energy savings from electric and natural gas hot water heating systems	857,503	202,279	-76%	kWh/year
6)	Annual energy savings from natural gas hot water heating system (used to calculate GHG emission)	27,546	6,908	-75%	therms/year
7)	Lifetime energy savings within System	262,976	150,312	-43%	kWh
8)	Lifetime energy savings from imported water	7,730,133	4,418,405	-43%	kWh
9)	Lifetime energy savings from electric hot water heating system	1,273,713	0	-100%	kWh
10)	Lifetime energy savings from natural gas hot water heating system	20,163,870	5,056,975	-75%	kWh
11)	Total lifetime energy savings from electric and natural gas hot water heating systems	21,437,583	5,056,975	-76%	kWh
GHG Emission Reductions		Grant Proposal	Program Evaluation	% Diff	Units
1)	Annual GHG emission reductions within System	2,924	1,671	-43%	kg CO_2e/year
2)	Annual imported GHG emission reductions	85,959	49,133	-43%	kg CO_2e/year
3)	Annual GHG emission reductions from electric hot water heating	14,164	0	-100%	kg CO_2e/year
4)	Annual GHG emission reductions from natural gas hot water heating system	145,995	36,615	-75%	kg CO_2e/year
5)	Total annual GHG reductions from electric and natural gas hot water heating system	160,159	36,615	-77%	kg CO_2e/year
6)	Lifetime GHG emission reductions within System	73,107	41,787	-43%	kg CO_2e
7)	Lifetime GHG emission reductions from imported water	2,148,977	1,228,317	-43%	kg CO_2e
8)	Lifetime GHG emission reductions from electric heating system	354,092	0	-100%	kg CO_2e
9)	Lifetime GHG emission reductions from natural gas water heating system	3,649,881	915,368	-75%	kg CO_2e
10)	Total lifetime GHG emission reductions from electric and natural gas hot water heating systems	4,003,973	915,368	-77%	kg CO_2e

Project Summary	Grant Proposal	Program Evaluation	% Diff	Units
Total annual water savings	31.8	18.2	-43%	MG/year
Total lifetime water savings	794.2	454.0	-43%	MG
Total annual energy savings	1,177,228	385,028	-67%	kWh/year
Total lifetime energy savings	29,430,692	9,625,693	-67%	kWh
Total annual GHG emission reductions	249,042	87,419	-65%	kg CO_2e/year
Total lifetime GHG emission reductions	6,226,057	2,185,471	-65%	kg CO_2e

7 SUMMARY OF FINDINGS

The following provides a summary of the program evaluation findings:

- The program successfully targeted customers in disadvantaged communities (DACs). 88% of the single-family participants and 100% of the multi-family and non-residential participants were in a DAC.

- The bathroom retrofit program installed new high-efficiency plumbing fixtures in 1,599 bathrooms across 673 single-family, multi-family, and non-residential sites, including the replacement of 1,678 toilets, 262 showerheads, and 128 faucet aerators.

- Overall, the program retrofitted 24% fewer toilets than projected in the grant proposal – 1,678 versus 2,200. Whereas the grant proposal assumed a fairly uniform distribution of retrofits across single-family, multi-family, and non-residential bathrooms, actual retrofits skewed strongly towards single-family bathrooms because of lower unit retrofit costs.

- The grant proposal assumed one showerhead and one aerator replacement in each single- and multi-family bathroom retrofit. However, these fixtures were replaced by the plumbing contractor only if they were (1) present in the bathroom and (2) not already low-flow. These two conditions were not met in most of the participating bathrooms. Consequently, the program installed 83% fewer showerheads and 91% fewer aerators than projected in the grant proposal.

- Estimated water savings are 43% less than projected in the grant proposal. The shortfall is caused by the replacement of fewer toilets, showerheads, and aerators than projected, as well as disproportionately more single-family retrofits than expected. The difference in projected and actual water savings would have been insignificant if the projected number of fixture replacements had been able to be realized.

- Estimated energy savings are 67% and GHG savings are 65% less than projected in the proposal. As with water savings, the shortfall is due to the installation of fewer fixtures and projected in the proposal. Note that the program evaluation found that faucet and aerator unit water savings were greater than projected in the grant proposal, which translates into higher unit energy savings. If the program had realized the proposed fixture retrofits, the energy and GHG savings would have exceeded the projected levels by 35% and 28%, respectively.

- Estimated mean water savings per bathroom are:

	Dominguez District	East Los Angeles District
Single-Family	25.8 gpd	35.5 gpd
Multi-Family	38.6 gpd	38.6 gpd
Non-Residential	20.6 gpd	21.5 gpd

- Estimated mean water savings per fixture are:

	Dominguez District			East Los Angeles District		
	Toilet	Showerhead	Aerator	Toilet	Showerhead	Aerator
Single-Family	23.9	12.6	3.0	30.7	12.6.0	3.0
Multi-Family	36.4	12.6	3.0	36.4	12.6	3.0
Non-Residential	20.6	NA	NA	21.5	NA	NA

- The bathroom retrofit program is estimated to annually save:
  - 18.2 MG of water (Lifetime savings: 454 MG)
  - 385.0 MWh of energy (Lifetime savings: 9.6 GWh)
  - 87,419 kg of CO_2-e (Lifetime savings: 2,185 metric tons)

8 REFERENCES

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Water Research Foundation (2016). Residential End Uses of Water, Version 2. Prepared by William B. DeOreo, Aquacraft, Inc. Water Engineering and Management Peter Mayer, Water Demand Management Benedykt Dziegielewski, University of Southern Illinois Jack Kiefer, Hazen and Sawyer, P.C.

9 CONTACT INFORMATION

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ATTACHMENT 1-7:
California Water Service Company's Advice Letter 2509.

STATE OF CALIFORNIA GAVIN NEWSOM, *Governor*

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

May 3, 2024

Natalie Wales
Director of Regulatory Policy & Compliance
California Water Service Company
1720 North First Street
San Jose, CA 95112-4598

Dear Ms. Wales,

The Water Division of the California Public Utilities Commission has approved California Water Service Company's Advice Letter No. 2509-A (Supplement to Advice Letter No. 2509), filed on April 16, 2024, regarding request to establish a Conservation Regulation Memorandum Account.

Enclosed are copies of the following revised tariff sheets, effective January 25, 2024, for the utility's files:

P.U.C. Sheet No.	**Title of Sheet**
13451-W	Preliminary Statement (page 1) BK. Conservation Regulation Memorandum Account (CRMA)
13452-W	Table of Contents (page 5)
13453-W	Table of Contents (page 1)

Please contact Mahdi Jahami at MJ4@cpuc.ca.gov or 916-743-5080, if you have any questions.

Thank you.

Enclosures

CALIFORNIA PUBLIC UTILITIES COMMISSION
DIVISION OF WATER AND AUDITS

Advice Letter Cover Sheet

Utility Name: California Water Service Company

District: All Regulated Areas (includes Grand Oaks)

CPUC Utility #: U-60-W

Advice Letter #: 2509-A

Tier: ☐1 ☒2 ☐3 ☐ Compliance

Authorization: General Order 96-B Rule 7.3.2(5)

Description: Request to establish a Conservation Regulation Memorandum Account (CRMA)

Date Mailed to Service List: 4/16/2024

Protest Deadline (20th Day): 5/6/2024

Review Deadline (30th Day): 5/16/2024

Requested Effective Date: 1/25/2024

Rate Impact: None

The protest or response deadline for this advice letter is 20 days from the date that this advice letter was mailed to the service list. Please see the "Response or Protest" section in the advice letter for more information.

Utility Contact: Albree Jewell
Phone: (916) 205-4539
Email: ajewell@calwater.com

Utility Contact: Natalie Wales
Phone: (408) 367-8566
Email: nwales@calwater.com

DWA Contact: Tariff Unit
Phone: (415) 703-1133
Email: Water.Division@cpuc.ca.gov

DWA USE ONLY

DATE	STAFF	COMMENTS

[ ] APPROVED [ ] WITHDRAWN [ ] REJECTED

Signature: ____________________ Comments: ____________________

Date: ____________________

CALIFORNIA WATER SERVICE COMPANY
1720 NORTH FIRST STREET
SAN JOSE, CA 95112 • (408) 367-8200

April 16, 2024

Advice Letter No. 2509-A

To the California Public Utilities Commission:

California Water Service Company ("Cal Water") respectfully submits this Tier 2 advice letter requesting approval to implement the tariff changes listed below applicable to all regulated service areas. ***Please note that this advice letter will only be distributed electronically to the Water Division and the attached service lists.***

New/Revised CPUC Sheet No.	Title of Sheet	Schedule No.	Cancelling CPUC Sheet No.
13451-W	Preliminary Statement (page 1)	CRMA	New
13452-W	Table of Contents (page 5)	TOC 5	13324-W
13453-W	Table of Contents (page 1)	TOC 1	13450-W

Summary

Cal Water requests authority to establish a Conservation Regulation Memorandum Account (CRMA) to record any incremental expenses that are required to comply with the "Making Conservation a California Way of Life" Regulation of the State Water Resources Control Board ("SWRCB") that are not in rates or otherwise tracked in another memorandum or balancing account.

This supplement changes the requested effective date from August 18, 2023 to January 25, 2024, reflects the adoption of D.24-03-042 resolving Cal Water's 2021 GRC, and updates the Preliminary Statement designation.

Background

On August 18, 2023, the SWRCB initiated the formal rulemaking for "Making Conservation a California Way of Life" and released draft regulatory text intended to implement AB 1668 and SB 606. These bills were passed by the Legislature in 2018 to develop a regulatory framework to achieve long-term water use efficiency.

Discussion

The proposed regulation would require each urban retail water supplier to comply with the following three components.

1. Meet an Agency-Specific Urban Water Use Objective and Begin Annual Reporting Starting in 2024.
2. Implement Commercial, Industrial and Institutional (CII) Performance Measures.
3. Comply with Annual Reporting Requirements.

Cal Water is requesting to establish a Conservation Regulation Memorandum Account (CRMA) to record expenses associated with the CRMA for any incremental operations and maintenance (O&M) expenses and carrying costs on any capital investments related to developing and staffing for the expansion of cost-effective programs, educating customers on the value of modifying their behavior, and complying with any other requirements that may result from the final regulation. Only costs that are not otherwise covered in Cal Water's revenue requirement would be tracked in the memorandum account.

Although currently unknown, the substantial costs Cal Water expects to incur include, but may not be limited to, the following activities:

- Development of district-specific readiness assessments;
- Development of district-specific Urban Water-Use Objectives compliance plans including, but not limited to, identification of additional water savings required and related conservation programs and budgets;
- Development of Performance Measures compliance plans including, but not limited to, Commercial, Industrial, and Institutional (CII) classifications, conversion of CII mixed-use meters to dedicated irrigation meters or implementation of in-lieu water technologies, identification of disclosable buildings, provisioning of water-use data to disclosable building owners/agents, and implementation of Best Management Practices (BMPs) for top 20% of CII customers in each classification category;
- Increased conservation program activity required to comply with urban water-use objectives and CII Performance Measures;
- Staffing required to implement increased program activity and support customers;
- Development of messaging and program marketing to support increased program activity.

Request To Establish A Memorandum Account

In accordance with the Commission's Standard Practice U-27-W, establishing a memorandum account is conditional and in consideration with the following criteria which have been met by Cal Water:

1. The event is not under the utility's control.

On August 18, 2023, the SWRCB initiated the formal rulemaking for Making Conservation a California Way of Life and released draft regulatory text. Under the new regulation, the SWRCB would require each urban retail water supplier to comply with three new components. The SWRCB is not under Cal Water's control, and the requirement to comply will result in new, unavoidable expenses for Cal Water, both exceptional in nature and not under Cal Water's control.

2. The event could not have been reasonably foreseen in the utility's last general rate case.

The SWRCB initiated the formal rulemaking for Making Conservation a California Way of Life in August 2023. Therefore, the expenses could not have been reasonably foreseen in Cal Water's last general rate case filed on July 1, 2021 (A.21-07-002).

3. The event occurred before the utility's next scheduled rate case.

Cal Water's next general rate case application will not be filed until July 2024 to set rates for the years 2026-2028. To make progress in meeting the current proposed reporting and compliance requirements, expenses must be incurred before new rates from Cal Water's 2024 GRC will be implemented on January 1, 2026.

4. The event is of a substantial nature in that the amount of money involved is worth the effort of processing a memo account.

Cal Water anticipates incurring substantial costs in order to comply with these individualized efficiency goals in our various service areas. Cal Water anticipates additional substantial costs will be incurred for conservation program activity, staffing, and conservation program marketing to support compliance with Urban Water-Use Objectives and CII Performance Measures.

The anticipated substantial costs were not included in the rates proposed in A.21-07-002.

5. The memorandum account has ratepayer benefits.

Cal Water's customers will benefit from the establishment of this memorandum account because it will allow Cal Water to adequately prepare all of its water systems for compliance with the updated SWRCB requirements.

Memorandum Account Treatment

Cal Water is aware that a memorandum account is not a guarantee of eventual recovery of expenses; nor is it carried as a regular account under the uniform system of accounts for water utilities. It is carried "off the books," as a memorandum account. Further, it is also known that Commission policy on memorandum account treatment has always been that the burden of proof of the reasonableness of expenses charged to the account is the responsibility of the utility requesting reimbursement of such costs.

Preliminary Statement Letter

This supplement adjusts the Preliminary letter from BG in Advice Letter 2509 to BK to avoid repetition of lettering.

Requested Effective Date

Cal Water is submitting this as a Tier 2 advice letter pursuant to General Order 96-B, Water Industry Rule 7.3.2(5) (New Memorandum Account request). Cal Water requests that the account be considered effective **January 25, 2024**, the date that Advice Letter 2509 was submitted requesting establishment of the CRMA.

Notice

Customer Notice – Individual customer notice of this advice letter is not required under General Order 96-B, Water Industry Rule 3.1 (Method of Notice for Advice Letter Increasing Rates) because it does not propose a rate increase or trigger any other customer notice requirement.

Service Lists – In accordance with General Order 96-B, General Rule 4.3 and 7.2 and Water Industry Rule 4.1, a copy of this advice letter will be electronically transmitted on **April 16, 2024**, to competing and adjacent utilities and other utilities or interested parties having requested such notification. ***Please note that this advice letter will only be distributed electronically.***

Response or Protest

Anyone may respond to or protest this advice letter. When submitting a response or protest, please include the utility name and advice letter number in the subject line. A response supports the filing and may contain information that proves useful to the Commission in evaluating the advice letter. A protest objects to the advice letter in whole or in part and must set forth the specific grounds on which it is based. These grounds are:

(1) The utility did not properly serve or give notice of the advice letter;
(2) The relief requested in the advice letter would violate statute or Commission order, or is not authorized by statute or Commission order on which the utility relies;
(3) The analysis, calculations, or data in the advice letter contain material error or omissions;
(4) The relief requested in the advice letter is pending before the Commission in a formal proceeding; or
(5) The relief requested in the advice letter requires consideration in a formal hearing, or is otherwise inappropriate for the advice letter process; or
(6) The relief requested in the advice letter is unjust, unreasonable, or discriminatory (provided such a protest may not be made where it would require relitigating a prior order of the Commission.)

A protest shall provide citations or proofs where available to allow staff to properly consider the protest. A response or protest must be made in writing or by electronic mail and must be received by the Water Division within 20 days of the date this advice letter is filed. The address for mailing or delivering a protest is:

Tariff Unit, Water Division, 3rd floor
California Public Utilities Commission,
505 Van Ness Avenue, San Francisco, CA 94102
water.division@cpuc.ca.gov

On the same date the response or protest is submitted to the Water Division, the respondent or protestant shall send a copy by mail (or e-mail) to Cal Water at the following address:

Natalie Wales
California Water Service Company
1720 North First Street,
San Jose, California 95112
E-mail: cwsrates@calwater.com

Cities and counties requiring Board of Supervisors or Board of Commissioners approval to protest should inform the Water Division within the 20-day protest period so a late-filed protest can be entertained. The informing document should include an estimate of the date the proposed protest might be voted on. The advice letter process does not provide for any responses, protests or comments, except for the utility's reply, after the 20-day comment period.

Replies: The utility shall reply to each protest and may reply to any response. Each reply must be received by the Water Division within 5 business days after the end of the protest period and shall be served on the same day to the person who filed the protest or response. If you have not received a reply to your protest within 10 business days, contact California Water Service Company at (408) 367-8200 and ask for the Rates Department.

CALIFORNIA WATER SERVICE COMPANY

/s/

____
Albree Jewell
Rates Analyst

Enclosures
cc: Syreeta Gibbs (Public Advocates Office), PublicAdvocatesWater@cpuc.ca.gov

Preliminary Statement BK Page 1 (N)

BK. Conservation Regulation Memorandum Account (CRMA) (N)

1. Purpose

The purpose of the Conservation Regulation Memorandum Account (CRMA) is to record any incremental expenses that are required to comply with the "Making Conservation a California Way of Life" Regulation of the State Water Resources Control Board that are not in rates or otherwise tracked in another memorandum or balancing account, such as the Conservation Expense Balancing Account.

2. Applicability

The CRMA is applicable to all regulated ratemaking areas.

3. Accounting Procedures

   a) The CRMA will track the difference between the conservation expenses authorized in rates and conservation expenses required to comply with the Making Conservation a California Way of Life Regulation.

   b) Monthly interest expense will be calculated at 1/12 of the most recent month's interest rate on Commercial Paper (prime, 90-day) published in the Federal Reserve Statistical Release.

4. Disposition

Amounts recorded in the Memorandum Account are subject to a reasonableness review in a General Rate Case, or in an appropriate advice letter filing consistent with General Order 96-B.

5. Effective Date

The CRMA is effective on January 25,2024, the date Advice Letter 2509 was submitted requesting establishment of the CRMA.

(N)

Table of Contents

Preliminary Statements

(Continued)

Table of Contents

The following listed tariff sheets contain all effective rates and rules affecting the rates and service of the Utility together with information relating thereto:

(Continued)

Antelope Valley District (Los Angeles County Region)

ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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Bakersfield District

ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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Bear Gulch District

ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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ADVICE LETTER FILING MAILING LIST
PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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Palos Verdes District (Los Angeles County Region)

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PER SECTION III (G) OF GENERAL ORDER NO. 96-A

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LIST OF ATTACHMENTS FOR CHAPTER 2

	Attachment #	Description
1	Attachment 2-1	Number of Customers Forecast.
2	Attachment 2-2	Normal-Scenario Sales Forecast.

ATTACHMENT 2-1:
Number of Customers Forecast.

Table 8. AV-FRE Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	83	79	81	83	85	84	85	86	86	87
Multi-Residential	15	0	0	0	0	0	0	0	0	0	0
Commercial	02	0	0	0	0	0	0	0	0	0	0
Public Authority	11	0	0	0	0	0	0	0	0	0	0

Table 9. AV-LAN Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	650	654	655	657	658	660	661	663	665	666
Multi-Residential	15	0	0	0	0	0	0	0	0	0	0
Commercial	02	11	11	11	11	11	11	11	11	11	11
Public Authority	11	7	7	7	7	7	7	7	7	7	7

Table 10. AV-LEO Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	594	604	604	608	609	614	618	621	625	628
Multi-Residential	15	5	5	5	5	5	5	5	5	5	5
Commercial	02	23	22	22	22	22	22	21	21	21	21
Public Authority	11	7	7	7	7	7	7	7	7	7	7

Table 11. BG Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	16,946	16,944	16,973	16,979	17,036	17,025	17,040	17,055	17,069	17,084
Multi-Residential	15	187	187	187	188	188	188	188	189	189	189
Commercial	02	1,244	1,248	1,249	1,248	1,252	1,251	1,251	1,252	1,253	1,253
Public Authority	11	136	136	136	138	138	143	146	149	152	154

Table 12. BK Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	8,795	7,658	6,072	4,869	2,974	2,231	744	0	0	0
Residential Metered	01	54,226	56,184	58,272	59,793	61,905	63,431	65,423	66,703	67,272	67,841
Multi-Residential	15	1,197	1,202	1,201	1,203	1,201	1,203	1,204	1,204	1,205	1,206
Commercial	02	6,272	6,267	6,276	6,282	6,253	6,260	6,257	6,253	6,249	6,246
Public Authority	11	730	731	734	743	747	748	752	755	759	762

Table 13. CH Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	25,267	25,563	25,766	25,960	26,098	26,419	26,655	26,891	27,127	27,363
Multi-Residential	15	997	1,028	1,048	1,062	1,083	1,102	1,121	1,140	1,159	1,178
Commercial	02	3,064	3,074	3,100	3,132	3,154	3,176	3,200	3,224	3,247	3,271
Public Authority	11	427	429	430	430	430	431	432	433	433	434

Table 14. DIX Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	2,747	2,801	2,846	2,847	2,849	2,904	2,934	2,963	2,993	3,023
Multi-Residential	15	27	27	27	27	27	27	27	27	27	27
Commercial	02	154	154	153	155	156	156	156	157	157	158
Public Authority	11	30	31	30	30	32	31	31	32	32	32

Table 15. DOM Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	28,906	28,975	29,060	29,100	29,165	29,218	29,275	29,332	29,389	29,447
Multi-Residential	15	750	750	749	747	747	747	747	746	746	745
Commercial	02	2,845	2,832	2,836	2,832	2,820	2,815	2,809	2,803	2,797	2,791
Public Authority	11	249	252	252	250	250	251	251	251	251	251

Table 16. ELA Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	20,331	20,382	20,424	20,458	20,459	20,510	20,543	20,577	20,610	20,643
Multi-Residential	15	728	729	729	729	732	732	732	733	733	734
Commercial	02	4,587	4,584	4,594	4,599	4,588	4,594	4,595	4,597	4,598	4,599
Public Authority	11	351	355	355	354	353	356	357	358	358	359

Table 17. HR Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	22,593	22,657	22,692	22,718	22,749	22,812	22,857	22,902	22,947	22,992
Multi-Residential	15	1,847	1,847	1,848	1,850	1,849	1,850	1,850	1,851	1,851	1,852
Commercial	02	1,823	1,811	1,812	1,806	1,807	1,801	1,797	1,794	1,790	1,787
Public Authority	11	357	357	356	355	357	356	356	355	355	355

Table 18. KC Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	2,266	2,310	2,352	2,387	2,415	2,459	2,497	2,534	2,572	2,610
Multi-Residential	15	35	35	35	35	35	35	35	35	35	35
Commercial	02	303	308	314	319	319	325	329	333	337	340
Public Authority	11	59	59	60	61	61	62	62	63	63	64

Table 19. KRV Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	3,819	3,870	3,917	3,922	3,898	3,949	3,970	3,992	4,013	4,034
Multi-Residential	15	7	7	7	7	7	7	7	7	7	7
Commercial	02	109	108	109	109	109	108	107	107	106	105
Public Authority	11	15	16	16	16	16	16	17	17	17	17

Table 20. LAS Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	16,980	16,985	16,990	16,990	16,989	17,000	17,005	17,010	17,015	17,020
Multi-Residential	15	171	171	171	171	171	171	171	171	171	171
Commercial	02	1,182	1,173	1,162	1,154	1,149	1,141	1,133	1,126	1,118	1,111
Public Authority	11	207	208	205	202	201	200	198	197	195	193

Table 21. LIV Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	17,076	17,147	17,197	17,236	17,252	17,318	17,364	17,410	17,456	17,502
Multi-Residential	15	99	101	102	102	103	104	105	106	106	107
Commercial	02	1,000	998	995	994	997	993	991	990	989	987
Public Authority	11	230	230	230	228	223	224	223	222	221	220

Table 22. MPS Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	31,344	31,347	31,359	31,375	31,365	31,393	31,406	31,420	31,433	31,446
Multi-Residential	15	756	759	760	760	760	765	767	769	771	773
Commercial	02	3,379	3,384	3,380	3,372	3,352	3,362	3,359	3,356	3,353	3,350
Public Authority	11	318	317	319	317	316	316	315	314	314	313

Table 23. MRL Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	3,049	3,059	3,054	3,058	3,056	3,062	3,064	3,067	3,069	3,072
Multi-Residential	15	133	134	134	134	137	136	136	137	137	138
Commercial	02	474	474	475	473	466	470	469	469	468	468
Public Authority	11	46	50	51	46	51	52	53	55	56	57

Table 24. ORO Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	2,663	2,669	2,674	2,675	2,663	2,676	2,678	2,681	2,684	2,687
Multi-Residential	15	79	81	85	85	85	88	90	92	94	96
Commercial	02	675	672	682	691	692	696	700	704	708	712
Public Authority	11	84	96	100	100	100	106	109	112	115	118

Table 25. PV Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	22,894	22,921	22,967	23,101	23,220	23,244	23,316	23,388	23,460	23,533
Multi-Residential	15	225	225	225	225	227	226	227	227	228	228
Commercial	02	672	672	674	678	676	678	679	681	682	683
Public Authority	11	255	254	253	253	254	252	252	251	250	250

Table 26. RDV-CSP Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	244	244	244	244	244	244	244	245	245	245
Multi-Residential	15	0	0	0	0	0	0	0	0	0	0
Commercial	02	3	5	5	5	5	6	7	7	8	8
Public Authority	11	2	2	2	2	2	2	2	2	2	2

Table 27. RDV-LUC Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	1,136	1,154	1,182	1,184	1,161	1,185	1,193	1,200	1,207	1,214
Multi-Residential	15	14	14	14	14	13	13	13	13	13	13
Commercial	02	41	41	42	41	41	42	42	43	43	43
Public Authority	11	8	8	8	7	7	7	7	6	6	6

Table 28. RDV-UNI Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	416	417	422	422	423	426	428	430	432	433
Multi-Residential	15	3	3	3	3	3	3	3	3	3	3
Commercial	02	6	6	6	6	6	6	6	6	6	6
Public Authority	11	3	3	3	3	3	3	3	3	3	3

Table 29. SEL Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	306	304	301	61	0	0	0	0	0	0
Residential Metered	01	5,380	5,409	5,439	5,712	5,801	5,847	5,888	5,929	5,970	6,011
Multi-Residential	15	66	66	66	66	66	66	66	66	66	66
Commercial	02	453	458	459	459	461	464	466	468	470	472
Public Authority	11	121	121	121	121	120	120	120	120	119	119

Table 30. SLN Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	24,587	24,601	24,626	24,636	24,626	24,656	24,670	24,684	24,698	24,712
Multi-Residential	15	435	435	436	437	437	437	438	438	439	439
Commercial	02	2,584	2,588	2,593	2,600	2,603	2,609	2,615	2,620	2,625	2,631
Public Authority	11	290	293	293	292	292	293	294	295	295	296

Table 31. SSF Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	14,043	14,052	14,058	14,064	14,055	14,070	14,076	14,081	14,087	14,093
Multi-Residential	15	179	182	185	187	188	191	194	196	199	201
Commercial	02	1,904	1,921	1,940	1,952	1,943	1,970	1,983	1,996	2,010	2,023
Public Authority	11	204	203	203	203	201	200	199	199	198	197

Table 32. STK Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	38,835	39,034	39,249	39,428	39,545	39,773	39,960	40,146	40,332	40,518
Multi-Residential	15	416	416	416	416	416	416	416	416	416	416
Commercial	02	3,821	3,832	3,868	3,869	3,846	3,884	3,897	3,910	3,923	3,936
Public Authority	11	317	318	317	317	316	317	317	317	317	317

Table 33. VIS Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	39,803	40,443	41,111	41,789	42,309	42,989	43,621	44,253	44,885	45,517
Multi-Residential	15	982	973	953	955	958	941	933	925	917	909
Commercial	02	3,031	3,071	3,105	3,151	3,204	3,231	3,269	3,308	3,346	3,385
Public Authority	11	934	936	938	939	938	942	944	946	948	950

Table 34. WIL Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	2,028	2,036	2,044	2,036	2,027	2,036	2,037	2,038	2,039	2,040
Multi-Residential	15	35	35	35	36	36	36	36	37	37	37
Commercial	02	267	263	269	274	272	273	275	276	278	279
Public Authority	11	49	49	49	49	49	49	49	49	49	49

Table 35. WLK Service Forecast

Revenue Class	Rev Code	*Actual* 2019	*Actual* 2020	*Actual* 2021	*Actual* 2022	*Actual* 2023	*Forecast* 2024	*Forecast* 2025	*Test Year* 2026	*Attrition* 2027	*Attrition* 2028
Residential Flat	04	0	0	0	0	0	0	0	0	0	0
Residential Metered	01	6,160	6,174	6,181	6,189	6,198	6,201	6,208	6,214	6,221	6,227
Multi-Residential	15	125	125	125	125	125	125	125	125	125	125
Commercial	02	523	519	515	515	514	509	506	504	501	498
Public Authority	11	89	89	89	89	89	89	89	89	89	89

ATTACHMENT 2-2:
Normal-Scenario Sales Forecast.

Table 48. AV-FRE Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	71	69	55	83
Multi-Residential	15	0	0	0	0
Commercial	02	0	0	0	0
Public Authority	11	0	0	0	0
2027 Attrition Year					
Residential Metered	01	71	69	55	82
Multi-Residential	15	0	0	0	0
Commercial	02	0	0	0	0
Public Authority	11	0	0	0	0
2028 Attrition Year					
Residential Metered	01	71	69	56	82
Multi-Residential	15	0	0	0	0
Commercial	02	0	0	0	0
Public Authority	11	0	0	0	0

Table 49. AV-LAN Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	214	209	166	228
Multi-Residential	15	0	0	0	0
Commercial	02	588	579	506	611
Public Authority	11	742	722	563	856
2027 Attrition Year					
Residential Metered	01	213	209	166	227
Multi-Residential	15	0	0	0	0
Commercial	02	588	579	506	610
Public Authority	11	742	722	563	852
2028 Attrition Year					
Residential Metered	01	213	208	165	227
Multi-Residential	15	0	0	0	0
Commercial	02	588	579	506	609
Public Authority	11	742	722	562	848

Table 50. AV-LEO Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	127	124	99	139
Multi-Residential	15	76	75	57	94
Commercial	02	223	220	187	237
Public Authority	11	913	889	708	1,001
2027 Attrition Year					
Residential Metered	01	127	124	99	138
Multi-Residential	15	76	75	57	95
Commercial	02	223	220	187	237
Public Authority	11	913	889	708	1,001
2028 Attrition Year					
Residential Metered	01	127	124	98	138
Multi-Residential	15	76	75	56	96
Commercial	02	223	220	187	237
Public Authority	11	913	889	708	1,001

Table 51. BG Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	227	221	177	243
Multi-Residential	15	636	627	565	653
Commercial	02	347	342	301	355
Public Authority	11	943	916	711	1,029
2027 Attrition Year					
Residential Metered	01	225	219	175	241
Multi-Residential	15	619	610	549	636
Commercial	02	348	342	301	355
Public Authority	11	930	904	702	1,015
2028 Attrition Year					
Residential Metered	01	223	217	173	239
Multi-Residential	15	602	593	533	619
Commercial	02	348	343	301	355
Public Authority	11	918	892	692	1,001

Table 52. BK Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	208	203	161	217
Multi-Residential	15	1,183	1,168	1,052	1,206
Commercial	02	674	664	588	694
Public Authority	11	2,846	2,767	2,194	3,081
2027 Attrition Year					
Residential Metered	01	208	203	161	217
Multi-Residential	15	1,178	1,162	1,047	1,201
Commercial	02	673	663	587	693
Public Authority	11	2,848	2,769	2,195	3,081
2028 Attrition Year					
Residential Metered	01	208	203	161	217
Multi-Residential	15	1,173	1,157	1,043	1,195
Commercial	02	672	662	586	692
Public Authority	11	2,850	2,771	2,196	3,081

Table 53. CH Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	167	162	131	180
Multi-Residential	15	1,117	1,101	998	1,157
Commercial	02	569	559	499	600
Public Authority	11	856	831	656	937
2027 Attrition Year					
Residential Metered	01	165	161	130	178
Multi-Residential	15	1,110	1,094	991	1,150
Commercial	02	569	560	499	600
Public Authority	11	846	821	648	926
2028 Attrition Year					
Residential Metered	01	163	159	128	176
Multi-Residential	15	1,103	1,088	985	1,143
Commercial	02	569	560	499	600
Public Authority	11	836	812	640	914

Table 54. DIX Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	107	104	83	114
Multi-Residential	15	1,379	1,361	1,216	1,416
Commercial	02	209	205	183	222
Public Authority	11	515	505	354	632
2027 Attrition Year					
Residential Metered	01	106	103	82	113
Multi-Residential	15	1,345	1,328	1,186	1,382
Commercial	02	214	210	187	227
Public Authority	11	518	508	357	635
2028 Attrition Year					
Residential Metered	01	105	102	81	112
Multi-Residential	15	1,311	1,294	1,155	1,347
Commercial	02	219	215	191	231
Public Authority	11	522	512	360	639

Table 55. DOM Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	113	110	87	117
Multi-Residential	15	1,305	1,288	1,152	1,318
Commercial	02	1,077	1,061	935	1,116
Public Authority	11	2,181	2,121	1,672	2,366
2027 Attrition Year					
Residential Metered	01	113	110	86	117
Multi-Residential	15	1,299	1,282	1,146	1,312
Commercial	02	1,085	1,068	941	1,123
Public Authority	11	2,215	2,155	1,698	2,401
2028 Attrition Year					
Residential Metered	01	112	110	86	116
Multi-Residential	15	1,293	1,276	1,141	1,306
Commercial	02	1,092	1,075	947	1,130
Public Authority	11	2,250	2,188	1,723	2,436

Table 56. ELA Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	126	123	96	130
Multi-Residential	15	459	453	406	466
Commercial	02	385	379	333	392
Public Authority	11	1,154	1,121	895	1,274
2027 Attrition Year					
Residential Metered	01	125	122	96	129
Multi-Residential	15	453	447	400	459
Commercial	02	385	379	333	392
Public Authority	11	1,168	1,135	905	1,287
2028 Attrition Year					
Residential Metered	01	125	122	95	129
Multi-Residential	15	447	441	395	453
Commercial	02	385	379	333	392
Public Authority	11	1,181	1,148	915	1,299

Table 57. HR Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	100	98	76	103
Multi-Residential	15	463	457	410	471
Commercial	02	309	304	267	317
Public Authority	11	474	461	362	504
2027 Attrition Year					
Residential Metered	01	100	97	76	103
Multi-Residential	15	462	456	409	470
Commercial	02	311	306	268	319
Public Authority	11	472	459	360	502
2028 Attrition Year					
Residential Metered	01	99	97	76	102
Multi-Residential	15	460	454	407	468
Commercial	02	313	308	270	320
Public Authority	11	470	457	359	499

Table 58. KC Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	126	123	97	130
Multi-Residential	15	951	939	830	968
Commercial	02	576	567	499	589
Public Authority	11	1,033	1,005	784	1,071
2027 Attrition Year					
Residential Metered	01	125	122	96	128
Multi-Residential	15	941	929	821	958
Commercial	02	581	572	503	594
Public Authority	11	1,056	1,027	801	1,094
2028 Attrition Year					
Residential Metered	01	124	121	96	127
Multi-Residential	15	931	919	812	948
Commercial	02	585	576	507	598
Public Authority	11	1,079	1,049	817	1,117

Table 59. KRV Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	48	47	37	50
Multi-Residential	15	249	245	214	267
Commercial	02	203	200	177	213
Public Authority	11	464	451	350	505
2027 Attrition Year					
Residential Metered	01	46	45	35	48
Multi-Residential	15	247	244	212	266
Commercial	02	204	201	178	214
Public Authority	11	457	444	345	498
2028 Attrition Year					
Residential Metered	01	43	42	33	45
Multi-Residential	15	245	242	210	264
Commercial	02	205	202	179	215
Public Authority	11	449	437	340	490

Table 60. LAS Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	172	168	134	181
Multi-Residential	15	1,527	1,506	1,365	1,572
Commercial	02	767	755	674	799
Public Authority	11	969	942	734	1,030
2027 Attrition Year					
Residential Metered	01	172	167	133	180
Multi-Residential	15	1,524	1,503	1,362	1,569
Commercial	02	784	771	687	815
Public Authority	11	992	964	751	1,053
2028 Attrition Year					
Residential Metered	01	171	166	132	179
Multi-Residential	15	1,521	1,500	1,358	1,566
Commercial	02	800	787	701	831
Public Authority	11	1,015	987	768	1,076

Table 61. LIV Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	138	134	106	147
Multi-Residential	15	1,453	1,433	1,283	1,503
Commercial	02	511	503	441	531
Public Authority	11	1,416	1,377	1,066	1,540
2027 Attrition Year					
Residential Metered	01	138	135	106	147
Multi-Residential	15	1,423	1,403	1,254	1,472
Commercial	02	516	508	446	537
Public Authority	11	1,445	1,405	1,087	1,569
2028 Attrition Year					
Residential Metered	01	138	135	106	148
Multi-Residential	15	1,392	1,373	1,226	1,441
Commercial	02	522	514	451	542
Public Authority	11	1,475	1,434	1,109	1,598

Table 62. MPS Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
		2026 Test Year			
Residential Metered	01	96	94	74	100
Multi-Residential	15	1,092	1,078	965	1,102
Commercial	02	306	301	264	311
Public Authority	11	976	949	741	1,047
		2027 Attrition Year			
Residential Metered	01	97	94	74	100
Multi-Residential	15	1,084	1,070	957	1,094
Commercial	02	311	306	268	316
Public Authority	11	993	965	753	1,063
		2028 Attrition Year			
Residential Metered	01	97	94	74	101
Multi-Residential	15	1,076	1,061	949	1,085
Commercial	02	315	311	272	321
Public Authority	11	1,009	981	765	1,080

Table 63. MRL Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
		2026 Test Year			
Residential Metered	01	105	102	81	112
Multi-Residential	15	855	843	753	880
Commercial	02	330	325	287	337
Public Authority	11	1,667	1,624	1,248	1,714
		2027 Attrition Year			
Residential Metered	01	105	103	81	112
Multi-Residential	15	851	839	749	876
Commercial	02	335	330	291	342
Public Authority	11	1,690	1,646	1,265	1,737
		2028 Attrition Year			
Residential Metered	01	105	103	81	112
Multi-Residential	15	848	836	746	873
Commercial	02	340	335	295	347
Public Authority	11	1,714	1,669	1,282	1,760

Table 64. ORO Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	108	106	85	115
Multi-Residential	15	869	857	786	896
Commercial	02	412	405	362	427
Public Authority	11	791	769	596	868
2027 Attrition Year					
Residential Metered	01	109	106	85	115
Multi-Residential	15	863	851	780	889
Commercial	02	413	406	363	428
Public Authority	11	776	754	584	852
2028 Attrition Year					
Residential Metered	01	109	107	85	116
Multi-Residential	15	857	845	774	883
Commercial	02	414	408	364	430
Public Authority	11	762	740	574	836

Table 65. PV Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	216	211	169	232
Multi-Residential	15	1,006	992	891	1,019
Commercial	02	1,348	1,325	1,161	1,494
Public Authority	11	1,134	1,102	896	1,286
2027 Attrition Year					
Residential Metered	01	214	209	167	230
Multi-Residential	15	990	977	876	1,002
Commercial	02	1,341	1,318	1,155	1,486
Public Authority	11	1,155	1,121	911	1,306
2028 Attrition Year					
Residential Metered	01	212	207	165	228
Multi-Residential	15	974	961	862	986
Commercial	02	1,334	1,311	1,148	1,479
Public Authority	11	1,175	1,141	926	1,327

Table 66. RDV-CSP Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	27	26	20	29
Multi-Residential	15	0	0	0	0
Commercial	02	196	192	99	278
Public Authority	11	2	1	1	2
2027 Attrition Year					
Residential Metered	01	27	26	20	29
Multi-Residential	15	0	0	0	0
Commercial	02	196	192	94	282
Public Authority	11	2	1	1	2
2028 Attrition Year					
Residential Metered	01	27	26	20	29
Multi-Residential	15	0	0	0	0
Commercial	02	196	192	88	287
Public Authority	11	2	1	1	2

Table 67. RDV-LUC Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	55	54	43	58
Multi-Residential	15	898	884	763	1,003
Commercial	02	81	80	66	90
Public Authority	11	327	315	207	418
2027 Attrition Year					
Residential Metered	01	55	54	43	58
Multi-Residential	15	898	884	765	1,000
Commercial	02	81	80	66	90
Public Authority	11	327	315	203	421
2028 Attrition Year					
Residential Metered	01	55	54	43	58
Multi-Residential	15	898	884	766	997
Commercial	02	81	79	67	89
Public Authority	11	327	315	199	424

Table 68. RDV-UNI Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	56	55	42	66
Multi-Residential	15	503	494	367	631
Commercial	02	233	230	188	291
Public Authority	11	79	77	45	142
2027 Attrition Year					
Residential Metered	01	56	55	42	66
Multi-Residential	15	503	494	379	617
Commercial	02	233	230	190	288
Public Authority	11	79	77	45	140
2028 Attrition Year					
Residential Metered	01	56	55	42	66
Multi-Residential	15	503	495	389	605
Commercial	02	233	230	191	285
Public Authority	11	79	77	46	138

Table 69. SEL Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	178	174	139	186
Multi-Residential	15	1,985	1,959	1,761	2,007
Commercial	02	462	455	408	484
Public Authority	11	967	940	744	1,009
2027 Attrition Year					
Residential Metered	01	176	171	136	183
Multi-Residential	15	1,947	1,921	1,727	1,969
Commercial	02	466	458	411	487
Public Authority	11	965	939	743	1,008
2028 Attrition Year					
Residential Metered	01	173	169	134	180
Multi-Residential	15	1,909	1,884	1,694	1,931
Commercial	02	469	461	413	490
Public Authority	11	964	938	742	1,007

Table 70. SLN Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	112	110	86	115
Multi-Residential	15	1,369	1,351	1,208	1,381
Commercial	02	661	651	571	670
Public Authority	11	1,267	1,231	966	1,334
2027 Attrition Year					
Residential Metered	01	112	109	85	114
Multi-Residential	15	1,364	1,346	1,202	1,375
Commercial	02	667	657	576	676
Public Authority	11	1,264	1,228	964	1,331
2028 Attrition Year					
Residential Metered	01	111	108	85	114
Multi-Residential	15	1,358	1,340	1,197	1,369
Commercial	02	673	663	581	682
Public Authority	11	1,261	1,226	962	1,328

Table 71. SSF Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	71	70	54	72
Multi-Residential	15	783	772	685	788
Commercial	02	673	662	583	690
Public Authority	11	509	495	385	537
2027 Attrition Year					
Residential Metered	01	71	70	54	72
Multi-Residential	15	761	750	664	766
Commercial	02	686	675	595	703
Public Authority	11	518	504	392	546
2028 Attrition Year					
Residential Metered	01	71	70	53	72
Multi-Residential	15	739	729	644	744
Commercial	02	700	689	606	717
Public Authority	11	527	513	398	555

Table 72. STK Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	113	110	88	119
Multi-Residential	15	1,500	1,479	1,337	1,546
Commercial	02	520	512	452	535
Public Authority	11	2,396	2,325	1,846	2,647
2027 Attrition Year					
Residential Metered	01	112	109	87	118
Multi-Residential	15	1,492	1,471	1,330	1,538
Commercial	02	519	511	452	534
Public Authority	11	2,380	2,310	1,833	2,625
2028 Attrition Year					
Residential Metered	01	111	108	86	117
Multi-Residential	15	1,483	1,463	1,322	1,529
Commercial	02	519	511	451	533
Public Authority	11	2,364	2,295	1,819	2,604

Table 73. VIS Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	186	182	143	199
Multi-Residential	15	624	617	555	647
Commercial	02	730	719	635	764
Public Authority	11	1,091	1,061	813	1,149
2027 Attrition Year					
Residential Metered	01	184	180	142	197
Multi-Residential	15	621	613	552	643
Commercial	02	731	720	636	765
Public Authority	11	1,106	1,076	825	1,164
2028 Attrition Year					
Residential Metered	01	183	179	141	196
Multi-Residential	15	617	609	548	639
Commercial	02	732	721	636	766
Public Authority	11	1,121	1,091	836	1,178

Table 74. WIL Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	133	129	107	145
Multi-Residential	15	1,222	1,205	1,097	1,251
Commercial	02	345	339	307	365
Public Authority	11	430	417	335	468
2027 Attrition Year					
Residential Metered	01	133	129	107	145
Multi-Residential	15	1,221	1,205	1,096	1,250
Commercial	02	345	339	307	365
Public Authority	11	430	417	335	466
2028 Attrition Year					
Residential Metered	01	133	129	107	145
Multi-Residential	15	1,220	1,204	1,096	1,250
Commercial	02	345	339	307	365
Public Authority	11	430	417	335	465

Table 75. WLK Test Year Avg. Use per Service Forecasts (CCF/Service)

Revenue Class	Rev Code	Unrestricted Sales	Expected Sales	95% CI Lower	95% CI Upper
2026 Test Year					
Residential Metered	01	262	256	208	287
Multi-Residential	15	535	528	475	548
Commercial	02	1,190	1,170	1,005	1,311
Public Authority	11	709	688	496	839
2027 Attrition Year					
Residential Metered	01	258	251	205	282
Multi-Residential	15	532	525	473	545
Commercial	02	1,189	1,169	1,004	1,310
Public Authority	11	708	687	495	837
2028 Attrition Year					
Residential Metered	01	258	252	204	282
Multi-Residential	15	531	524	471	544
Commercial	02	1,216	1,196	1,032	1,337
Public Authority	11	731	710	518	860

LIST OF ATTACHMENTS FOR CHAPTER 3

	Attachment #	Description
1	Attachment 3-1	The United Nations Resolution 64-292
2	Attachment 3-2	The impact of pricing structure change on residential water - Journal of Water Resources and Economics (2024)

ATTACHMENT 3-1:
The United Nations Resolution 64-292

General Assembly

Distr.: General
3 August 2010

Sixty-fourth session
Agenda item 48

Resolution adopted by the General Assembly on 28 July 2010

[*without reference to a Main Committee (A/64/L.63/Rev.1 and Add.1)*]

64/292. The human right to water and sanitation

The General Assembly,

Recalling its resolutions 54/175 of 17 December 1999 on the right to development, 55/196 of 20 December 2000, by which it proclaimed 2003 the International Year of Freshwater, 58/217 of 23 December 2003, by which it proclaimed the International Decade for Action, "Water for Life", 2005–2015, 59/228 of 22 December 2004, 61/192 of 20 December 2006, by which it proclaimed 2008 the International Year of Sanitation, and 64/198 of 21 December 2009 regarding the midterm comprehensive review of the implementation of the International Decade for Action, "Water for Life"; Agenda 21 of June 1992;[1] the Habitat Agenda of 1996;[2] the Mar del Plata Action Plan of 1977 adopted by the United Nations Water Conference;[3] and the Rio Declaration on Environment and Development of June 1992,[4]

Recalling also the Universal Declaration of Human Rights,[5] the International Covenant on Economic, Social and Cultural Rights,[6] the International Covenant on Civil and Political Rights,[6] the International Convention on the Elimination of All Forms of Racial Discrimination,[7] the Convention on the Elimination of All Forms of Discrimination against Women,[8] the Convention on the Rights of the Child,[9] the

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[1] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3–14 June 1992*, vol. I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex II.

[2] *Report of the United Nations Conference on Human Settlements (Habitat II), Istanbul, 3–14 June 1996* (United Nations publication, Sales No. E.97.IV.6), chap. I, resolution 1, annex II.

[3] *Report of the United Nations Water Conference, Mar del Plata, 14–25 March 1977* (United Nations publication, Sales No. E.77.II.A.12), chap. I.

[4] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3–14 June 1992*, vol. I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex I.

[5] Resolution 217 A (III).

[6] See resolution 2200 A (XXI), annex.

[7] United Nations, *Treaty Series*, vol. 660, No. 9464.

[8] Ibid., vol. 1249, No. 20378.

[9] Ibid., vol. 1577, No. 27531.

Convention on the Rights of Persons with Disabilities[10] and the Geneva Convention relative to the Protection of Civilian Persons in Time of War, of 12 August 1949,[11]

Recalling further all previous resolutions of the Human Rights Council on human rights and access to safe drinking water and sanitation, including Council resolutions 7/22 of 28 March 2008[12] and 12/8 of 1 October 2009,[13] related to the human right to safe and clean drinking water and sanitation, general comment No. 15 (2002) of the Committee on Economic, Social and Cultural Rights, on the right to water (articles 11 and 12 of the International Covenant on Economic, Social and Cultural Rights)[14] and the report of the United Nations High Commissioner for Human Rights on the scope and content of the relevant human rights obligations related to equitable access to safe drinking water and sanitation under international human rights instruments,[15] as well as the report of the independent expert on the issue of human rights obligations related to access to safe drinking water and sanitation,[16]

Deeply concerned that approximately 884 million people lack access to safe drinking water and that more than 2.6 billion do not have access to basic sanitation, and alarmed that approximately 1.5 million children under 5 years of age die and 443 million school days are lost each year as a result of water- and sanitation-related diseases,

Acknowledging the importance of equitable access to safe and clean drinking water and sanitation as an integral component of the realization of all human rights,

Reaffirming the responsibility of States for the promotion and protection of all human rights, which are universal, indivisible, interdependent and interrelated, and must be treated globally, in a fair and equal manner, on the same footing and with the same emphasis,

Bearing in mind the commitment made by the international community to fully achieve the Millennium Development Goals, and stressing, in that context, the resolve of Heads of State and Government, as expressed in the United Nations Millennium Declaration,[17] to halve, by 2015, the proportion of people who are unable to reach or afford safe drinking water and, as agreed in the Plan of Implementation of the World Summit on Sustainable Development ("Johannesburg Plan of Implementation"),[18] to halve the proportion of people without access to basic sanitation,

1. *Recognizes* the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights;

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[10] Resolution 61/106, annex I.

[11] United Nations, *Treaty Series*, vol. 75, No. 973.

[12] See *Official Records of the General Assembly, Sixty-third Session, Supplement No. 53* (A/63/53), chap. II.

[13] See A/HRC/12/50 and Corr.1, part one, chap. I.

[14] See *Official Records of the Economic and Social Council, 2003, Supplement No. 2* (E/2003/22), annex IV.

[15] A/HRC/6/3.

[16] A/HRC/12/24.

[17] See resolution 55/2.

[18] See *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August–4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

2. *Calls upon* States and international organizations to provide financial resources, capacity-building and technology transfer, through international assistance and cooperation, in particular to developing countries, in order to scale up efforts to provide safe, clean, accessible and affordable drinking water and sanitation for all;

3. *Welcomes* the decision by the Human Rights Council to request that the independent expert on human rights obligations related to access to safe drinking water and sanitation submit an annual report to the General Assembly,[13] and encourages her to continue working on all aspects of her mandate and, in consultation with all relevant United Nations agencies, funds and programmes, to include in her report to the Assembly, at its sixty-sixth session, the principal challenges related to the realization of the human right to safe and clean drinking water and sanitation and their impact on the achievement of the Millennium Development Goals.

108th plenary meeting
28 July 2010

ATTACHMENT 3-2:
The impact of pricing structure change on residential water - Journal of Water Resources and Economics (2024)

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The impact of pricing structure change on residential water consumption: A long-term analysis of water utilities in California

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ABSTRACT

California's demand-side urban water management policies, such as shifting water pricing structures from non-conservation to conservation-based rates, have received much attention in terms of meeting the state's short- and long-term water conservation policies. This paper quantifies the effect of pricing structure changes on residential water consumption using a survey dataset of 189 major California water utilities from 1994 to 2019. Results of our study demonstrate that residential per capita per day water consumption was reduced by an average of 2.6% when water agencies switched from non-conservation-based to conservation-based pricing structures. We also found evidence that the longer a utility maintained a non-conservation-based rate structure before switching to conservation-based pricing, the larger the water consumption reduction in that utility's service area. In addition, utilities that reverted to non-conservation rates after having longer-term conservation pricing structures experienced smaller increases compared to having long-term non-conservation ones in water use in their service areas. This suggests evidence of a crowding-in effect for transitions from conservation-based to non-conservation-based pricing structures.

1. Introduction

California's municipal water suppliers face water resource management challenges due to frequent and prolonged droughts [1]. As a result, for many years, California enacted water conservation measures to address its growing water demands and insecure water supply levels. State and local demand-side water management policies collectively reduced per capita residential water use by 34% in 2019, compared to usage levels in 1994 [2,3]. However, the effects of the state's expected population increase [4] and climate change will pose substantial challenges for future water management [4,5,6,7,8,9,10], highlighting the need for continued water conservation.

Water utilities continue to rely on diverse demand-side management strategies, such as the use of conservation-based pricing structures, price adjustments, subsidies, water-saving rebates as economic incentives, and outdoor water use restrictions to meet conservation goals and targets. These measures are cost-effective in reducing water use, compared to developing new supply sources or enacting measures, such as recycled water, desalination, or wastewater reuse [11,12,13,14,15]. Among demand-side management

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strategies, price adjustments—both levels and structures—are standard tools to decrease household water demand [16,17,18]. For example, Gaur et al. [19] found that from 2003 to 2015, California's water utilities' use of conservation-based pricing structures increased from 39% to 67%. A recent study found that 71% of California's water utilities adopted conservation-based pricing structures, compared to 44% in 2006 [20].

California has 419 urban water suppliers that serve more than 90% of its population. Each of these utilities adopts different water pricing structures, including non-conservation-based pricing structures (i.e., flat rate and uniform), and conservation-based pricing structures (i.e., increasing block rates (IBR) and budget-based)—See Table 1 for definitions [21]. Utilities move across structures and adjust prices based on their characteristics, such as population, financing requirements, regional weather conditions, conservation goals, and peer adoption [20,22,23,24,25,26,27,28]. California's numerous utilities, for example, have altered their pricing structures in response to short-term supply shocks, such as the recent California droughts, as well as the governor's long-term water use policy targets, such as the "*Make Water Conservation a California Way of Life*" standards [29].

While conservation-based pricing structures have grown in popularity and prominence among California water utilities [20,19], there is still a gap in quantifying how transitioning to and from conservation-based pricing structures impacts water consumption, and how these effects vary depending on how long a utility keeps its pricing structure before transitioning to a different one (i.e., intuitively varying degrees of experience). Such aspects are critically important for water management and policy considerations, and very few published studies have assessed the effect of pricing structure change on water consumption. The majority of the economic literature focuses on the effect of the change in water price levels on water consumption [30,31,32,33,34], but not on the effects of switching to and from conservation-based pricing structures.

This study addresses the following policy-relevant questions: (i) How have pricing structures and water consumption changed within water utilities in California? (ii) What is the effect of switching to different types of pricing structures on residential water consumption? (iii) Does this effect vary by the length of time utilities keep a specific pricing structure in place before switching to a different one?

To answer these questions, we used monthly data from 189 utilities on the pricing structure and average water consumption by single-family residential households in California from 1994 to 2019. A temporal design of policy interventions allows us to study the persistence of pricing structure change in altering water consumption. That is because policy interventions' effects appear through short-term behavioral adjustments and relatively long-term physical capital adjustments (technology adoption) [35], providing a more in-depth analysis and policy insights.

As expected, the results show a statistically significant decrease in water consumption under conservation-based structures. After controlling for changes in average price, switching to conservation-based from non-conservation-based pricing structures reduced average water use by 2.6%. The estimated reductions varied depending on how long a utility remained on a non-conservation-based pricing structure before switching to conservation-based pricing structures—water consumption reductions were greater the longer utilities remained non-conservation-based before switching to conservation-based pricing structures. Conversely, we found a statistically significant increase (9.8%) in water consumption if the utility kept a conservation-based pricing structure in place for less than two years before transitioning to a non-conservation-based one. After keeping the conservation-based pricing structure in place for more than two years, we found a lower increase in water consumption but no statistically significant effect. Long-term adjustments for water savings will likely motivate households to conserve, even after the policy changes back to non-conservation-based pricing. We observed these household responses as the crowding-in effect in which the pecuniary incentives alter the underlying motivation and behavior such that once the pecuniary part is changed, the household behavior remains.

California stands out as a compelling case study among the numerous countries and urban centers grappling with water scarcity. Its experiences hold valuable lessons for other jurisdictions facing similar challenges. Notably, states in the Western US, such as Arizona, Nevada, New Mexico, and parts of Texas, encounter analogous water issues owing to their arid or semi-arid climates. These regions have confronted prolonged droughts, prompting the formulation of distinct water management policies tailored to their specific circumstances.

While these policies and approaches may differ, California's proactive measures in addressing water scarcity and implementing sustainable water management strategies offer crucial insights. These insights are particularly relevant for other states and regions

Table 1
Definition of the pricing structures employed in California.

	Types	Description
Non-conservation-based	Flat	Flat pricing is a pricing structure in which all customers pay the same fee regardless of how much water they use. Flat pricing is the simplest structure for charging operating bills, but it is rarely used in California.
	Uniform	Uniform pricing (or constant unit pricing) is a pricing structure that imposes a constant per-unit price for water consumed. It differs from flat pricing in that it requires metered services to charge fees based on all metered units of water used.
Conservation-based	Increasing Block Rate (IBR)	Increasing block rate (IBR) is a structure in which the unit price of each succeeding block of water use is imposed at a higher unit pricing than the previous block(s). For larger volumes of water, the system charges a higher price.
	Budget-based	Budget-based pricing (also known as allocation-based pricing) is similar to IBR but includes individualized tier definitions based on the unique characteristics of each customer. This pricing, for example, allows water users to choose how to use their budgeted water. Budget pricing is increasingly popular in Southern California, with higher outdoor water use.

Note: Refer to Ref. [21] for more details and examples of each pricing structure.

dealing with comparable water-related issues. Furthermore, our research findings facilitate meaningful cross-comparisons of policy approaches and their effectiveness across diverse regions. Despite the variety in management strategies, all share a unified objective of water conservation. California's experiences, thus, present an opportunity to extract valuable policy implications through these cross-regional comparisons.

2. Literature review

After the pioneering studies by Gottlieb [36] and Howe and Linaweaver Jr. [37], extensive research has been conducted on residential water consumption with the role of demand function in water pricing. Much of this literature focuses on estimating the water demand function in which individual or aggregate residential consumption is expressed as a function of water price and other factors, such as income, household and community characteristics, and environmental conditions. In particular, previous studies related to water pricing have mainly investigated the effect of changes in price levels and rate structures on water consumption using two different approaches: (i) estimating price elasticities of water demand under different pricing levels and structures and (ii) estimating the effect of implementing a new pricing structure (e.g., transitioning between different pricing structures). Below, we summarize related literature on these two approaches.

The price elasticity of water demand has been the subject of extensive research. This is because comprehending this relationship is essential for effective water resource management and policy decision-making, as it can impact pricing strategies, conservation efforts, and social equity considerations regarding water allocation. In most cases, water demand is assessed to be relatively inelastic, which means that the proportional reduction in the quantity of water consumption is less than the proportional increase in water price. Several meta-analyses have identified the effect of price on water demand by demonstrating the range of elasticities of demand for various pricing structures. Espey et al. [38] analyzed 124 estimates of price elasticity of demand and reported a mean price elasticity of −0.51. In a similar vein, Dalhuisen et al. [31] examined 296 estimates and noted a mean price elasticity of −0.41. Most studies found that increasing block rates (IBR) produced higher price elasticity estimates than other pricing structures [39,30,31,40,32,41,42,33,43,27]. This structure imposes a low marginal price for the first few units of water and incrementally increases the price for households consuming outside of the first block. Higher-than-average marginal price[1] promotes a reduction in water demand by signaling a water shortage to high-volume water users who might respond by curtailing consumption levels, while also offering low-cost water for households using water necessary for drinking, cooking, cleaning, and bathing [34]. The IBR structure's conservation-based and equity-oriented features give high-volume consumers a strong incentive for water-saving, and encourage policymakers to use prices to achieve water conservation and an equity price scheme for low-income consumers. Meanwhile, differences in elasticity estimates across pricing structures may also arise from factors beyond price. For instance, Hajispyrou et al. [44] found that large families are more likely to be disadvantaged under IBR than small families at the same utility due to a higher marginal price of water. Hoffmann et al. [45] discovered that the price elasticity of water demand is higher in owner-occupied households than in renter households.

Few studies investigated the effect of implementing a new pricing structure on water demand [46,47,48,49,50,34]. Notably, Zhang et al. [34] elucidated the effect of China's urban water pricing structure reforms that departed from uniform to IBR structures, using a cross-comparison among 28 cities that adopted IBR pricing structures and 110 cities that had not yet done so, based on the household-level monthly water use data during 2002–2009. The authors found that the policy reform to IBR adoption reduced annual water consumption by 3.3%, on average. A more recent study by Stitzel and Rogers [48] reported heterogeneous responses to IBR across consumption groups in which ultra-low-volume users responded to the price-regime change by increasing consumption, whereas higher-volume users reduced consumption.

As indicated in the introduction section, this paper contributes to the existing studies by using long-term historical panel data across water utilities in California to investigate the effects of the transition to and from conservation-based pricing structures on residential water demand. In addition, we investigate the differences in the estimated effect of the transitions to and from conservation-based pricing structures by the length of time water utilities keep their existing pricing structure in effect.

3. Conceptual framework

This section develops a conceptual framework generating hypotheses relevant to the research question. We applied a multi-period setting to elucidate the relationship between pricing structure change and water consumption by residential customers for water services. Water utilities are the local water suppliers who set the price of water delivered to customers. The price charged for water is determined by multiple factors, including the costs to construct, operate, and maintain water infrastructures, such as pipelines, storage tanks, and pumps to deliver water to end-users, government water policy, and the scarcity value of water.[2] Water price levels determined in this manner can affect residential water usage.

With this mechanism, the profitability of water utilities is determined by the profit function of revenue and cost. However, in our analysis, water price levels and usage constituting this revenue are exogenously determined by the switch of water pricing structure

[1] Exceptionally, Nieswiadomy and Cobb [66] identifies cases in which customers are more sensitive to average prices than to marginal prices, showing that the IBR conservation effect is not as great as expected. Ito [67] and Wichman [50] have found significant evidence of average price responses in energy and water demand.

[2] In many cases of water pricing, the scarcity value of water is considered to reflect the opportunity cost of new sources of water. Ignoring the scarcity value leads to a relatively low water price, which may cause an inefficiently large level of use [68,69].

under government policy and the water quantity consumed.[3] By market-clearing conditions—the quantity supplied equals the quantity demanded—the quantity supplied is also the sum of all household consumption of water. As a result, rather than profit maximization of water utilities, our conceptual framework employs a household utility maximization approach, assuming a representative household.

Under a given budget constraint, a rational household maximizes its expected lifetime utility by deciding on current and future consumption. This decision-making process is influenced by a concept known as 'time preference,' which reflects the household's relative preference for immediate consumption or future consumption. Considering a simple two-period economy, the household utility function is $U = U(C_t) + \beta U(C_{t+1})$ where β is the household's time discount factor on intertemporal utility, reflecting a weight on the expected utility that households will get through future consumption. Correspondingly, household utility maximization is[4]:

$$\underbrace{Max}_{C_t, C_{t+1}} \quad U(C_t) + \beta U(C_{t+1}) \qquad \text{s.t.} \quad C_t + \frac{C_{t+1}}{1+r} = m_t + \frac{m_{t+1}}{1+r} \tag{1}$$

We denote the terms C_t and C_{t+1} as water consumption at periods t and $t+1$, respectively. The parameter r is the real discount rate. The terms m_t and m_{t+1} represent a budget allowance for water usage.[5] As we consider water consumption, measured in gallons per capita per day (gpcd) in the household, the composition of households is already controlled. In addition, we assume that household characteristics within a single water utility before and after the water pricing structure change are identical. We also assume that the household's budget allowance for water usage is constrained within the total expenditure (i.e., $m_t \leq \overline{M_t} < x_t$, where $\overline{M_t}$ is a maximum allowance of water usage and x_t is total expenditure). This allows us to avoid the complexity of analysis that arises when taking into account all complemental effects from spending on other goods, such as food, clothing, utilities, and other necessities.

The intertemporal water consumption relationship derived from equation (1) is:

$$U'(C_t) - \beta(1+r)U'\{(C_{t+1})\} = 0 \tag{2}$$

Considering the first-order conditions of optimal consumption level with constant relative risk-averse (CRRA) utility function (i.e., $U(C_t) = \frac{C_t^{1-\gamma}}{1-\gamma})$)[6] yields:

$$1 = \beta(1+r)\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \tag{3}$$

where γ serves a dual function as a parameter that signifies the extent of relative risk aversion. On the one hand, it indicates the degree of aversion of households to differences in consumption levels between present and future times—this aversion to these differences is often associated with the concept of 'risk' in economic decision-making. It is equal to the coefficient of relative risk aversion, which measures a household's level of relative risk aversion [51,52–54]). A higher γ indicates higher risk aversion, while a lower γ suggests lower risk aversion. In essence, the parameter γ summarizes a household's response or attitude toward risk. On the other hand, the reciprocal of the coefficient of relative risk aversion γ is equivalent to the intertemporal substitution elasticity of consumption, which can be measured as the growth rate of consumption (i.e., the rate of change in consumption) resulting from alterations in the relative price of current and future consumption [51,52–54]. In this context, intertemporal substitution reflects a household's willingness to switch consumption patterns between two consecutive periods. This parameter captures different aspects of each household's preferences for water consumption in response to changes in water pricing structures. Given that risk preferences from various institutional, social, and cultural factors can lead to heterogeneous water consumption among residential consumers [55], we expect that risk preferences from water pricing structure changes may yield differences in water consumption.

In the light of water management, the extent of risk aversion γ is related to how a household responds to changes in water pricing structures and is highly likely affected by how long the household has remained in the previous pricing structure. We define *small* γ as a

[3] In standard scenarios, the goals of water utilities vary, spanning from achieving financial equilibrium to optimizing profits, contingent upon their ownership framework. For instance, government-owned water utilities in California are mandated to generate revenues solely for cost coverage and are restricted from yielding profits. Consequently, their principal aim is to achieve a "break-even" scenario, where their revenues roughly equal their expenses. Conversely, privately owned water utilities may operate with a profit motive, striving to maximize their financial gains while providing water services. Our theoretical analysis has been crafted with this common industry landscape in mind, acknowledging the prevalent diversity of objectives within the water utility sector. Therefore, our findings are applicable to scenarios where water utilities aim to break even or pursue profit maximization. Given that the majority of the sample utilities in our analysis are publicly owned by local governments, our insights are particularly pertinent to real-world practices where water utilities prioritize zero profit over profit maximization.

[4] See Appendix (A): Mathematical derivation for details.

[5] In the context of our discussion, the units of water consumption (C) are measured in a unit of volume (gallons per capita per day), and the budget allocation (m) is measured in a unit of currency (dollars).

[6] The CRRA (or Isoelastic) utility function is a mathematical representation of a representative household's preferences. It is expressed as a power function that exhibits constant relative risk aversion. In the CRRA utility function, the intertemporal elasticity of substitution for consumption is calculated as the reciprocal of the coefficient of risk aversion. Because of its tractability and simplicity, the CRRA utility function has been widely utilized in the economic literature on consumption since Hansen and Singleton's publications in 1982 and 1983 [53,54].

long-term stay on water policies. Long-term water policies typically provide consumers with a greater time horizon to adapt to changes in their water usage patterns and potentially implement more sustainable practices. Therefore, in the long term, households' aversion to differences in consumption levels between present and future times is small (i.e., $\gamma_{small}^{long-term\ stay}$) and the decline in water consumption is likely to be larger (i.e., $\left(\frac{C_{t+1}}{C_t}\right)_{large\ reduction}^{long-term\ stay}$). In comparison, we define *large* γ as a *short-term stay* on water policies. In the short term, consumers may not have immediate alternatives or the ability to adjust their consumption. For this reason, consumers may be required to adjust their behavior quickly under the short-term policies, and thereby, households' aversion to differences in consumption levels between present and future times is large (i.e., $\gamma_{large}^{short-term\ stay}$), and the decline in water consumption is likely to be smaller (i.e., $\left(\frac{C_{t+1}}{C_t}\right)_{small\ reduction}^{short-term\ stay}$).

The two-period model implies that water prices at periods *t* and *t+1* are not the same under different pricing structures. Hence, our study derives the equilibrium water consumption path with the CRRA function under the assumption of different unit prices for water consumption between periods *t* and *t+1.* The objective function is written as follows:

$$\underbrace{Max}_{C_t, C_{t+1}} \quad U(C_t) + \beta U(C_{t+1})$$
$$s.t. \quad C_t + \frac{A_{t+1} C_{t+1}}{(1+r)} = m_t + \frac{m_{t+1}}{1+r} \tag{4}$$

Consequently, the equilibrium water consumption path derived is:

$$1 = \beta(1+r)\frac{1}{A_{t+1}}\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \tag{5}$$

The variable A_{t+1} indicates a relative water unit price ratio, namely, $A_{t+1} = \frac{P_{t+1}}{P_t}$. Note that we assume in our analytical framework that, $P_{t+1} > P_t$ or relative price $A_{t+1} = \frac{P_{t+1}}{P_t} > 1$ since the average unit price of water consumption under conservation-based pricing structures is likely more expensive than non-conservation-based pricing structures.[7] Generally, it is known that conservation-based pricing structures have complex structures that require metering tools and cost-tracking methodologies, leading them to be more costly to administer [56]. As β and r are constant over time, the following periodical optimal consumption path is summarized to a proportionality relationship ($\propto$) between water consumption and relative water unit price:

$$\left(\frac{C_{t+1}}{C_t}\right) \propto (A_{t+1})^{\frac{-1}{\gamma}} \tag{6}$$

Equation (6) forms a set of hypotheses relevant to our research questions as follows: Firstly, under switching from non-conservation-based to conservation-based pricing structures, (i) if the household stays in a non-conservation-based pricing structure for a long time and then changes to a conservation-based pricing structure, the household's response (i.e., $\gamma_{small}^{long-term\ stay}$) presents a lower rate of change in consumption (i.e., $\left(\frac{C_{t+1}}{C_t}\right)_{large\ reduction}^{long-term\ stay}$). This reflects that more water can be saved by driving a large reduction in water consumption. (ii) If a household stays in a non-conservation-based pricing structure for a short time and then changes to a conservation structure, the household's response (i.e., $\gamma_{large}^{short-term\ stay}$) indicates a higher rate of change in consumption $\left(\text{i.e., } \left(\frac{C_{t+1}}{C_t}\right)_{small\ reduction}^{short-term\ stay}\right)$. This indicates that less water can be saved by deriving small reduction in water consumption.

Secondly, under switching from a conservation-based to non-conservation-based pricing structure, (i) if a household stays in a conservation-based pricing structure for a long time and then changes to a non-conservation-based pricing structure, the household's response (i.e., $\gamma_{small}^{long-term\ stay}$) presents a lower rate of change in consumption (i.e., $\left(\frac{C_{t+1}}{C_t}\right)_{large\ reduction}^{long-term\ stay}$). This reflects that more water can be saved by driving a small rebound in water consumption. (ii) If the household stays in the conservation-based pricing structure for a short time and then changes to the non-conservation-based pricing structure, the household's response (i.e., $\gamma_{large}^{short-term\ stay}$) indicates a higher rate of change in consumption $\left(\text{i.e., } \left(\frac{C_{t+1}}{C_t}\right)_{small\ reduction}^{short-term\ stay}\right)$. This indicates that less water can be saved by deriving a large rebound

[7] Water pricing structures designed to emphasize conservation goals typically lead to higher average unit prices compared to pricing structures that do not prioritize conservation. This phenomenon arises from the fundamental premise of conservation pricing, which posits that as the price of water increases, customer water usage tends to decrease, fostering more effective conservation efforts. One of the most prevalent structural forms of conservation-based pricing is the Increasing Block Rate (IBR) pricing structure. IBR pricing is strategically designed to incentivize water conservation by imposing higher rates for elevated consumption levels. Under IBR pricing, the price per unit of water (e.g., per gallon or cubic meter) escalates as consumers move across various consumption tiers or blocks. The initial block, typically catering to essential or low-level use, is characterized by a lower rate, while subsequent blocks progressively entail higher rates. Consequently, consumers with higher water usage patterns incur elevated average unit prices for the additional water they consume.

in water consumption.

Fig. 1 provides visual confirmation of these hypotheses, depicting the connection between the rate of change in consumption, $\left(\frac{C_{t+1}}{C_t}\right)$ and the household's level of relative risk aversion, γ at any given relative water unit price ratio, A_{t+1} (where $A_{t+1} > 1$). Furthermore, the household's attitude toward risk, denoted by γ, may vary based on the duration of the previous pricing structure the household experienced, influencing its willingness to substitute consumption across two consecutive periods. As depicted in Fig. 1, the relationship between the rate of change in consumption and the household's level of relative risk aversion is expressed as $\left(\frac{C_{t+1}}{C_t}\right)^{long-term\ stay}_{large\ reduction} < \left(\frac{C_{t+1}}{C_t}\right)^{short-term\ stay}_{small\ reduction}$ when $\gamma^{long-term\ stay}_{small} < \gamma^{short-term\ stay}_{large}$.

4. Data and empirical specification

4.1. Urban water suppliers

Based on the US Environmental Protection Agency active water systems database,[8] there are three main types of public water systems in California: (1) Community Water System (CWS), which is a public water system that supplies water to the same population year-round; (2) Non-Transient Non-Community Water System (NTNCWS) which is a public water system that regularly supplies water to at least 25 of the same people at least six months per year. Some examples are schools, factories, office buildings, and hospitals with their water systems. And (3) Transient Non-Community Water System (TNCWS) is a public water system that provides water in a place such as a gas station or campground where people do not remain for long periods. As indicated in Table 2, more than 40 million of California's population is served by CWS water systems. Only a small percentage are served by NTNCWS or TNCWS systems.

Community water systems (2,874 suppliers) (Fig. 2), which are public water systems that supply water year-round to a population, serve more than 97%, or about 40 million, of California's population. Among community water systems, only urban water suppliers are subject to emergency conservation regulations by the state. Water suppliers with more than 3,000 customers who provide more than 3,000 acre-feet of water per year (419 water utilities) in California are subject to state water use regulations and conservation targets, such as the 2015 water mandate, 2021 voluntary cutbacks, or long-term conservation regulations such as "*Make Water Conservation a California Way of Life*" regulations [57,29,3,58]. This study focuses on these 419 urban water suppliers.

4.2. Price and pricing structure data

Focusing on these 419 water utilities, we collected data for this study through an extensive survey of water utilities on their residential water prices, pricing structures, and billing cycles from 1994 to 2019. The survey was conducted through a combination of an extensive review of the utilities' websites (e.g., relevant financial information, water plans), follow-up emails, and phone interviews. Some utilities could only provide the most recent pricing structure data, and some provided data for the entire sample period. The final dataset includes 189 water utilities in California with at least one year of pricing (levels and structures) information. Notably, these 189 water utilities account for roughly 80% of California's residential water consumption (serving more than 23 million people in the state). The unique dataset on water utilities' choice of pricing and pricing structure over 25 years allows us to investigate the effects of changes in the structure of average monthly water use.

4.3. Water consumption data

Monthly water consumption for these 189 water utilities is taken from the State Water Resources Control Board. The monthly average consumption is at the water utility level and is measured in gallons per capita per day. After combining all the information, we created an unbalanced dataset covering pricing structures, price levels, and average monthly water consumption measures from 1994 to 2019 for 189 utilities across the state.

4.4. Summary statistics

Table 3 presents the total number of utilities included in each year of the study, average water consumption in the sample utilities, and percent of utilities by pricing structure over time. The survey consists of 189 unique utilities with at least one year of data from 1994 to 2019. As expected, the number of utilities that provided requested data increased substantially over time. Table 3 also shows the average per capita water use in the study utilities with a downward trend. The average gallons per capita per day in these utilities has been reduced from 142 in 1994 to 86 in 2019, with an overall average of 118. This trend reflects the state and local efforts to encourage conservation and improve efficiency through various tools, such as pricing mechanisms [59,2,3]. California's water utilities adopt an IBR pricing structure the most, followed by uniform, budget, and flat pricing structures. We confirmed earlier research [20,19], which showed the percentage of utilities that adopted conservation-based pricing structures increased from 32% in 1994 to 74% in 2019.

Table 4 explains the overall count change in pricing structures. Most of the utilities in our dataset have adopted an IBR pricing

[8] Environmental Protection Agency [70], https://www.epa.gov/enviro/sdwis-search.

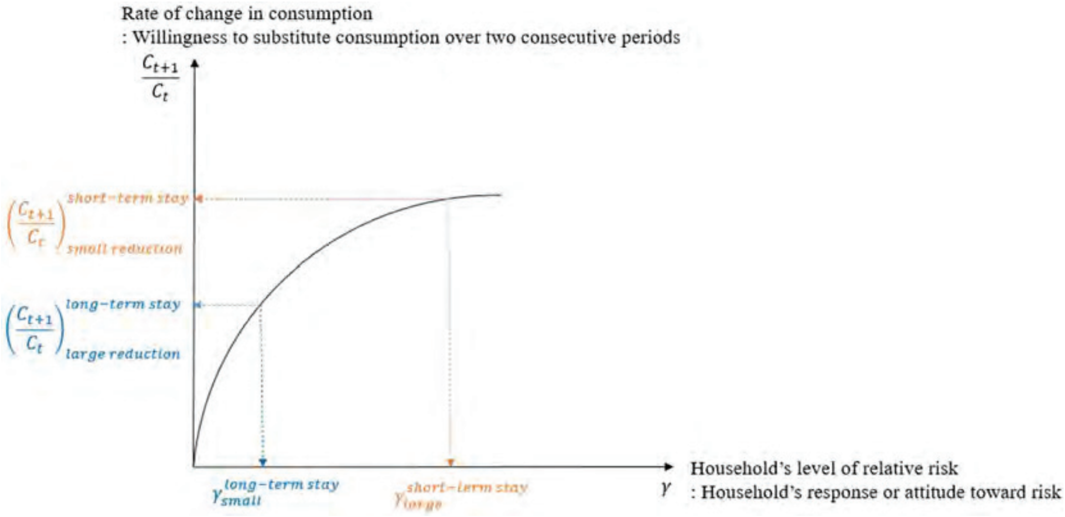

Fig. 1. Relationship between intertemporal consumption and subjective preference for pricing structure change.

Table 2
Water systems in California by type.

		Population Served					
		≤500	501- 3,300	3,301–10,000	10,001–100,000	>100,000	Total
CWS	Number of systems	1,722	488	225	351	88	2,874
	Total population served (1,000)	260	675	1,381	13,276	24,457	40,049
	Percent of systems	60	17	8	12	3	100
	Percent of population	1	2	3	33	61	100
NTNCWS	Number of systems	1323	152	12	4	0	1,491
	Total population served (1,000)	169	166	72	98	0	505
	Percent of systems	89	10	1	0	0	100
	Percent of population	33	33	14	19	0	100
TNCWS	Number of systems	2,775	200	21	4	0	3,000
	Total population served (1,000)	301	229	120	58	0	708
	Percent of systems	93	7	1	0	0	100
	Percent of population	42	32	17	8	0	100

Notes: Authors' calculations are based on data from the EPA active water systems inventory data.

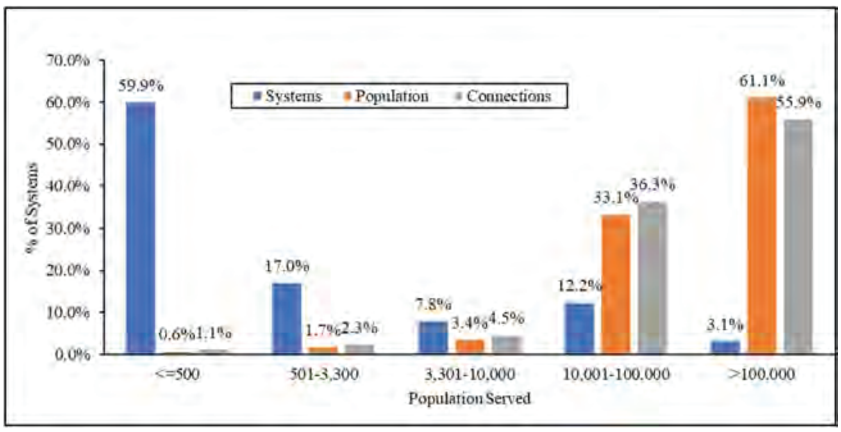

Fig. 2. Community Water Systems (CWS) by connections and population served by population served categories.

Table 3
Summary statistics of the data used in the analysis.

Year	Total Number of Utilities	Mean GPCD	Percent of utilities by pricing Structure			
			Uniform	Flat	IBR	Budget
1994	24	141.77	68	0	32	0
1995	24	144.95	64	0	36	0
1996	28	121.99	55	0	45	0
1997	34	122.83	43	0	57	0
1998	34	144.73	56	0	44	0
1999	32	100.37	48	0	52	0
2000	30	131.35	52	0	48	0
2001	39	126.88	48	0	53	0
2002	42	130.25	42	0	58	0
2003	44	120.74	39	0	61	0
2004	42	121.58	34	0	66	0
2005	42	116.43	35	0	65	0
2006	41	113.21	36	0	64	0
2007	48	137.80	34	0	66	0
2008	62	124.62	45	0	55	0
2009	101	123.14	33	2	64	1
2010	110	113.25	29	2	66	3
2011	110	112.23	25	2	68	5
2012	95	117.91	25	1	67	7
2013	97	120.44	26	2	65	7
2014	105	123.25	26	2	65	8
2015	119	92.59	25	2	67	6
2016	128	91.37	29	1	63	7
2017	134	96.78	28	1	63	8
2018	162	97.68	24	1	68	7
2019	125	85.97	25	1	67	7

Note: GPCD = Gallons Per Capita per Day; IBR = Increasing Block Rate.

Table 4
Matrix for total change count in pricing structures.

From	To				
	Uniform	IBR	Budget	Non- conservation	Conservation
Uniform	–	35	5		
IBR	14	–	6		
Budget	2		–		
Non-conservation				–	42
Conservation				18	–

Note: Total 60 treatments; Flat was excluded since there was only one unique utility that used it in our sample.

structure (i.e., a total of 35 changes). The next most dominant pricing choice is the uniform pricing structure (i.e., a total of 14 changes), followed by switching from uniform to budget, and switching from IBR to budget, indicating a total of five changes and six changes, respectively. Switching from non-conservation-based water pricing structures to conservation-based pricing structures—generally referred to as IBR and budget pricing structures—was most often made with a total of 42 changes. In the opposite case, switching from conservation-based water pricing structures to non-conservation-based pricing structures had fewer changes (a total of 18). Table 4 explains how water utilities have changed their pricing structure over time and identifies the direction utilities prefer[9] to adjust to (primarily conservation-oriented structures).

4.5. Water consumption estimation

Our conceptual framework includes a relationship between the change in water price structures and household water consumption. Such change in water consumption is projected on the household's response γ, which varies according to pricing structures and length of stay in the structure before switching from one pricing structure to another. We first estimate equation (7) to explore single-family residential responses and interpret the temporal effects of changes in the type of each pricing structure on water consumption using the flat pricing structure as a reference.

$$\ln GPCD_{it} = \beta_0 + \beta_1 Uniform_{it} + \beta_2 \text{IBR}_{it} + \beta_3 Budget_{it} + \delta_i + \varphi_m + \mu_y + \varepsilon_{it} \quad (7)$$

[9] Allaire and Dinar [20] explored what motivates water utilities to implement pro-conservation water prices.

where the outcome of interest, In $GPCD_{it}$, is the log of average water consumption in utility *i* and month *t*. We take the log of the outcome variable to handle the skewness of its distribution and for a more straightforward interpretation as a percentage change. We use the flat pricing structure as a benchmark and define three other forms on the right-hand side. $Uniform_{it}$ is an indicator variable which is set equal to 1 for all months that utility *i* has uniform pricing structure in effect. Similarly, IBR_{it} and $Budget_{it}$ are indicator variables and are set to 1 for all months that utility *i* has IBR or budget-based pricing structures in effect, respectively. β_1, β_2, and β_3 are parameters to be estimated from each type of pricing structure, a uniform, an IBR, and a budget. The parameter δ_i is utility fixed effects, φ_m indicates utility calendar month fixed effects, and μ_y refers to year-fixed effects. Lastly, ε_{it} captures all remaining unobservable effects that affect the dependent variable.

Next, following previous studies [30,33,60,48,61], we separately estimate equations 8–11 to measure changes in average water consumption when a utility changes from the existing pricing structure to another structure.

$$\text{In } GPCD_{it} = \alpha_0 + \alpha_1 \bullet \text{IBR}^{uniform}{}_{it} + \delta_i + \varphi_m + \mu_y + \varepsilon_{it} \tag{8}$$

$$\text{In } GPCD_{it} = \beta_0 + \beta_1 \bullet Uniform^{tiered}{}_{it} + \delta_i + \varphi_m + \mu_y + \varepsilon_{it} \tag{9}$$

$$\text{In } GPCD_{it} = \vartheta_0 + \vartheta_1 \bullet Budget^{unifom}{}_{it} + \delta_i + \varphi_m + \mu_y + \varepsilon_{it} \tag{10}$$

$$\text{In } GPCD_{it} = \tau_0 + \tau_1 \bullet Budget^{tiered}{}_{it} + \delta_i + \varphi_m + \mu_y + \varepsilon_{it} \tag{11}$$

where In $GPCD_{it}$ is the natural log of average water consumption for utility *i* in month *t*. In equation (8), $\text{IBR}_{it}^{uniform}$ is an indicator variable that is set equal to 1 for all months after utility *i* switches from a uniform pricing structure to an IBR pricing structure. We expect the estimate α_1 to be negative, meaning switching to an IBR pricing structure reduces water consumption. Similarly, in equation (9), $\beta_1 Uniform^{tiered}{}_{it}$ is an indicator variable that is set equal to 1 for all months after utility *i* switches from IBR pricing structure to uniform pricing structure, and we expect to estimate a positive sign for β_1.

In equations (10) and (11), $Budget^{unifom}$ and $Budget^{tiered}$ are indicator variables set equal to 1 for all months after utility *i* switches from a uniform and an IBR pricing structure to a budget-based one, respectively. We expect the estimated signs for both ϑ_1 and τ_1 to be negative. Descriptions of the remaining parameters are the same as those described in equation (7).

Lastly, we define a non-conservation-based pricing structure indicator variable equal to 1 if a utility has a flat or uniform pricing structure in place. In addition, we define a conservation-based pricing structure indicator variable that takes a value of 1 if a utility has an IBR or budget-based pricing structure in place. We separately estimate equations (12) and (13) using these variables.

$$\text{In } GPCD_{it} = \alpha_0 + \alpha_1 \bullet conservation^{non-conservation}{}_{it} + \delta_i + \varphi_m + \mu_y + \varepsilon_{it} \tag{12}$$

$$\text{In } GPCD_{it} = \beta_0 + \beta_1 \bullet non\_conservan^{conservation-based}{}_{it} + \delta_i + \varphi_m + \mu_y + \varepsilon_{it} \tag{13}$$

where in equation (12), $conservation^{non-conservation}$ is an indicator variable that is set equal to 1 for all months after utility *i* switches from a non-conservation-based pricing structure to a conservation-based pricing structure, and we expect to estimate negative signs for α_1. In equation (13), $non\_conservan_{it}^{conservation-based}$ is an indicator variable that is set equal to 1 for all months after utility *i* switches from a conservation-based pricing structure to a non-conservation-based pricing structure, and we expect to estimate positive signs for β_1. Descriptions of the remaining parameters are the same as those described in equation (7).

In addition to estimating equations (12) and (13) for the entire sample, we consider various sub-samples and estimate the demand for each sub-sample separately. Sub-samples are defined based on how long a utility uses the existing pricing structure before switching to the new pricing structure. In the case of switching from non-conservation-based to conservation-based pricing structures, we divided

Table 5
Cut-offs according to the time in non-conservation-based and conservation-based pricing structures.

From non-conservation to conservation			
(1) Less than or equal to two years (i.e., ≤2)	(2) Between two and five years (i.e., >2 & 5)	(3) More than five years (i.e., >5)	A total of 42 utility switches from non-conservation-based to conservation-based pricing structures.
14 (33%)	14 (33%)	14 (33%)	
From conservation to non-conservation			
(1) Less than or equal to two years (i.e., ≤2)	(2) More than two years (i.e., >2)		A total of 18 utility switches from conservation-based to non-conservation-based pricing structures.
9 (50%)	9 (50%)		

Notes: cut-offs are determined based on the number of unique utilities that remain in the same pricing structure and the duration range.

the length of time the utility kept an existing pricing structure into three cut-offs in equation (12) (i.e., less than or equal to two years; between two and five years; and more than five years). We then examined two cut-offs for the case of switching from conservation-based to non-conservation-based pricing structures for the case of equation (13) (i.e., less than or equal to two years, and more than two years). As shown in Table 5, these cut-offs are defined based on the number of utilities that remain in the same pricing structure and the duration range. A total of 42 water utilities switch from a non-conservation-based pricing structure to a conservation-based one. A total of 18 utilities switched from a conservation-based pricing structure to a non-conservation-based pricing structure.

5. Empirical results and discussion

5.1. Pricing structure change and water consumption

Table 6 shows the estimation of equation (7), where the log of gpcd is the dependent variable and pricing structures are indicator variables on the right-hand side (flat pricing structure is base). First, we use the ordinary least squares (OLS) estimator, followed by a fixed-effects estimator after controlling for utility and month-fixed effects. In the cross-comparison between structures, we find more water savings under a conservation-based structure, such as budget and IBR pricing structures. As indicated in Table 6, compared to flat pricing structure, on average, uniform, IBR, and budget pricing structure reduce gpcd by 4.8%, 8.4%, and 11.9%, respectively. This is consistent with previous research in this area where IBR pricing structures reduce water use [30,46,41,33,43,48,50,34].

Table 7 presents equations 8–11 estimates using a fixed-effects estimator that controls for the utility, month, and year fixed effects. We performed a separate regression on each structure change. As expected, column (1) shows a negative coefficient sign, meaning that when a utility switches from a uniform to an IBR pricing structure, the average gpcd decreases by 2.9%. Interestingly, we do not find statistically significant results for all other types of switches, namely, from IBR to uniform, from uniform to budget, and from IBR to budget pricing structures (columns 2–4). We explore this issue by aggregating multiple pricing structures into one in the following Sections 5.2 and 5.3.

5.2. Switching from non-conservation-based to conservation-based pricing structures

Table 8 presents the results of switching from non-conservation-based to conservation-based pricing structures, given the temporal design of the interventions. The results are derived from the estimation of combined data for conservation-based pricing structures and non-conservation-based pricing structures. Column (1) in Table 8 reports the estimated average effects of the pricing structure switch for the whole sample. Utilities decrease the average gpcd by 2.9% for the switch from non-conservation-based to conservation-based pricing structures. This indicates that policy intervention in switching to a conservation-based pricing structure is likely to result in water-saving effects.

Columns (2) and (3) show the results for subsamples by the duration that a utility keeps its non-conservation-based pricing structure before transitioning to conservation-based ones. The results show how water consumption reduction varies according to the length of time the utility remains in the existing pricing structure before changing to the new structure. Specifically, column (2) shows a statistically insignificant effect from transitioning to a conservation-based pricing structure if less than two years were spent in the previous non-conservation-based pricing structure. On the other hand, when staying in the previous non-conservation-based pricing structure between two and five years, the water consumption decreases by 5.0%. Finally, when the non-conservation-based pricing structure remains longer than five years before the transition, water consumption decreases by 6.2%. These results are all statistically significant at the 1% level.

According to these findings, the longer the utility remained in the non-conservation-based pricing structure, the greater the reduction in water consumption caused by the conversion to the conservation-based pricing structure. This result is most likely due to

Table 6
Parameter estimates for changes in gpcd by the type of each pricing structure
(Reference structure: Flat; Dependent variable: log of gpcd of water).

Structures	(1)	(2)	(3)
	OLS	Fixed effects	Fixed effects
Uniform	−0.100**	−0.147***	−0.048*
	(0.044)	(0.042)	(0.027)
IBR	−0.244***	−0.254***	−0.084***
	(0.044)	(0.001)	(0.014)
Budget	−0.102**	−0.405***	−0.119**
	(0.046)	(0.060)	(0.060)
Observations	20,614	20,614	20,614
R-squared	0.023	0.370	0.482
Utility FEs	No	Yes	Yes
Month FEs	No	Yes	Yes
Year FEs	No	No	Yes

Notes: Asterisks ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7
Parameter estimates for changes in gpcd by switching pricing structures
(Reference structure: Previous pricing structure; Dependent variable: log of gpcd of water).

From	To			
	(1) IBR	(2) Uniform	(3) Budget	(4) Budget
Uniform	−0.029** (0.012)			
IBR		−0.032 (0.021)		
Uniform			0.007 (0.036)	
IBR				0.038 (0.026)
Observations	4,611	1,606	600	1,023
R-squared	0.521	0.690	0.714	0.652
Utility FEs	Yes	Yes	Yes	Yes
Month FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes

Notes: Asterisks ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8
Parameter estimates by the length of time stayed in non-conservation under switching from non-conservation-based to conservation-based pricing structures (Dependent variable: log of gpcd).

Structure	Length of time stayed in non-conservation			
	(1)	(2)	(3)	(4)
	No length	Less than or equal to two years (i.e., ≤2)	Between two and five years (i.e., >2 & 5)	More than five years (i.e., >5)
From non-conservation to conservation (Reference pricing structure: non-conservation)	−0.029*** (0.010)	−0.004 (0.018)	−0.050*** (0.019)	−0.062*** (0.015)
Observations	5,372	1,058	1364	2,950
R-squared	0.559	0.699	0.659	0.570
Utility FEs	Yes	Yes	Yes	Yes
Month FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes

Notes: Asterisks ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

the following explanations: First, when the time spent by a utility to keep in the previous non-conservation-based pricing structure is short (i.e., less than or equal to two years), households tend to be less involved in water conservation-related policies. Accordingly, households have less experience in making behavioral adjustments for water conservation. That said, they might have less exposure to education or promotion that encourages pro-conservation knowledge, awareness or perceptions, and consequential habits. Second, in this vein, households have less experience in water-saving investments under relatively long-term water conservation, such as installing water-saving appliances or gadgets and following water-saving techniques in their homes. These investments include home upgrades or techniques, such as a water-saving shower or flow restrictor, taking shorter showers or fewer baths, checking for faucets and pipe leaks, and turning off the water while shaving or brushing teeth. Any water-saving-relevant adjustments involve monetary costs for purchasing and applying certain devices, which can incur high personal and social costs [62,63].

Alongside capital investments, these adjustments also involve a time commitment for households. These capital investments and time commitments can be interpreted as sunk costs that households pay from an economic point of view. In other words, households that experienced non-conservation-based pricing structures for a short period would also face a small sunk cost. When a utility remains in a non-conservation-based pricing structure for an extended period (e.g., over two years, as seen in columns 3 and 4), households tend to have fewer experiences with adjustments for water conservation. Moreover, households that persist in a non-conservation-based pricing structure for an extended duration are likely to have used water at relatively lower prices for a significant period. It is important to note that pricing structures designed to emphasize conservation goals typically result in higher average unit prices compared to those that do not prioritize conservation (see footnote 7 in the Conceptual Framework section). Consequently, the transition to conservation-based pricing structures may curtail households from continuing to benefit from these lower prices. Therefore, when households accustomed to lower water prices resulting from long-term non-conservation-based pricing structures undergo changes to conservation-oriented pricing structures, whether due to droughts or other factors, their reduction in water consumption appears considerably more pronounced.

5.3. Switching from conservation-based to non-conservation-based pricing structures

Table 9 presents the estimation results of switching from conservation-based to non-conservation-based pricing structures, which offers asymmetric results compared to Table 8. Column (1) estimates the average effects of the pricing structure without considering the time durations. We presumed that the policy intervention of switching from conservation-based pricing structures to non-conservation-based structures would lead to an increase in water consumption. As expected, its result shows positive coefficients but no statistically significant change in water use when a utility transitions from conservation-based to non-conservation-based pricing structures.

Meanwhile, given the length of periods staying in the conservation-based structure, we find positive and statistically significant coefficients (column 2). When a utility has a conservation-based pricing structure for less than two years before switching to a non-conservation-based structure, we observe that the average gpcd rises by 9.8%. That said, the rebound effect of water consumption is noticeable. In contrast, column (3) shows negative but statistically insignificant coefficients. This result implies that if a utility stayed in the conservation-based pricing structure for longer than two years and then switched to a non-conservation structure, the rebound effect of water consumption is not statistically significant.

In essence, the duration of exposure to the conservation-based pricing structure plays a crucial role in determining the magnitude of the rebound effect. When a water utility used a conservation-based pricing structure for a short period before transitioning to a non-conservation-based one, households served by the utility might not have fully internalized the conservation habits encouraged by the pricing structure. The relatively short duration of exposure to higher water prices under the conservation-based pricing structures may not have been sufficient to induce lasting behavior changes. Consequently, when the water utility switches to a non-conservation-based pricing structure, households may quickly revert to their previous consumption patterns, causing a rebound in water use. This rebound results from the lack of a strong, enduring incentive for behavioral adjustments due to the short exposure to conservation-oriented pricing.

On the other hand, when the water utility maintained a conservation-based pricing structure for an extended period, such as more than two years, before the transition, it means that households in the utility's service area had a longer time to adapt to the conservation pricing structure. They likely incorporated water-saving practices into their daily routines, leading to more sustainable behavior changes. Thus, as the utility transitions to a non-conservation-based pricing structure, households may still experience some increase in water use, but the rebound effect will not be as pronounced as the effect in the short-term case. This is because the longer exposure to conservation pricing has solidified behavioral changes, resulting in a lower percentage of rebound.

Alternatively, the tendency for continued reduction in water consumption may lead to the absence of a rebound effect. Under the longer duration, households are highly likely to make capital and time investments as adjustments for water consumption reduction. For instance, households might install water-efficient devices (e.g., appliances, fixtures, garden irrigation) or be involved in a long-term behavior change (e.g., fully loading the dishwasher, taking shorter showers). This implies that interventions can yield long-term, additive behavioral change when treatments are continued and persist after the treatments are discontinued. This can also be interpreted as a kind of crowding-in effect in which the financial incentives or investments alter the underlying motivations and behaviors, leading to continuing their behavior after the pricing structure is altered.

5.4. Robustness check: role of the average price

We verified the impact of the pricing structure change on residential water consumption. We focused on the effects of the structure change itself on water demand. In this regard, we can think of two potential problems: rather than imposing increased water prices, if the pricing structure is driving the change, we could see an effect of holding the average price constant. For example, two households under different water pricing structures could behave differently. Taking into account information on how the average prices are changed by pricing structure would be helpful to get more robust results. In doing so, we avoid any potential bias about the influence of omitted variables caused by excluding water prices. We addressed possible concerns about omitted variables by conducting a robustness check by including the price variable in the models.

We re-estimated equations (12) and (13) by adding the natural log of the median tier of the price schedule. The potential issue with adding the price variable into the model is whether the estimator for the coefficient of our price measure suffers from simultaneity bias. However, simultaneity bias caused by contemporaneous market price and demand shocks is not a concern in this paper because water prices in California are set by the local government rather than by market supply and demand equilibrium. Another concern is a simultaneity bias resulting from IBR, in which the marginal price is a function of personal consumption. Previous studies used instrumental variables of marginal or average price to address this issue [64]. However, since we use utility service area-level average household consumption data, we can calculate neither a meaningful marginal nor an average price. Following previous studies with a similar dataset [65,57,58], our primary response to address this form of simultaneity bias is to use price on the median tier of each utility's tiered pricing schedule (by year) as our price measure.

Columns (1) and (3) in Table 10 show the effect of switching to and from conservation-based pricing structures without adding the price variable. Columns (2) and (4) indicate the effect of switching to and from conservation-based pricing structures with price variables. The results demonstrate that we cannot reject the null hypothesis that the estimate is indistinguishable from the point estimate in columns (1) and (3) (i.e., after accounting for the price difference before and after the switch, we find similar results on the effect of pricing structure change on water consumption). Consistent with previous research, our results suggest that, in addition to price levels, pricing structures themselves can be valuable in promoting conservation [46,47,48,49,34]. Specifically, results presented in column (2) of Table 10 (dealing with average prices) indicate that when faced with a conservation-based pricing structure, on

Table 9
Parameter estimates by the length of time stayed in conservation under switching from conservation-based to non-conservation-based pricing structures (Dependent variable: log of gpcd of water).

Structure	Length of time stayed in conservation		
	(1)	(2)	(3)
	No length	Less than or equal to two years (i.e., ≤2)	More than two years (i.e., >2)
From conservation to non-conservation (Reference pricing structure: conservation)	0.006 (0.020)	0.098*** (0.034)	−0.001 (0.025)
Observations	1,706	473	1,233
R-squared	0.688	0.609	0.727
Utility FEs	Yes	Yes	Yes
Month FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes

Notes: Asterisks ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10
Parameter estimates for switching to and from conservation-based pricing structures with and without considering the average price of water (Dependent variable: log of gpcd of water).

From	To			
	(1) Conservation	(2) Conservation	(3) Non-conservation	(4) Non-conservation
Non-conservation	−0.029*** (0.010)	−0.026** (0.010)	–	–
Conservation	–	–	0.006 (0.020)	0.004 (0.021)
Average price	–	−0.134*** (0.019)	–	−0.068*** (0.013)
Observations	5,372	4,390	1,706	1,422
R-squared	0.559	0.593	0.688	0.532
Utility FEs	Yes	Yes	Yes	Yes
Month FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes

Notes: Asterisks ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. We do not report estimated results with cut-offs of the length of time the utility kept an existing pricing structure since those results were similar to Tables 8 and 9

average, gpcd is reduced by 2.6%, compared to the gpcd reduction under a non-conservation-based pricing structure. This result is statistically significant at the 5% level. Additional results (dealing with average prices) suggest that when faced with a non-conservation-based pricing structure, gpcd is slightly increased (by 0.4%) on average. However, similar to our previous results in section 5.3, we do not find a significant change in gpcd after switching from conservation-based to non-conservation-based pricing structures.

6. Conclusions

We evaluated in this study the effect of policy intervention on residential water consumption and through pricing structure changes by answering the following questions: (i) How are pricing structures and water consumption changing within utilities in California? (ii) How do residential households respond to different pricing structure changes? Moreover, (iii) how long does the effect of the pricing structure change persist? California provides an ideal setting to study these questions because it is renowned for its proactive urban water management systems, particularly when compared to many states and regions facing water scarcity. Additionally, due to its prolonged struggles with drought and population growth, California has developed a rich history of water conservation policies and management practices.

Greater reliance on demand-side management as a tool to moderate urban water use has increased the need to understand the effectiveness of pricing structures on household water use. Much of the literature has focused on the price elasticity of demand for residential water. Yet, it remains unclear whether households respond to changes in the pricing structure itself, particularly when they face switching from non-conservation-based to conservation-based pricing structures and vice versa. Therefore, in addition to estimating water consumption based on various pricing structures, our study adds significant value by thoroughly examining the effects of policy interventions through structural changes. This involves assessing situations where a utility switches from an existing structure to another, using a previously adopted pricing structure as the reference, while considering the intervention period. This comprehensive analysis enhances the overall significance of our study.

In the cross-comparison between different pricing structures, we find more water savings under a conservation-based structure, such as IBR or budget pricing structures, than under uniform or flat structures. We observe that policy intervention on switching toward conservation-based prices from non-conservation-based ones is potentially likely to have water-saving effects by reducing water consumption by an average of 2.9%. This reduction is more significant if the utilities maintain the non-conservation-based pricing longer before switching to conservation-based pricing structures.

Conversely, when utilities switch from conservation-based to non-conservation-based pricing structures, water consumption is rebounded by 9.8%; however, the degree of rebound is reduced when utilities remain on a conservation-based pricing structure longer before switching to a non-conservation-based pricing structure. Longer-term adjustments for water savings likely motivate households to decrease water consumption continuously. We see these responses as the crowding-in effect in which the pecuniary incentives alter the underlying motivation and behavior such that once the pecuniary part is altered, the behavior remains.

Quantifying the effect of pricing structure transitions on water consumption has direct implications for water utilities, many of which consider pricing strategies to encourage conservation. Given this importance, our findings will provide policymakers, regulators, water utilities, and residential households with new information to help mitigate future water shortages. Policymakers and regulators, who are stakeholders first and fundamentally involved in the pricing structures, can utilize this information to reduce demand during water shortages (droughts). Water utilities often facing zero-profit constraints may also use this information to estimate the impact of pricing changes on total revenues and prepare uncertainty in revenue streams through policy interventions. For instance, water utilities must factor in mechanisms for cost recovery consistently. In addition to the information we presented, the inclusion of additional information concerning how water utilities communicate with citizens regarding different pricing structures could offer valuable guidance for designing customized, region-specific water conservation mechanisms. This additional information can provide insights into why there are changes or no changes in households' behaviors related to water consumption.

CRediT authorship contribution statement

Juhee Lee: Data curation, Formal analysis, Investigation, Software, Visualization, Writing – original draft. **Mehdi Nemati:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing. **Maura Allaire:** Conceptualization, Methodology, Writing – review & editing. **Ariel Dinar:** Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Mehdi Nemati reports financial support was provided by National Institute of Food and Agriculture.

Data availability

Data will be made available on request.

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Appendix

Appendix (A): Mathematical derivation

The utility function is given by $U(C_t) = \frac{C_t^{1-\gamma}}{1-\gamma}$ at time t ($\Rightarrow\ U'(C_t) = C_t^{-\gamma}$). Considering a two-period model, $U = U(C_t) + \beta U(C_{t+1})$, the objective function is:

$$\begin{aligned}
&\underbrace{Max}_{C_t, C_{t+1}} \quad U(C_t) + \beta U(C_{t+1}) \\
&s.t. \quad C_t + \frac{C_{t+1}}{1+r} = m_t + \frac{m_{t+1}}{1+r} \\
&\Rightarrow \frac{C_{t+1}}{1+r} = m_t - C_t + \frac{m_{t+1}}{1+r} \\
&\Rightarrow C_{t+1} = (1+r)(m_t - C_t) + m_{t-1}
\end{aligned} \tag{A1}$$

Substituting C_{t+1} into the objective function yields as:

$$\begin{aligned}
&\underbrace{Max}_{C_t} \quad U(C_t) + \beta U\{(1+r)(m_t - C_t) + m_{t-1}\} \\
&FOC: \; U^{'}(C_t) - \beta\, U^{'}\{(1+r)(m_t - C_t) + m_{t-1}\}(1+r) = 0 \\
&\Rightarrow \; U^{'}(C_t) - \beta(1+r)U^{'}\{(C_{t+1})\} = 0 \; (\because C_{t+1} = (1+r)(m_t - C_t) + m_{t-1}) \\
&\qquad\qquad \Rightarrow \; U^{'}(C_t) = \beta(1+r)U^{'}\{(C_{t+1})\} \\
&\qquad\quad \Rightarrow \; C_t^{-\gamma} = \beta(1+r)C_{t+1}^{-\gamma} \; (\because U^{'}(C_t) = C_t^{-\gamma})
\end{aligned} \tag{A2}$$

Applying the constant relative risk-averse (CRRA) utility function, $C_t^{-\gamma} = \beta(1+r)C_{t+1}^{-\gamma}$, the Euler equation is:

$$1 = \beta(1+r)\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} = \beta R\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \text{ such that } (1+r) = R \tag{A3}$$

Let us assume $P_{t+1} > P_t$ or relative price $A_{t+1} = \frac{P_{t+1}}{P_t} > 1$ since the unit price of water consumption under conservation-based pricing structures tends to be more expensive than that of non-conservation-based pricing structures. By employing the relative water price, we formulate the objective function as follows:

$$\begin{aligned}
&\underbrace{Max}_{C_t, C_{t+1}} \quad U(C_t) + \beta U(C_{t+1}) \\
&s.t. \quad P_t C_t + \frac{P_{t+1}C_{t+1}}{(1+r)} = m_t + \frac{m_{t+1}}{1+r} \\
&Or, C_t + \frac{A_{t+1}C_{t+1}}{(1+r)} = m_t + \frac{m_{t+1}}{1+r} \Leftrightarrow C_{t+1} = \frac{(1+r)}{A_{t+1}}(m_t - C_t) + \frac{m_{t+1}}{A_{t+1}}
\end{aligned} \tag{A4}$$

The variable C_{t+1} can then be substituted into the objective function (A4) to get a maximization in a single variable C_t, taking the derivative, yields the first-order conditions such as the equation:

$$\begin{aligned}
&\underbrace{Max}_{C_t} \quad U(C_t) + \beta U\left\{\frac{(1+r)}{A_{t+1}}(m_t - C_t) + \frac{m_{t+1}}{A_{t+1}}\right\} \\
&FOC: \; U^{'}(C_t) - \beta(1+r)\frac{U^{'}(C_{t+1})}{A_{t+1}} = 0 \\
&\Leftrightarrow U^{'}(C_t) = \beta R\frac{U^{'}(C_{t+1})}{A_{t+1}} \text{ such that } (1+r) = R \\
&\Leftrightarrow 1 = \beta R\frac{1}{A_{t+1}}\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} (\because U^{'}(C_t) = C_t^{-\gamma}; \; U^{'}(C_{t+1}) = C_{t+1}^{-\gamma})
\end{aligned} \tag{A5}$$

At $\beta R = 1$ and at $A_{t+1} = \left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}$, we get the following dynamic optimal consumption path:

$$\underbrace{C_{t+1}}_{\substack{future \\ consumption}} = \underbrace{C_t}_{\substack{current \\ consumption}} \times \underbrace{(A_{t+1})^{\frac{-1}{\gamma}}}_{retlavie\ price} \tag{A6}$$

The exchange pricing between today's consumption and tomorrow's consumption is proportional to $-1/\gamma$. The parameter γ may vary depending on how long the household stayed in the previous pricing structures.

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