2023

DRINKING WATER

NEEDS ASSESSMENT

RISK ASSESSMENT RESULTS FOR PUBLIC WATER SYSTEMS

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Full Report:
HTTPS://WWW.WATERBOARDS.CA.GOV/DRINKING_WATER/CERTLIC/DRINKINGWATER/DOCUMENTS/NEEDS/2023NEEDSASSESSMENT.PDF

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Acknowledgements

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CONTENTS

RISK ASSESSMENT RESULTS FOR PUBLIC WATER SYSTEMS 6

Overview 6

Key 2023 Risk Assessment Methodology Updates 6

Water Systems Assessed 6

Risk Assessment Methodology 7

Risk Indicators 8

Risk Assessment Results 9

At-Risk Water Systems 9

Results by System Size 15

Risk Drivers 15

Risk Indicator Category Results 19

Demographic Analysis of At-Risk Public Water Systems 19

Limitations of the Risk Assessment for Public Water Systems 21

Risk Assessment Refinement Opportunities 22

APPENDIX A: RISK ASSESSMENT METHODOLOGY FOR PUBLIC WATER SYSTEMS .. 25

INTRODUCTION 25

Public Water Systems Assessed 25

Risk Assessment Methodology Development Process 26

RISK ASSESSMENT METHODOLOGY 26

Risk Indicators 27

Initial 2021 Risk Indicators 27

2022 New and Removed Risk Indicators 29

2023 Added and Removed Risk Indicators 29

Risk Indicator Thresholds, Scores, & Weights 31

Thresholds 31

Scores 31

Weights 32
Risk Indicator Category Weights 39
Aggregated Risk Assessment Calculation Methodology 40
Adjusting for Missing Data 41
Aggregated Risk Assessment Thresholds 42
Aggregated Risk Assessment Results Analysis 42
Explanation of the Changes in the Risk Assessment Results from 2022 to 2023 43
RISK INDICATOR DETAILS 45
Identification of Water Systems Assessed 45
Water Quality Risk Indicators 45
History of E. coli Presence 46
Increasing Presence of Water Quality Trends Toward MCL 49
Treatment Technique Violations 57
Past Presence on the Failing List 59
Percentage of Sources Exceeding an MCL 61
Constituents of Emerging Concern 65
Accessibility Risk Indicators 73
Number of Sources 74
Absence of Interties 76
DWR – Drought & Water Shortage Risk Assessment Results 78
Critically Overdrafted Groundwater Basin 81
Source Capacity Violations 82
Bottled or Hauled Water Reliance 85
Affordability Risk Indicators 88
Percent of Median Household Income (%MHI) 89
Extreme Water Bill 92
Household Socioeconomic Burden 94
TMF Capacity Risk Indicators 100
Operator Certification Violations 101

Monitoring & Reporting Violations 102
Significant Deficiencies 105
Operating Ratio 107
Total Annual Income 110
Days Cash on Hand 111

RISK ASSESSMENT RESULTS FOR PUBLIC WATER SYSTEMS

OVERVIEW

The purpose of the Risk Assessment for public water systems is to identify systems at-risk or potentially at-risk of failing to meet one or more key Human Right to Water goals: (1) providing safe drinking water; (2) accessible drinking water; (3) affordable drinking water; and/or (4) maintaining a sustainable water system. Data on performance and risk is most readily available for public water systems and thus the Risk Assessment methodology for public water systems allows for a multi-faceted examination across four risk indicator categories: Water Quality, Accessibility, Affordability; and TMF (technical, managerial, and financial) Capacity.

KEY 2023 RISK ASSESSMENT METHODOLOGY UPDATES

Minimal changes have been made to the Risk Assessment methodology when compared to the methodology used in the 2022 Needs Assessment. The following summarizes the enhancements the State Water Board has made to the 2023 Risk Assessment methodology for public water systems. See Appendix A for more information:

- **Removed two affordability risk indicators** from the Risk Assessment due to outdated data. These risk indicators include: 'Percentage of Residential Arrearages' and 'Residential Arrearage Burden.' Learn more in Appendix A.
- **Incorporated one affordability new risk indicator** into the Risk Assessment: 'Household Socioeconomic Burden.' Learn more in Appendix A.
- **Updated the risk indicator calculation methodology** for 'Increasing Presence of Water Quality Trends Toward MCL', 'Contaminants of Emerging Concern', and 'Bottled or Hauled Water Reliance' Learn more in Appendix A.

WATER SYSTEMS ASSESSED

The Risk Assessment is conducted for community water systems up to 30,000 service connections or 100,000 population served and non-transient, non-community systems that serve K-12 schools. Large community water systems are excluded from the Assessment. The

inventory of systems included in the Risk Assessment align with State Water Board expanded funding eligibilities in the 2021-22 Intended Use Plan to medium disadvantaged community water systems.[1] The 2023 Risk Assessment excludes 68 wholesalers because they do not provide direct service to residential customers. Some water system types have also been excluded from certain risk categories or specific risk indicators (Table 1).

Table 1: Public Water Systems Analyzed in the 2023 Risk Assessment

Water System Type[2]	Number	Water Quality	Accessibility	Affordability	TMF Capacity
Community Water Systems[3]	2,695	Yes	Yes	Yes	Yes[4]
K-12 Schools[5]	358	Yes	Yes	No[6]	Yes
TOTAL ANALYZED:	**3,053**				

RISK ASSESSMENT METHODOLOGY

The first Risk Assessment published in the 2021 Needs Assessment was developed in partnership between the State Water Board and UCLA though a phased public process from January 2019 through January 2021. Since the initial Risk Assessment, many enhancements have been made to the methodology to accommodate for new or missing data, respond to stakeholder feedback, and improve the predictive power of the analysis. In 2022, the State Water Board hosted three public workshops to develop and solicit public feedback on the development of a new affordability risk indicator: 'Household Socioeconomic Burden.' Appendix A contains an in-depth overview of the Risk Assessment methodology which relies on three core elements that are utilized to calculate an aggregated risk score for the public water systems assessed (Figure 1):

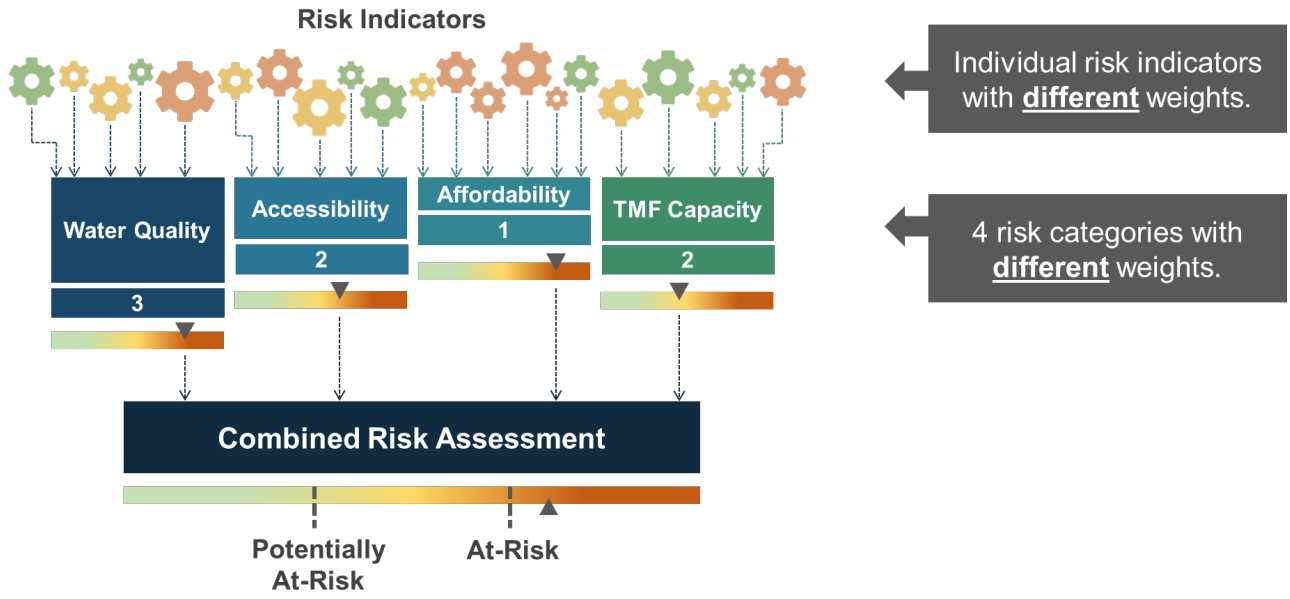
Risk Indicators: quantifiable measurements of key data points that allow the State Water Board to assess the potential for a water system to fail to sustainably provide an adequate supply of safe drinking water due to water quality, water quantity, infrastructure, and/or institutional issues.

Risk Indicator Thresholds: the levels, points, or values associated with an individual risk indicator that delineates when a water system is more at-risk of failing, typically based on regulatory requirements or industry standards.

[1] Drinking Water State Revolving Fund (DWSRF) Intended Use Plan https://www.waterboards.ca.gov/water_issues/programs/grants_loans/docs/dwsrf_iup_sfy2021_22_final2.pdf
[2] Systems on the Failing list were included in the Risk Assessment analysis, however, they were excluded from the final Risk Assessment results.
[3] Wholesalers were excluded.
[4] Military bases are excluded from the financial risk indicators: Days Cash on Hand, Operating Ratio, & Income.
[5] These systems were manually identified by the State Water Board.
[6] Schools do not typically charge for water; therefore, schools received a risk score of zero in the Affordability category for the Risk Assessment.

Scores & Weights: the application of a multiplying value or weight to each risk indicator and risk category, as certain risk indicators and categories may be deemed more critical than others and/or some may be out of the control of the water system.

Figure 1: Illustration of the Risk Assessment Methodology



RISK INDICATORS

The initial 2021 Risk Assessment utilized 19 risk indicators. These risk indicators were identified and developed from 2019-2021 in partnership between the State Water Board and UCLA and with public feedback.[7] A concerted effort was made to select a range of risk indicators that measure water quality, accessibility, affordability, and TMF capacity based on their criticality as it relates to a water system's ability to remain in compliance with safe drinking water standards. In 2021, the State Water Board made significant changes to the indicators used in the 2022 Risk Assessment. In an effort to keep the Risk Assessment methodology static, minimal changes were made to the 2023 risk indicators (Table 2). The State Water Board removed two affordability indicators and added one new indicator to accommodate for missing data. Information on each risk indicator calculation methodology, thresholds, scores, and weights can be found in Appendix A.

[7] The effort to identify and select the initial 2021 risk indicators included full consideration of indicators identified in efforts conducted by the Office of Environmental Health Hazard Assessment (OEHHA), the Department of Water Resources (DWR), and the California Public Utilities Commission. Risk indicators were also assessed based on the availability of quality statewide data. Information on how the 19 risk indicators were selected from a list of 129 potential risk indicators is detailed in the October 7, 2020 white paper:
Evaluation of Potential Indicators and Recommendations for Risk Assessment 2.0 for Public Water Systems
https://www.waterboards.ca.gov/safer/docs/e_p_i_recommendations_risk_assessment_2_public_water_systems.pdf

Table 2: Risk Indicators

Category	2023 Risk Indicators
Water Quality	History of *E. coli* Presence
	Increasing Presence of Water Quality Trends Toward MCL
	Treatment Technique Violations
	Past Presence on the HR2W List
	Percentage of Sources Exceeding a MCL
	Constituents of Emerging Concern
Accessibility	Number of Sources
	Absence of Interties
	DWR – Drought & Water Shortage Risk Assessment Results
	Critically Over drafted Groundwater Basin
	Bottled or Hauled Water Reliance
	Source Capacity Violations
Affordability	Percent of Median Household Income (%MHI)
	Extreme Water Bill
	NEW: Household Socioeconomic Burden
TMF Capacity	Operator Certification Violations
	Monitoring and Reporting Violations
	Significant Deficiencies
	Days Cash on Hand
	Operating Ratio
	Net Annual Income

RISK ASSESSMENT RESULTS

AT-RISK WATER SYSTEMS

The 2023 Risk Assessment was conducted for 3,053 public water systems. After removing the 381 Failing list systems,[8] the 2023 Risk Assessment results identified 512 (17%) At-Risk water systems, 453 (15%) Potentially At-Risk water systems, and 1,707 (56%) Not At-Risk water

[8] There were 388 Failing systems on January 1, 2023. This number excludes seven large water systems that are not included in the Risk Assessment.

systems (Figure 2).[9] Of the 381 Failing water systems, 302 (79%) meet the At-Risk threshold. If these systems come off the Failing list, they will be considered At-Risk systems.

Figure 2: 2023 Risk Assessment Results (n=3,053)[10]

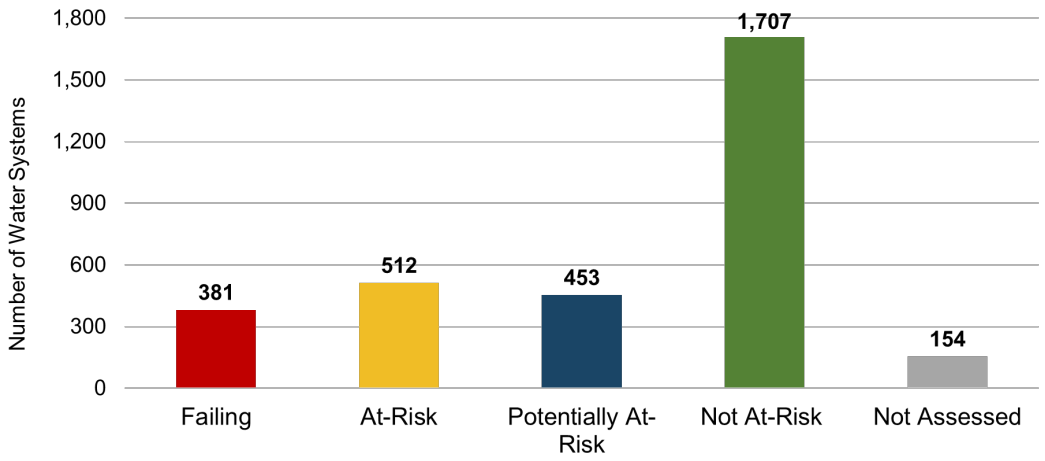
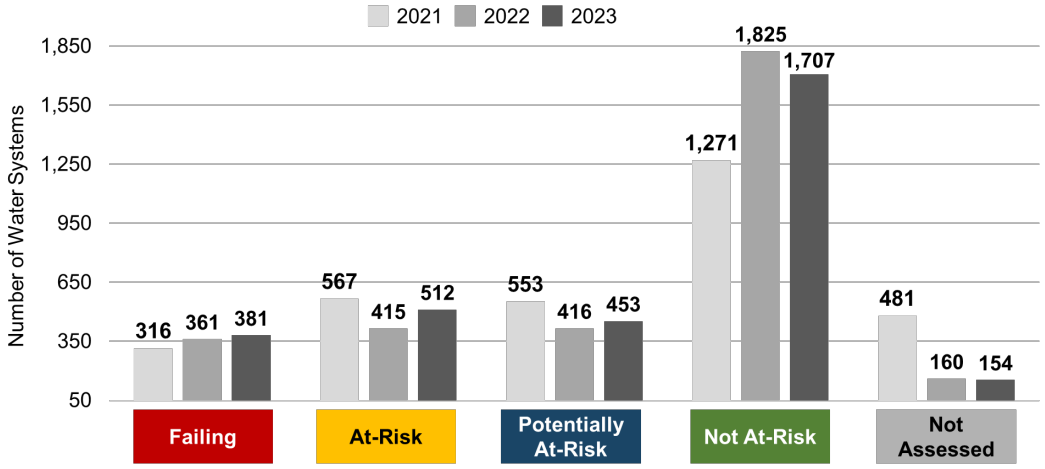


Figure 3: Risk Assessment Results Since 2021[11]



Compared to the 2022 Risk Assessment results, the 2023 Assessment identifies 113 more At-Risk water systems (including Failing system performance in the Risk Assessment) and a statewide increase in total average risk scores from 0.56 to 0.61. The increase in the number of At-Risk water systems and total average statewide risk scores is mostly attributed to the addition of the new Affordability Category risk indicator 'Household Socioeconomic Burden.'

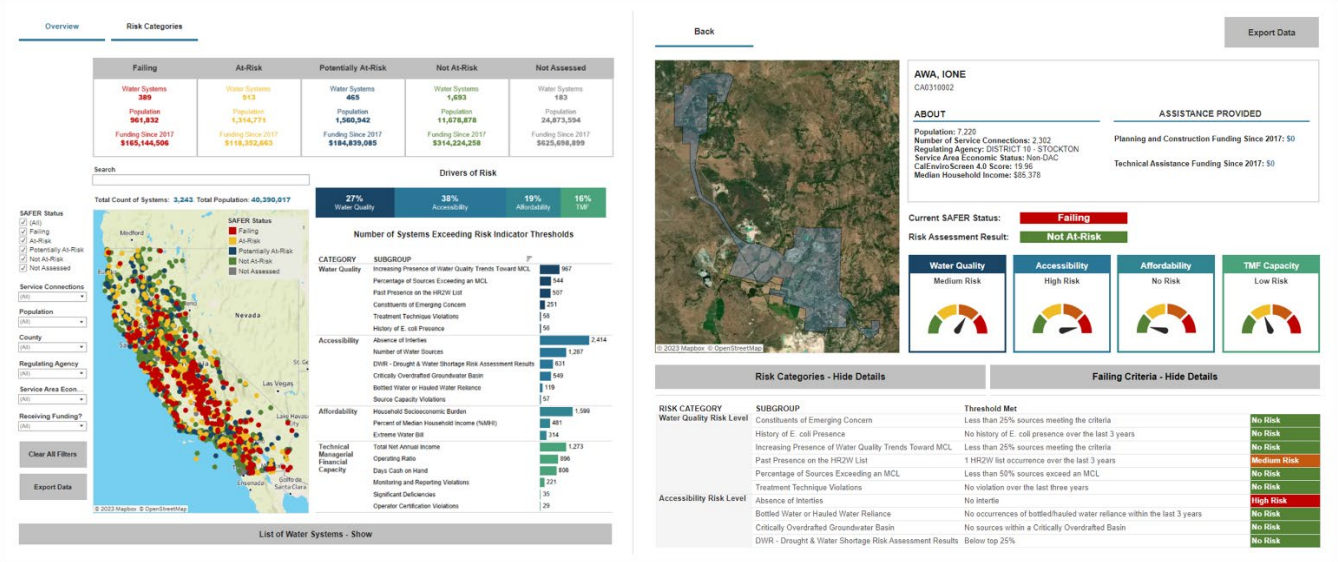
[9] Attachment A1: Risk Assessment Data and Results
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023risk.xlsx
[10] Not Assessed includes 86 large community water systems that serve greater than 30,000 service connections or 100,000 population served and 68 wholesalers.
[11] Not Assessed includes: in 2021, wholesalers and community water systems with greater than 3,300 service connections; in 2022 and 2023, wholesalers and community water systems with greater than 30,000 service connections or 100,000 population served.

Furthermore, 119 (4%) of At-Risk systems were automatically at-risk, regardless of their performance across all risk indicators because they have relied on bottled and/or hauled water to meet customer demand within the last three years. This is 30 more systems when compared to the 2022 Risk Assessment results, which had 89 (3%) of systems automatically At-Risk. Learn more about this in Appendix A.

Since the State Water Board began identifying At-Risk water systems in the Risk Assessment in the 2021 Needs Assessment, the total number of unique At-Risk water systems has remained fairly constant. This is due to a number of factors, including expanding Failing criteria, improved risk indicators and data, and the expansion of the inventory of systems included in the Risk Assessment.

The results of the Risk Assessment and the current list of Failing water systems are accessible online through the State Water Board's SAFER Dashboard.[12] The Dashboard updates the Failing list daily and the Risk Assessment results will be updated on a quarterly basis with new data as it becomes available. Learn more about the SAFER Dashboard in Appendix E.

Figure 4: SAFER Dashboard



The Risk Assessment results for public water systems indicated that Failing systems have more than double the average risk score (1.15 vs. 0.53) when compared to non-Failing systems. Furthermore, 301 (79%) Failing systems exceeded the At-Risk threshold compared to 495 (19%) non-Failing systems (Figure 5).

[12] SAFER Dashboard
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/saferdashboard.html

Figure 5: Distribution of Total Risk Score for Water Systems (n=3,053)

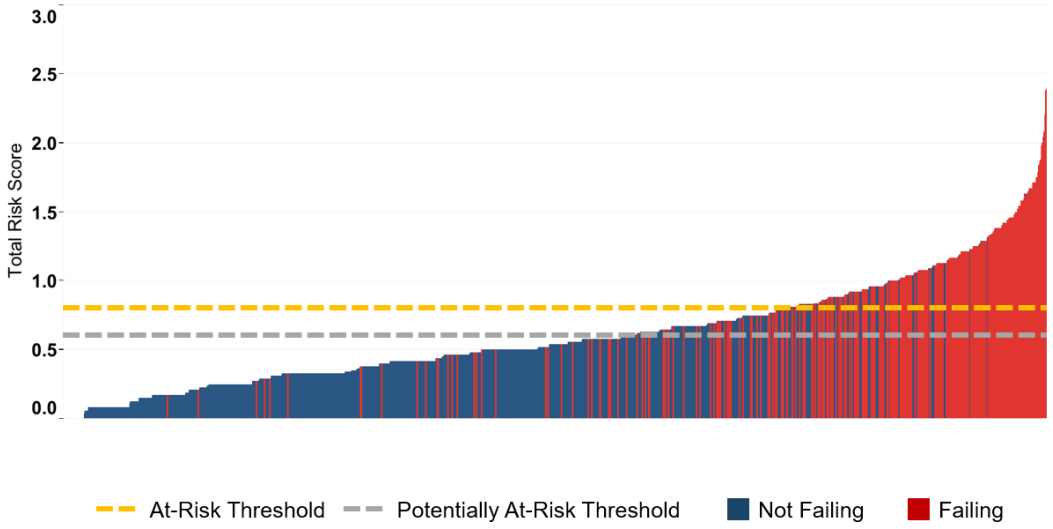
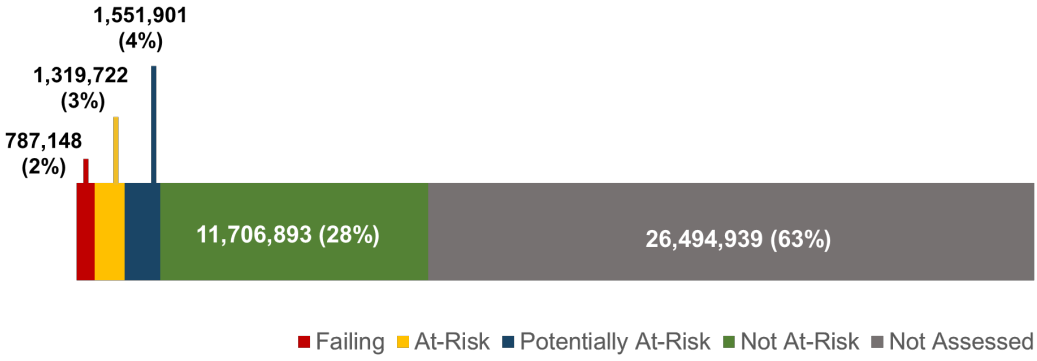


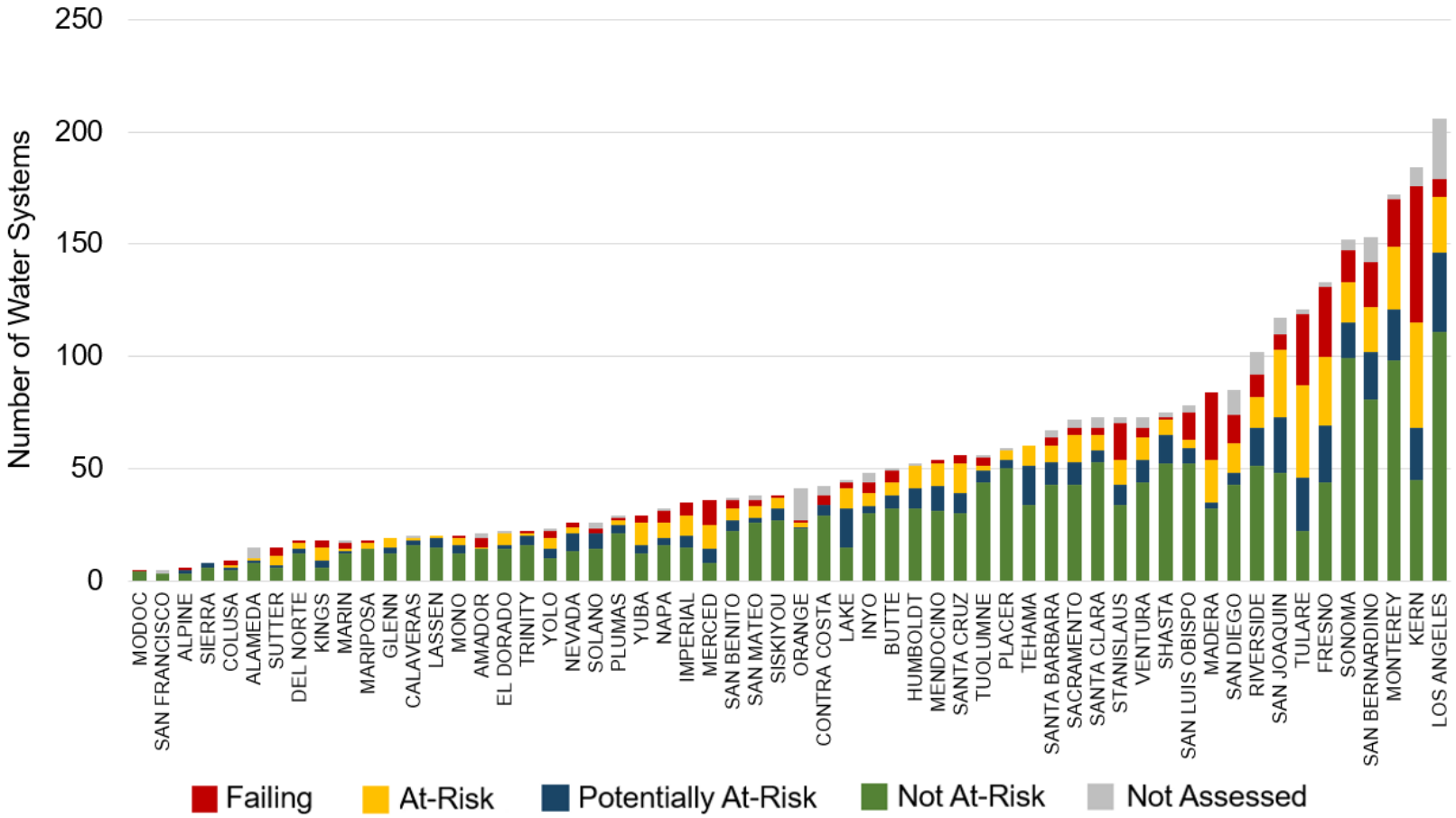
Figure 6 shows the proportion of population served by SAFER status of water systems included in the Risk Assessment. The majority of the population, approximately 28%, is served by Not At-Risk water systems. Both At-Risk and Potentially At-Risk water systems serve approximately 7% of the population compared to systems included in the Risk Assessment and Failing systems serve 2%. 63% of the population served by community water systems is not assessed in the Risk Assessment.

Figure 6: Population of Communities by SAFER Status



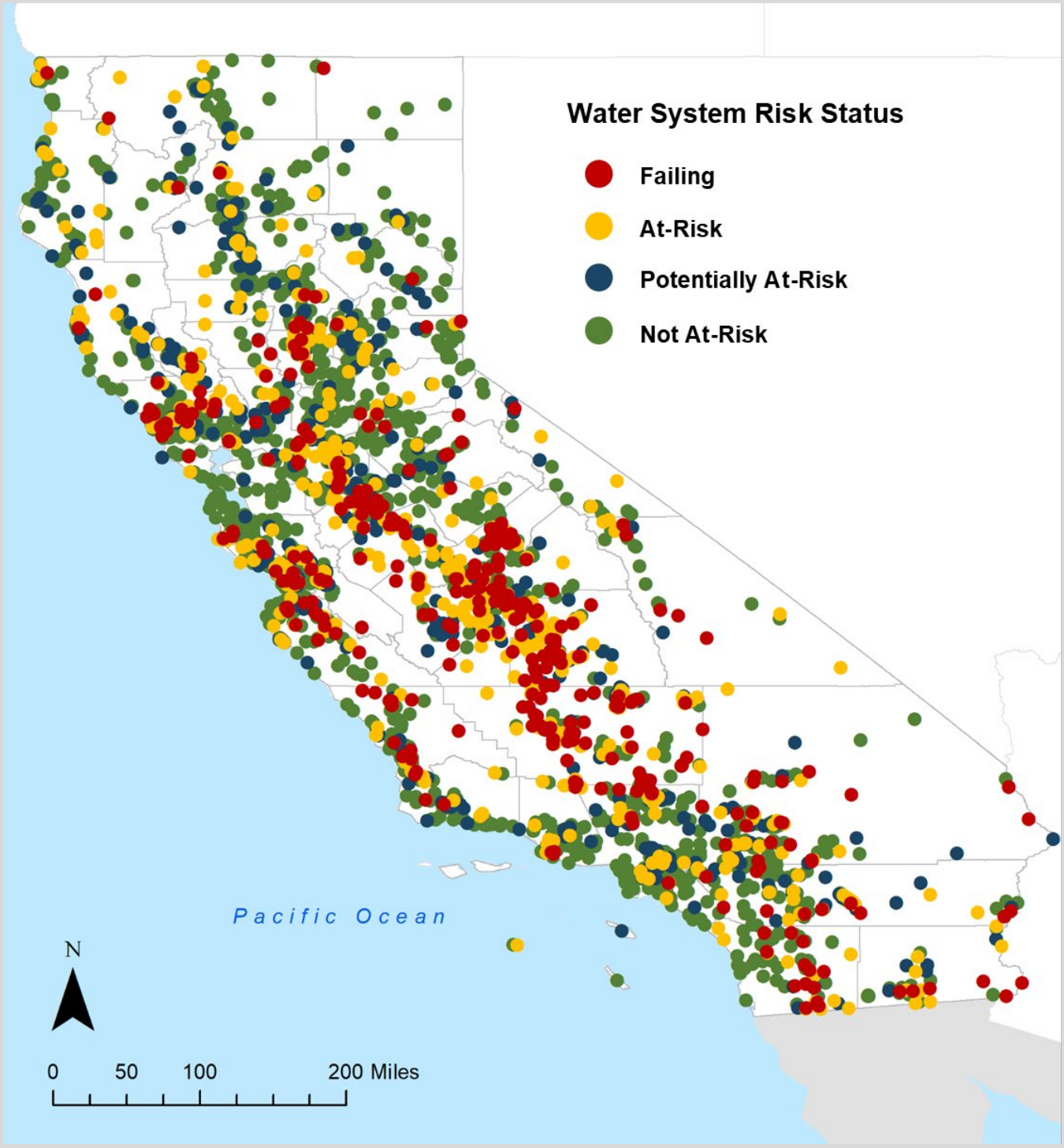
The distribution of At-Risk and Potentially At-Risk systems also varies substantially across the state, as shown in Figure 7 and Figure 11. For instance, Yuba County has the highest proportion of At-Risk systems (34.5%), whereas Alpine County, Contra Costa County, Modoc County, San Francisco County, Sierra County, and Solano County have the lowest proportion of At-Risk systems (0%).

Figure 7: Proportion of Failing and At-Risk Water Systems in Each County[13]



[13] Not Assessed represents large community water systems with service connections greater than 30,000 or population serves greater than 100,000. It also includes wholesalers.
Attachment A1: Risk Assessment Data and Results
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023risk.xlsx

Figure 8: Map of Public Water Systems Evaluated for the Risk Assessment (n=3,053)



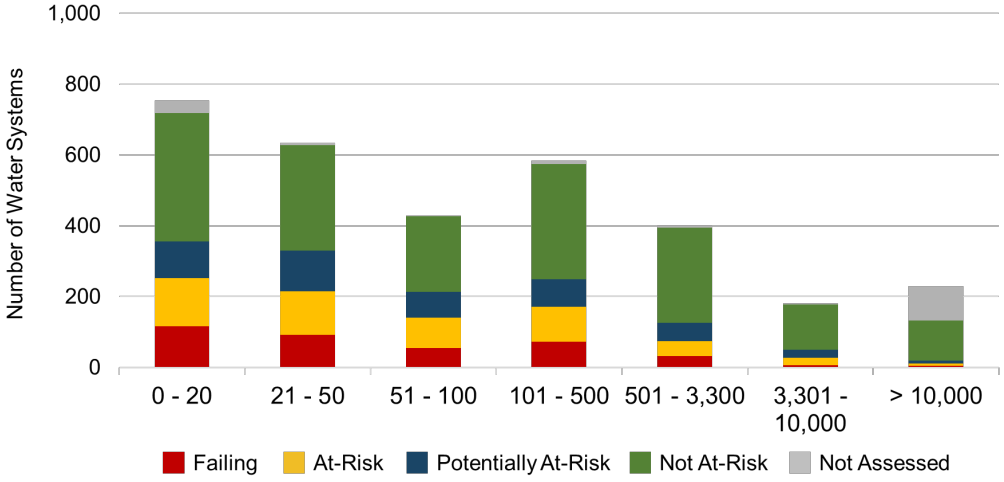
RESULTS BY SYSTEM SIZE

The analysis of the Risk Assessment results indicates the majority (86%) of At-Risk water systems are small water systems with 3,000 service connections or less (Table 3).

Table 3: 2023 Risk Assessment Results by Systems Size and Type

System Type	Small Systems[14]	Medium Systems[15]	K-12 Schools[16]
Failing	311	12	58
At-Risk	442	26	44
Potentially At-Risk	377	32	44
Not At-Risk	1,254	241	212
TOTAL:	**2,384**	**311**	**358**

Figure 9: Risk Assessment Results by Number of Service Connections

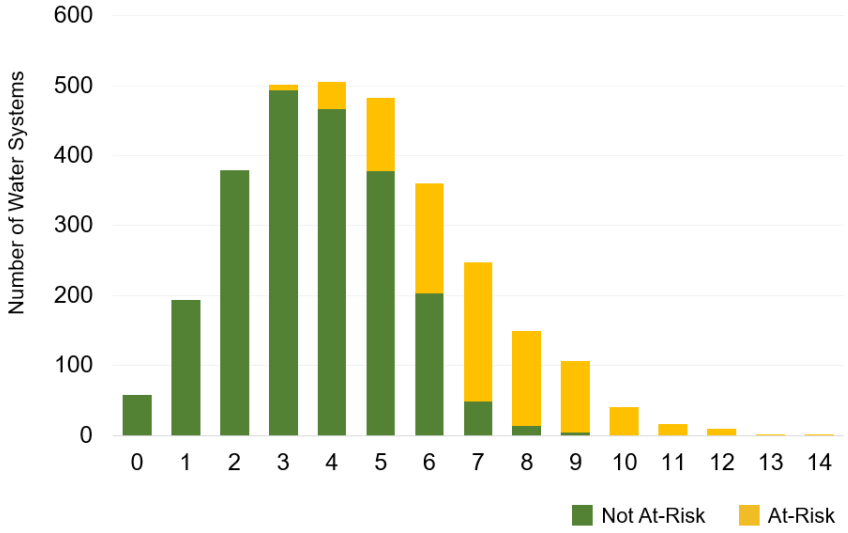


RISK DRIVERS

As Figure 10 below shows, all At-Risk systems exceed a threshold of concern for at least three risk indicators, with the average At-Risk system exceeding more than seven risk indicator thresholds of concern. This means that systems were not designated as At-Risk based on a single or even a handful of risk indicators. Moreover, At-Risk systems tended to have many more indicator concerns than Not At-Risk systems.

[14] 3,000 service connections or less.
[15] Greater than 3,000 service connections (Risk Assessment results limited to systems up to 30,000 connections and 100,000 population served).
[16] Community and non-community public water systems that serve K-12 schools.

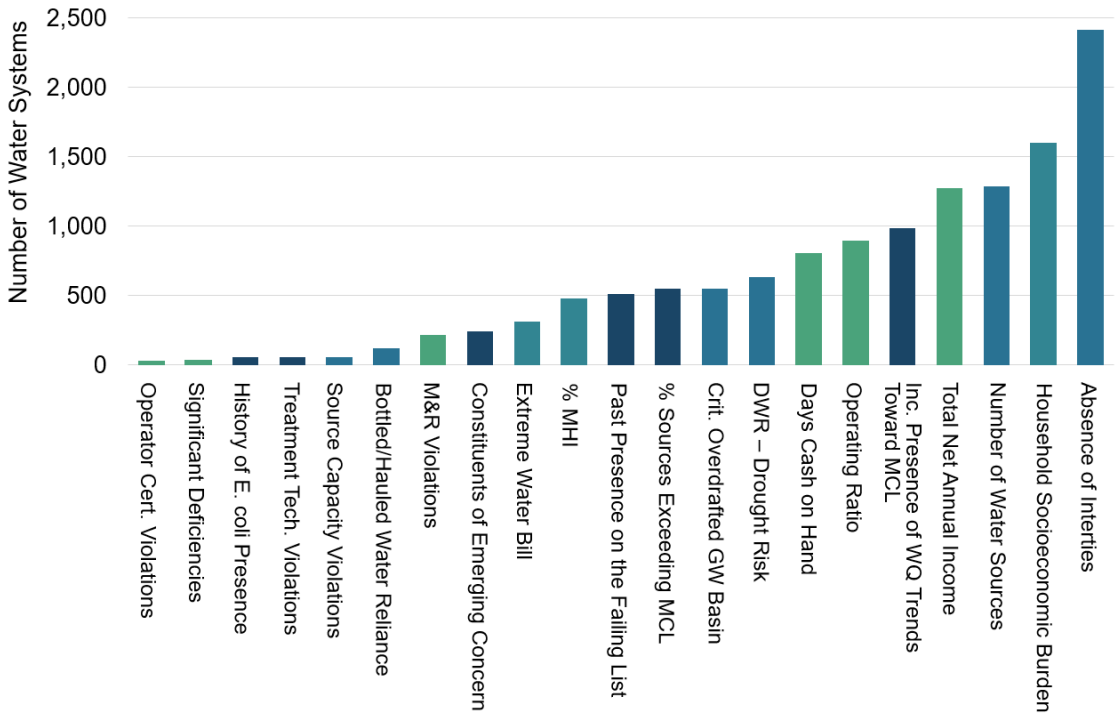
Figure 10: Distribution of the Number of Risk Indicator Thresholds Exceeded by At-Risk and Not At-Risk Water Systems (n=3,053)[17]



An analysis was also conducted to identify which risk indicator minimum thresholds were exceeded the most. As shown in Figure 11, the 'Absence of Interties', 'Household Socioeconomic Burden', 'Number of Water Sources', 'Total Net Annual Income', and 'Increasing Presence of Water Quality Trends Toward MCL' are the five risk indicators that the majority of water systems were exceeding the minimum risk threshold for. Two of these risk indicators fall into the Accessibility category, and the other three are spread in each of the Water Quality, Affordability, and TMF Capacity categories.

[17] Systems that were automatically At-Risk for meeting the risk thresholds for "Number of Water Sources" and/or "Bottled or Hauled Water Reliance" were excluded from this analysis.

Figure 11: Risk Indicators Ranked by Number of Systems Exceeding Min. Risk Threshold



Based on the Risk Assessment methodology, individual risk indicators are assigned weights between one and three depending on how critical they are for a water system to meet the goals of the HR2W. To better understand which risk indicators are contributing the most towards a water system's total risk score, the average weighted scores for each risk indicator were calculated for At-Risk water systems. Table 4 shows in descending order the most influential risk indicators which contributed the most weighted points to the final risk scoring for all At-Risk systems.

Table 4: Risk Indicators Ranked by their Contribution to Total Risk Scores for At-Risk Water Systems

Category	Risk Indicator	Max Possible Weighted Risk Score	Avg. Weighted Score	Percent Contributing to Total Risk Score[18]
Accessibility	Number of Water Sources	3	1.72	15.6%
Water Quality	Percentage of Sources Exceeding an MCL	3	1.67	15.1%

[18] This column represents the proportion of each risk indicator's statewide average weighted score to the total risk score. The total risk score was calculated by summing up the weighted risk scores across all risk indicators for At-Risk systems and then averaging them. In this analysis 119 systems that are meeting the criteria for automatically At-Risk were excluded.

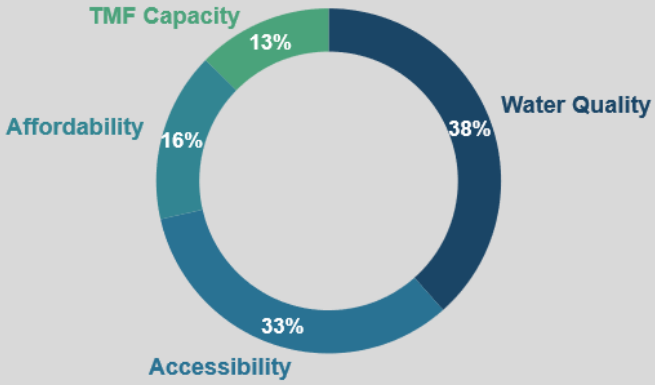
Category	Risk Indicator	Max Possible Weighted Risk Score	Avg. Weighted Score	Percent Contributing to Total Risk Score[18]
Affordability	Household Socioeconomic Burden	2	1.06	9.6%
Accessibility	Absence of Interties	1	0.91	8.2%
Affordability	Percent of Median Household Income	3	0.86	7.8%
Water Quality	Increasing Presence of Water Quality Trends Toward MCL	2	0.72	6.5%
Accessibility	Critically Overdrafted Groundwater Basin	2	0.71	6.4%
TMF Capacity	Total Net Annual Income	1	0.54	4.9%
TMF Capacity	Operating Ratio	1	0.45	4.1%
Water Quality	Past Presence on the HR2W List	2	0.44	4.0%
Accessibility	DWR – Drought & Water Shortage Risk Assessment Results	2	0.41	3.7%
Water Quality	Constituents of Emerging Concern	3	0.38	3.4%
TMF Capacity	Days Cash on Hand	1	0.34	3.0%
TMF Capacity	Monitoring & Reporting Violations	2	0.31	2.8%
Water Quality	History of *E. coli* Presence	3	0.19	1.8%
Affordability	Extreme Water Bill	1	0.14	1.2%
Accessibility	Source Capacity Violations	3	0.1	0.9%
TMF Capacity	Significant Deficiencies	3	0.09	0.8%
TMF Capacity	Operator Certification Violations	3	0.08	0.7%

Category	Risk Indicator	Max Possible Weighted Risk Score	Avg. Weighted Score	Percent Contributing to Total Risk Score[18]
Water Quality	Treatment Technique Violations	1	0.05	0.5%
Accessibility	Bottled Water or Hauled Water Reliance[19]	3	N/A	N/A

RISK INDICATOR CATEGORY RESULTS

The performance of At-Risk water systems across all individual risk indicators shows that the Water Quality category contributes the most weighted risk points to At-Risk scoring (38%), with Accessibility coming second (33%) and the Affordability (16%) and TMF Capacity (13%) categories contributing distant third and fourth highest shares of risk points.

Figure 12: Share of Each Risk Indicator Category in Calculating the Total Risk Score for Systems Meeting At-Risk Threshold (n=814)[20]



DEMOGRAPHIC ANALYSIS OF AT-RISK PUBLIC WATER SYSTEMS

Results for the 2023 Risk Assessment for public water systems can be combined with demographic data to better understand the populations most at-risk. However, there are several limitations to this demographic analysis. Demographic data is collected at the census block group or census tract level, and current census surveys do not indicate household drinking water source type. Therefore, the demographic information presented in the tables

[19] Water systems meeting the threshold for the 'Bottled Water or Hauled Water Reliance' risk indicator are automatically At-Risk regardless of the risk scores from other risk indicators, therefore this indicator is not considered in this analysis.
[20] This analysis includes 302 Failing systems that meet the At-Risk threshold in the Risk Assessment.

below may not represent the actual population served by public water systems. Any interpretation of these results should keep in mind the limitations of the analysis.

Demographic data (household size, linguistic isolation, poverty, median household income, and race/ethnicity) was taken from the 2021 American Community Survey. CalEnviroScreen 4.0 data is from OEHHA.[21] The CalEnviroScreen 4.0 data is displayed as percentiles, with higher percentiles indicating areas that are most affected by pollution and where people are especially vulnerable to the effects of pollution. The socioeconomic analysis was calculated using water service area boundaries, area-weighted census tract data where appropriate, and calculating weighted averages. This methodology means that there may be a bias towards demographic data from larger, rural tracts/block groups as these areas are often larger than smaller, urban tracts/block groups.

When compared with not at-risk water systems, Failing and At-Risk public water systems areas tend to have higher CalEnviroScreen scores, a higher percentage of households in poverty, a higher percentage of limited English-speaking households, a larger household size, non-white communities, and are equally likely to be in a DAC or SDAC area.

Table 5: Demographic Analysis for At-Risk and Failing Systems[22]

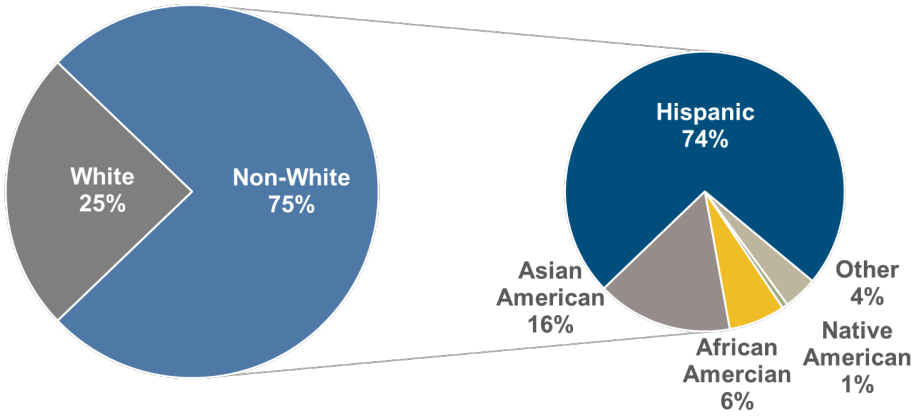
	Statewide (all areas)	Not At-Risk	Potentially At-Risk	At-Risk	Failing
Total Count of Systems	**3,053**	**1,707**	**453**	**512**	**381**
Average CalEnviroScreen 4.0 Percentile	42.7	36.1	47.6	52.2	53.4
Average CalEnviroScreen 4.0 Population Characteristics Percentile	49.1	38.5	49.1	52.1	51.7
Average CalEnviroScreen 4.0 Pollution Burden Percentile	45.4	37.7	45.4	50.7	53.6
Average percentage of households 2x below federal poverty	30.4%	25.8%	35%	37%	36.9%

[21] OEHHA CalEnviroScreen
https://oehha.ca.gov/calenviroscreen

[22] The three CaleEnviroscreen 4.0 data categories in this assessment utilize 2015-2019 American Community Survey (ACS) data. The following data categories in this assessment utilize updated 2016-2021 ACS data: Average percentage of households 2x below federal poverty, Average percentage of households with limited English speaking, Average household size, Percent of systems in DAC/SDAC areas, and Percent of non-white customers served.

	Statewide (all areas)	Not At-Risk	Potentially At-Risk	At-Risk	Failing
Average percentage of households with limited English speaking	6%	4.1%	6.3%	8.7%	9.6%
Average household size	2.8	2.7	2.8	2.8	3
Percent of systems in DAC/SDAC areas[23]	53.7% (1,639)	44.8% (765)	63.6% (288)	68.6% (351)	61.7% (235)
Percent of non-white customers served	57.8%	53.7%	67.5%	75.4%	69.7%

Figure 13: Distribution of At-Risk Public Water Systems by Majority Race/Ethnicity of Census Tract



LIMITATIONS OF THE RISK ASSESSMENT FOR PUBLIC WATER SYSTEMS

The Risk Assessment for public water systems is an important endeavor in assessing water system performance and risk. While the State Water Board has worked to advance the methodology since the first iteration of the Risk Assessment in 2021, the following limitations exist in the current methodology and approach:

Water Systems Not Assessed

Three types of systems have not been incorporated in the Risk Assessment. First, federally recognized tribal systems were originally envisioned to be included in the same risk

[23] DAC = "disadvantaged community" and represents areas with Median Household Income less than 80% of the California Median Household Income ($67,277).
SDAC = "severely disadvantaged communities" represents areas with Median Household Income less than 80% of the California Median Household Income ($50,458).

assessment as public water systems and attempts were made to gather data to this end, but ultimately tribal systems had to be excluded from the assessment due to missing data. Instead, State Water Board is working with U.S. EPA and Indian Health Service to merge and compare existing risk/need assessments for tribal water systems. Second, public water systems with greater than 30,000 service connections or more than 100,000 population served were not included, but these larger systems may be included in future iterations of the Risk Assessment. Finally, wholesalers have been excluded from the Risk Assessment. To evaluate the performance risk of wholesalers, the State Water Board may need to develop an alternative approach to assessing these systems than the methodology developed for other public water systems as there are not always direct correlations on risk indicators.

Data Quality

In 2021, the State Water Board expanded the electronical Annual Report (eAR) to require the submission of income data for the first time. Many water systems struggled to provide this information. Many water systems may have provided inaccurate data which may explain why three of the top five risk indicators with thresholds exceeded are the new financial risk indicators utilizing this data in the TMF Capacity category. The State Water Board has provided additional guidance for water systems completing the eAR to assist systems in providing accurate information. Updates to the eAR, including improved data validation checks and warning messages, will also improve data quality for future years.

Database and Data Collection Limitations

The State Water Board's primary violation, enforcement and regulatory tracking database, the Safe Drinking Water Information Systems (SDWIS), was designed for reporting compliance to the U.S. EPA for national tracking purposes. The database was not designed for the type of complex risk assessments being done in California or tailored to California's specific water quality regulations or drought-monitoring needs. SDWIS is limited in its ability to store technical, managerial and financial data and currently does not separate out other key system-level data components, such as boil water notices, how water system connections are utilized, water quality trends, etc. Several efforts to augment this data collection and management have been made by the State Water Board through project-specific efforts, such as the Modified Drinking Water Watch,[24] the eAR[25] and the creation of the SAFER Clearinghouse. The ideal solution would likely entail the creation of a comprehensive data management system to fully support the transparent and data-driven work required for this program.

RISK ASSESSMENT REFINEMENT OPPORTUNITIES

The Risk Assessment methodology will evolve over time to incorporate additional and better-quality data; evidence from targeted research to support existing and new risk indicators and thresholds; experience from implementing the SAFER Program; and further input from the

[24] Drinking Water Watch
https://sdwis.waterboards.ca.gov/PDWW/
[25] Electronic Annual Report (EAR) | California State Water Resources Control Board
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/ear.html

State Water Board and public. The following highlights are near-term opportunities for Risk Assessment refinement:

Outreach to Tribal Water Systems
Concerted outreach to Tribal water systems was conducted in 2021 by the State Water Board and the Department of Water Resources (DWR). These outreach efforts were centered on informing tribal government and their representatives about the purpose of the SAFER Program and informing them on the benefits of sharing information so that they may be included in future Risk Assessments. In the interim, SAFER Program staff will implement the SAFER Tribal Drinking Water Outreach Plan[26] and work with individual tribes, as requested by tribal governments or in response to drinking water needs identified through coordination with the U.S. EPA and DWR.

Mid-Sized Urban Disadvantaged Water Systems
Mid-sized urban disadvantaged water systems, like those in Los Angeles County, in some cases appear to be ranking lower on the At-Risk list than expected. This may be attributed to the fact that many of the risk indicators in the Water Quality category do not score issues related to secondary standards as high compared to primary standards. Regulations for compliance with secondary standards typically require sampling at the source, rather than the distribution system. Furthermore, many of these systems have interties and multiple sources, which means they do not score as many risk points in the Accessibility category. The limitations of the TMF Capacity category discussed above also contribute to the lower risk scores for some of these systems.

Expanded Data Collection Efforts
The State Water Board has already begun taking steps necessary to improve data coverage and accuracy for the Risk Assessment. Improvements to the eAR include new requirements for completing survey questions related to the Needs Assessment.[27] eAR functionality has been developed that will help auto-calculate certain datapoints like average customer charges for six hundred cubic feet (HCF). This helps reduce data errors.

The State Water Board will also begin developing new strategies to collect data related to drought resiliency, asset management and TMF Capacity for future iterations of the Needs Assessment. Recommendations on potential asset management and TMF Capacity risk indicators identified through the Risk Assessment methodology development process[28] will serve as a starting point for this effort.

Refinement of Risk Indicators and Thresholds
During the Risk Assessment methodology development process, three additional Affordability

[26] SAFER 2022 Tribal Outreach Plan
https://www.waterboards.ca.gov/safer/docs/2022/SAFER-Tribal-Outreach-Plan-ENG-03242022.pdf
[27] Electronic Annual Report (EAR) | California State Water Resources Control Board
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/ear.html
[28] October 7, 2020 White Paper:
Evaluation of Potential Indicators and Recommendations for Risk Assessment 2.0 for Public Water Systems
https://www.waterboards.ca.gov/safer/docs/e_p_i_recommendations_risk_assessment_2_public_water_systems.pdf

risk indicators were recommended for inclusion in future iterations of the Risk Assessment:[29] 'Household Burden Indicator,' 'Poverty Prevalence Indicator,' and 'Housing Burden.'[30] The State Water Board has partnered with the Office of Environmental Health Hazard Assessment (OEHHA) to develop potential affordability indicators and will begin stakeholder engagement needed to develop the appropriate affordability thresholds necessary for inclusion in the Risk Assessment and Affordability Assessment.

Furthermore, as data on water system risk indicators and failures is tracked consistently over time going forward, future versions of the Risk Assessment will be able to more fully evaluate data-driven weighting and scoring approaches to characterizing water system risk. This may lead to dropping risk indicators from the assessment which demonstrate less relationship to risk than expected, and adding others which reflect new, or previously underestimated dimensions of risk.

The intent of the State Water Board going forward is to update the Risk Assessment annually, and in so doing, enhance the accuracy and inclusiveness of the assessment via an iterative, engaged process. Accordingly, future versions of the Risk Assessment will continue to incorporate new data and enhance existing data quality.

[29] October 7, 2020 White Paper:
Evaluation of Potential Indicators and Recommendations for Risk Assessment 2.0 for Public Water Systems
https://www.waterboards.ca.gov/safer/docs/e_p_i_recommendations_risk_assessment_2_public_water_systems.pdf

[30] *Household Burden Indicator*: This indicator measures the economic burden that relatively low-income households face in paying their water service costs by focusing on the percent of these costs to the 20th percentile income (i.e., the Lowest Quintile of Income (LQI) for the service area). This indicator is calculated by adding the average drinking water customer charges, dividing them by the 20th Percentile income in a community water system, and multiplying this by one hundred.
Poverty Prevalence Indicator: This indicator measures the percentage of population served by a community water system that lives at or below 200% the Federal Poverty Level. This measurement indicates the degree to which relative poverty is prevalent in the community.
Housing Burden: This indicator measures the percent of households in a water system's service area that are both low-income and severely burdened by housing costs (paying greater than 50% of their income for housing costs). This metric is intended to serve as an indicator of the affordability challenges low-income households face with respect to other non-discretionary expenses, which may impact their ability to pay for drinking water services.

APPENDIX A:
RISK ASSESSMENT METHODOLOGY FOR PUBLIC WATER SYSTEMS

INTRODUCTION

The purpose of the Risk Assessment for public water systems is to identify systems at-risk or potentially at-risk of failing to meet one or more key Human Right to Water goals: (1) providing safe drinking water; (2) accessible drinking water; (3) affordable drinking water; and/or (4) maintaining a sustainable and resilient water system. Data on performance and risk is most readily available for public water systems and thus the risk assessment methodology for public water systems allows for a multi-faceted examination across four risk indicator categories: Water Quality, Accessibility, Affordability; and TMF (technical, managerial, and financial) Capacity.

PUBLIC WATER SYSTEMS ASSESSED

The 2021 Risk Assessment for public water systems was conducted for community water systems with 3,300 service connections or less and all non-transient non-community water systems which serve K-12 schools. The 2022 Risk Assessment was expanded to include medium-sized community water systems. The expansion of the Risk Assessment to include larger community water systems allows the State Water Board to more thoroughly track the performance and capacity of community water systems, especially the larger water systems that are or have been on the Failing list.

The 2023 Risk Assessment excludes 68 wholesalers because they do not provide direct service to residential customers. Some water system types have also been excluded from certain risk categories or specific risk indicators See Table A1 for details.

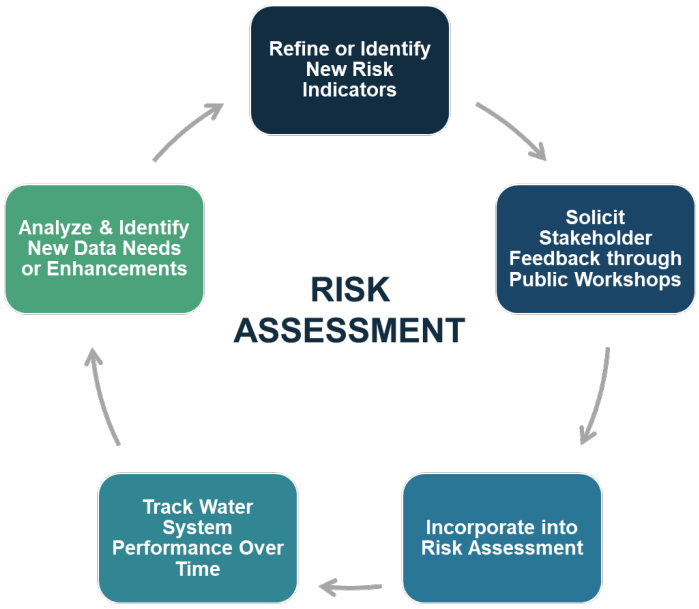
Table A1: Public Water Systems Analyzed in the 2023 Risk Assessment

Water System Type	Number	Water Quality	Accessibility	Affordability	TMF Capacity
Community Water Systems	2,695	Yes	Yes	Yes	Yes
K-12 Schools	359	Yes	Yes	No	Yes
TOTAL ANALYZED:	**3,054**				

RISK ASSESSMENT METHODOLOGY DEVELOPMENT PROCESS

The State Water Board, in partnership with UCLA, began developing the initial Risk Assessment in 2019. The State Water Board and UCLA hosted four public webinar workshops in 2020 to solicit feedback and recommendations on the development of the Risk Assessment. Approximately 683 individuals[31] participated in these workshops through either Zoom or CalEPA's live webcast. Since the initial launch of the Risk Assessment in 2021, the methodology has been refined following the development stages summarized in Figure A1. This effort was designed to encourage public and stakeholder participation, providing opportunities for feedback and recommendations throughout the methodology development process. Proposed Risk Assessment methodology updates are detailed in publicly available white papers, presented at public webinars, and public feedback is often incorporated into the final methodology and results. These materials are hosted on the Needs Assessment webpage.[32]

Figure A1: Phases of Risk Assessment Development



RISK ASSESSMENT METHODOLOGY

The Risk Assessment methodology relies on three core elements which are utilized to calculate an aggregated risk score for each public water system assessed:

Risk Indicators: quantifiable measurements of key data points that allow the State Water Board to assess the probability of a water system's failure to deliver safe drinking water or

[31] Individuals that participated in more than webinar workshop are double counted in this figure.
[32] State Water Board Needs Assessment Webpage
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/needs.html#affordability-assessment

other infrastructure and institutional failures. Risk indicators that measure water quality, accessibility, affordability, and TMF capacity are incorporated based on their criticality as it relates to a system's ability to remain in compliance with safe drinking water standards and their data availability and quality across the state.

Risk Indicator Thresholds: the levels, points, or values associated with an individual risk indicator that delineates when a water system is more at-risk of failing.

Scores & Weights: the application of a multiplying value or weight to each risk indicator and risk category, as certain risk indicators and categories may be deemed more critical than others and/or some may be out of the control of the water system. The application of weights to risk indicators and risk categories allows the State Water Board multiple ways to assess all risk indicators within each category together in a combined Risk Assessment score.

RISK INDICATORS

The Risk Assessment utilizes risk indicators to assess water system performance and risk. The following section provides a summary of how the indicators used in the Risk Assessment have evolved over time. Sections further below in this Appendix provide details on each individual risk indicator including definitions, required datapoints, and calculation methodologies.

INITIAL 2021 RISK INDICATORS

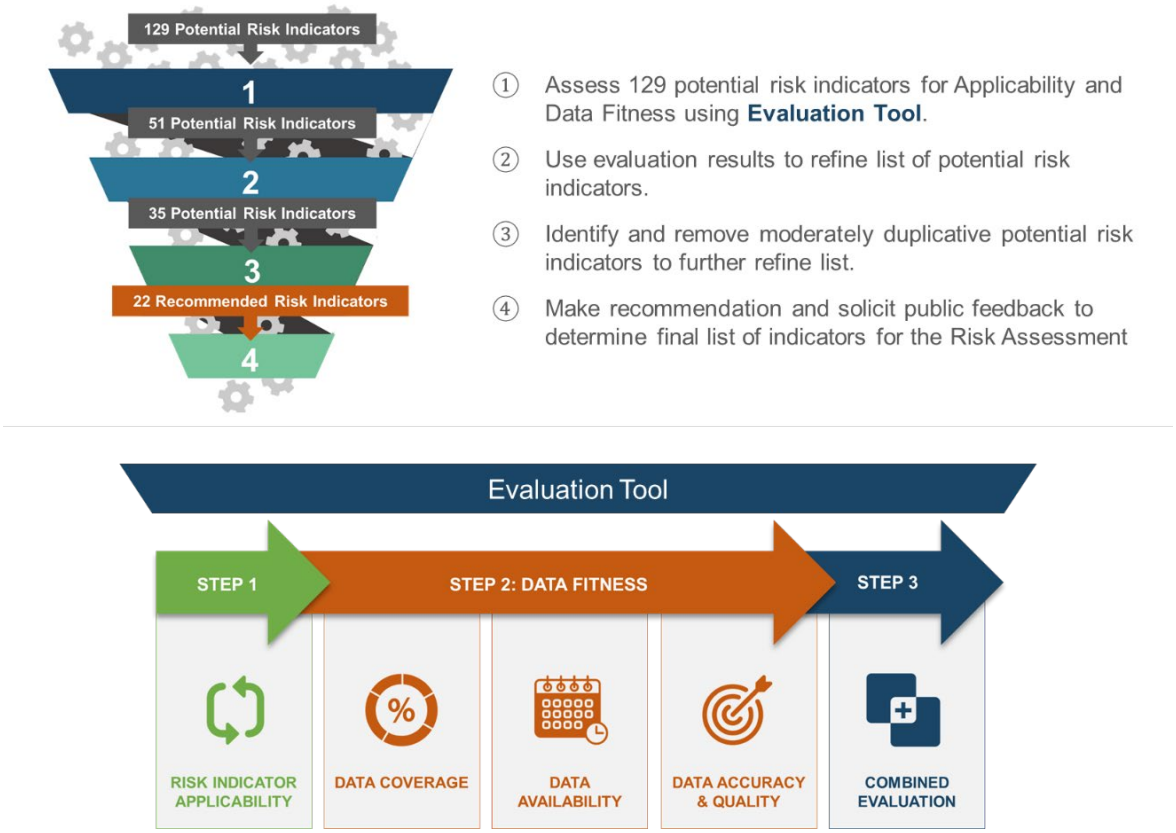
The State Water Board, in partnership with UCLA, began an effort in April 2020 to identify potential risk indicators to be considered for inclusion in the Risk Assessment for public water systems. The initial version of the draft Risk Assessment utilized 14 risk indicators.[33] In response to public feedback from its April 17, 2020, webinar workshop, the State Water Board and UCLA expanded the Risk Assessment scope to evaluate a much broader number of risk indicators. The State Water Board, UCLA, and the public identified 129 potential risk indicators, several from other complementary state agency efforts, to help predict the probability of a water system's failure to deliver safe drinking water. A concerted effort was made to identify potential risk indicators that measure water quality, accessibility, affordability, and TMF capacity based on their criticality as it relates to a system's ability to remain in compliance with safe drinking water standards. This effort included full consideration of risk indicators identified in efforts conducted by the Office of Environmental Health Hazard

[33] Identification of Risk Assessment 2.0 Indicators for Public Water Systems https://www.waterboards.ca.gov/drinking_water/programs/safer_drinking_water/docs/draft_white_paper_indicators_for_risk_assessment_07_15_2020_final.pdf

Assessment (OEHHA),[34] the Department of Water Resources (DWR),[35] and the California Public Utilities Commission.[36]

To facilitate the selection of the final indicators for the Risk Assessment, the State Water Board and UCLA conducted an extensive potential risk indicator evaluation process (Figure A2) with internal and external feedback to refine the list of 129 potential risk indicators to a recommend list of 22 risk indicators for the Risk Assessment. Learn more about the risk indicator identification, refinement, and selection process in the October 7, 2020, white paper *Evaluation of Potential Indicators & Recommendations for Risk Assessment 2.0 for Public Water Systems.*[37]

Figure A2: Potential Risk Indicator Evaluation Process



[34] The Human Right to Water in California | OEHHA
https://oehha.ca.gov/water/report/human-right-water-california
[35] Countywide Drought and Water Shortage Contingency Plans | DWR
https://water.ca.gov/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/County-Drought-Planning
[36] California Public Utilities Commission
https://www.cpuc.ca.gov/
[37] October 7, 2020 White Paper: Evaluation of Potential Indicators & Recommendations for Risk Assessment 2.0 for Public Water Systems
https://www.waterboards.ca.gov/safer/docs/e_p_i_recommendations_risk_assessment_2_public_water_systems.pdf

The 2020-21 potential risk indicator evaluation process yielded a recommended list of 19 risk indicators. Table A2 provides a summary of the risk indicators utilized in the 2021 Risk Assessment.

2022 NEW AND REMOVED RISK INDICATORS

To respond to stakeholder feedback, the State Water Board added eight new risk indicators and removed five risk indicators for the 2022 Risk Assessment. Additional information about what led to these changes are documented in the 2022 Needs Assessment.[38]

- New risk indicators included: 'Constituents of Emerging Concern,' 'Source Capacity Violations,' 'Bottled or Hauled Water Reliance,' 'Income,' 'Operating Ratio,' 'Days Cash on Hand,' 'Percent Residential Arrearages,' and 'Residential Arrearage Burden.'
- Removed risk indicators included: 'Maximum Duration of High Potential Exposure (HPE),' 'Water Source Types,' '% Shut-Offs,' 'Number of Service Connections,' and 'Extensive Treatment Installed.'

2023 ADDED AND REMOVED RISK INDICATORS

The State Water Board made minimal changes to the 2023 Risk Assessment indicators:

- Remove two affordability risk indicators: 'Percentage of Residential Arrearages' and 'Residential Arrearage Burden.'
- Add one new affordability risk indicator: 'Household Socioeconomic Burden.'

Removed Risk Indicators

Recent actions have affected the available data for use in affordability indicators in the 2023 Needs Assessment. Arrearage data was collected one-time in the 2021 Drinking Water Arrearage Payment Program, which ended in June 2021. For these reasons, 'Percentage of Residential Arrearages' and 'Residential Arrearage Burden' are not included in the 2023 Needs Assessment since updated data to support these metrics has not been collected. These indicators were advantageous to include in the Needs Assessment because they represent a direct measurement of households struggling to pay their water bills and may be incorporated into future iterations of the Needs Assessment if data becomes available.

Added Risk Indicator

The State Water Board, in partnership with the Office of Environmental Health Hazard Assessment (OEHHA), hosted three webinar workshops in 2022 to solicit stakeholder feedback on new and future affordability indicators for the Needs Assessment. The workshop white papers, presentations, and webinar recording are available on the Needs Assessment

[38] 2022 Needs Assessment https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2022needsassessment.pdf

website.[39] The State Water Board has incorporated one new affordability risk indicator to the 2023 Risk Assessment, 'Household Socioeconomic Burden,' and identified potential new affordability indicators to include once data becomes available. Details on 'Household Socioeconomic Burden' calculation methodology, thresholds, scoring and weight can be found below in this Appendix.

Table A2: Risk Indicators Over Time

Indicators	Category	2021	2022	2023
History of *E. coli* Presence	**Water Quality**	✓	✓	✓
Increasing Presence of Water Quality Trends Toward MCL	**Water Quality**	✓	✓	✓
Treatment Technique Violations	**Water Quality**	✓	✓	✓
Past Presence on the Failing List	**Water Quality**	✓	✓	✓
Percentage of Sources Exceeding an MCL	**Water Quality**	✓	✓	✓
Maximum Duration of High Potential Exposure (HPE) (Removed 2022)	**Water Quality**	✓		
Constituents of Emerging Concern	**Water Quality**		✓	✓
Number of Sources	**Accessibility**	✓	✓	✓
Absence of Interties	**Accessibility**	✓	✓	✓
Water Source Types (Removed 2022)	**Accessibility**	✓		
DWR – Drought & Water Shortage Risk Assessment Results	**Accessibility**	✓	✓	✓
Critically Overdrafted Groundwater Basin	**Accessibility**	✓	✓	✓
Bottled or Hauled Water Reliance	**Accessibility**		✓	✓
Source Capacity Violations	**Accessibility**		✓	✓
Percent of Median Household Income (%MHI)	**Affordability**	✓	✓	✓
Extreme Water Bill	**Affordability**	✓	✓	✓
% Shut-Offs (Removed 2022)	**Affordability**	✓		
Residential Arrearage Burden (Removed 2023)	**Affordability**		✓	
Percentage of Residential Arrearages (Removed 2023)	**Affordability**		✓	
NEW: Household Socioeconomic Burden	**Affordability**			✓
Number of Service Connections (Removed 2022)	**TMF Capacity**	✓		
Operator Certification Violations	**TMF Capacity**	✓	✓	✓
Monitoring and Reporting Violations	**TMF Capacity**	✓	✓	✓
Significant Deficiencies	**TMF Capacity**	✓	✓	✓
Extensive Treatment Installed (Removed 2022)	**TMF Capacity**	✓		
Days Cash on Hand	**TMF Capacity**		✓	✓

[39] State Water Board Needs Assessment Source Capacity Violations Webpage
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/needs.html#affordability-assessment

Indicators	Category	2021	2022	2023
Operating Ratio	TMF Capacity		✓	✓
Net Annual Income	TMF Capacity		✓	✓

RISK INDICATOR THRESHOLDS, SCORES, & WEIGHTS

THRESHOLDS

To develop thresholds for the risk indicators in the Risk Assessment, the State Water Board reviewed multiple available types of evidence, looking both within California, across other state agencies nation-wide, and at the U.S. EPA's standards. Few exact risk indicator thresholds relating to water system failure were derived from sources beyond California legislative and regulatory definitions, given both the unique definition of water system failure employed in this assessment and the unique access to indicator data which this assessment enabled. However, similar indicators and associated thresholds to inform this process were also identified across other sources.

Based on the research conducted, most risk indicators did not have regulatorily defined thresholds. For binary risk indicators (*e.g.,* operator certification violations), the process of setting thresholds was straightforward because it is either present or absent. For other risk indicators with continuous or categorical data, thresholds were derived using cut points in the distribution of a given risk indicator, where Failing list systems started to cluster, as well as the professional opinion of external stakeholders, State Water Board staff, as well as an internal advisory group of District Engineers. Where possible, tiered thresholds were determined to capture more nuanced degrees of risk within indicators. Sections below provide more details about the rationale for the thresholds developed for each indicator.

Moving forward, the State Water Board will continue to refine the risk indicator thresholds as data availability improves and the SAFER Program matures. The process may include refining thresholds by analyzing historical data trends such as looking at the relationship between historical thresholds and the likelihood that systems came out of compliance.

SCORES

To enable the evaluation and comparison of risk indicators, a standardized score between 0 and 1 has been applied to each developed risk indicator threshold. This is important since many of the risk indicators are measured in different units and scales. The score normalizes the thresholds and allows the Risk Assessment to assess water system performance across all risk indicators. The scores assigned to the risk indicator thresholds were developed with the professional opinion of external stakeholders, State Water Board staff, as well as an internal advisory group of District Engineers (Table A3).

WEIGHTS

When evaluating the risk indicators, the Risk Assessment methodology can either apply the same "weight" to each risk indicator or apply different weights (see Figure A3). Public feedback during four public workshops indicated that the Risk Assessment should weigh some risk indicators higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Weights between 1 and 3 were applied to individual risk indicators (Table A3), with a weight of 3 indicating the highest level of criticality). The individual risk indicator weights were developed with the professional opinion of external stakeholders, State Water Board staff, as well as an internal advisory group of District Engineers. In 2020, an analysis of how the application of risk indicator weights impacts the performance of Failing systems was shared with the public for feedback with white paper *Recommendations for Risk Assessment 2.0 Thresholds, Scores, & Weights for Public Water Systems*[40] and a December 14, 2020 webinar,[41] which ultimately supported the final inclusion decision regarding individual risk indicator weights in the Risk Assessment.

[40] December 14, 2020 White Paper:
Recommendations for Risk Assessment 2.0 Thresholds, Scores, & Weights for Public Water Systems
https://www.waterboards.ca.gov/safer/docs/draft_white_paper.pdf

[41] December 14, 2020 Webinar
Presentationhttps://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/safer_risk_assessment_webinar_accessible.pdf
December 14, 2020 Webinar Recording
https://www.youtube.com/embed/6XDak8R5IDk?cc_load_policy=1&modestbranding=1&rel=0&autoplay=1

Table A3: Individual Risk Indicator Thresholds, Scores, and Weights

Risk Indicator	Thresholds	Score		Weight	Max Score	Risk Level
History of *E. coli* Presence	**Threshold 0** = **No** history of *E. coli* presence within the last three years.	0		N/A	0	None
	Threshold 1 = **Yes** history of *E. coli* presence (*E. coli* violation and/or Level 2 Assessment) within the last three years.	1		3	3	High
Increasing Presence of Water Quality Trends Toward MCL	**Threshold 0** = **Less than 25%** of sources are meeting one or more criteria listed below.	0		N/A	0	None
	Threshold 1 = **Secondary Contaminants**: 9-year average of running annual averages is at or greater than 80% of MCL and the running annual average has increased by 20% or more.	0.25 per source	If 25% or greater of sources are meeting any criteria, average the scores across all contaminated sources. (0 ≤ n ≤ 1)	2	2	Medium (0 < n ≤ 0.5)
	Threshold 2 = **Primary Non-Acute Contaminants**: 9-year average of running annual averages is at or greater than 80% of MCL and the running annual average has increased by 5% or more.	0.5 per source				
	Threshold 3 = **Acute Contaminants**: If a source is meeting the following criteria: • 9-year average (no running annual average) is at or greater than 80% of MCL; or • Most recent 24-month average is at or greater than 80% of MCL; or • Any one sample is over the MCL.	1 per source				High (0.5 < n ≤ 1)

Risk Indicator	Thresholds	Score		Weight	Max Score	Risk Level
Treatment Technique Violations	**Threshold 0** = **0** Treatment technique violations over the last three years.	0		N/A	0	None
	Threshold 1 = **1 or more** Treatment technique violations over the last three years.	1		1	1	High
Past Presence on the Failing List	**Threshold 0** = **0** Failing list occurrence over the last three years.	0		N/A	0	None
	Threshold 1 = **1** Failing list occurrence over the last three years.	0.5		2	1	
	Threshold 2 = **2 or more** Failing list occurrences over the last three years.	1		2	2	High
Percentage of Sources Exceeding an MCL	**Threshold 0** = **less than 50%** of sources exceed an MCL.	0		N/A	0	None
	Threshold 1 = **50% or greater** of sources exceed an MCL.	1		3	3	High
Constituents of Emerging Concern	**Threshold 0** = **Less than 25%** of sources are meeting the criteria for Thresholds 1 and 2.	0		N/A	0	None
	Threshold 1 = If a source is meeting the following criteria: • **CrVI: 1 or more** calculated RAA(s) over 5-year period are at or above 80% of the former MCL and below the former MCL (8 µg/L ≤ RAA < 10 µg/L); or • **PFAS: 2 or more** samples over 5-year period are positive; this criterion applies to all 18 chemicals.	0.5 per source	If 25% or greater of sources are meeting any criteria, average the scores across all contaminated sources. (0 ≤ n ≤ 1)	3	3	Medium (0 < n ≤ 0.5)

Risk Indicator	Thresholds	Score		Weight	Max Score	Risk Level
	Threshold 2 = If a source is meeting the following criteria: • **CrVI: 1 or more** calculated RAA(s), over 5-year period, are at or above the former MCL (10 µg/L ≤ RAA); or • **PFAS: 2 or more** samples, over 5-year period, are at or above the notification level; this criterion only applies to 4 chemicals that have notification level; or • **1,4-Dioxane: 1 or more** calculated RAA(s), over 5-year period, are at or above the notification level (1 µg/L ≤ RAA).	1 per source				High (0.5 < n ≤ 1)
Number of Sources	**Threshold X** = **0** sources.	Automatically At-Risk		N/A	At-Risk	Very High
	Threshold 0 = **multiple** sources.	0		N/A	0	None
	Threshold 1 = **1** source only.	1		3	3	High
Absence of Interties	**Threshold 0** = **1 or more** interties.	0		N/A	0	None
	Threshold 1 = **0** interties.[42]	1		1	1	High
DWR – Drought & Water Shortage Risk	**Threshold 0** = **Below top 25%** of systems most at risk of drought and water shortage.	0		N/A	0	None
	Threshold 1 = **Between top 25% - 10.01%** of systems most at risk of drought and water shortage.	0.25		2	0.5	Medium

[42] All water systems with 10,000 service connections or greater, that have more than one source are excluded and risk scores of 0 are assigned. If a water system with 10,000 service connections or more has only one source and it is not an intertie, they receive a risk score of 1.

Risk Indicator	Thresholds	Score	Weight	Max Score	Risk Level
Assessment Results	**Threshold 2** = **Top 10%** of systems most at risk of drought and water shortage.	1	2	2	High
Critically Overdrafted Groundwater Basin	**Threshold 0** = **Less than 25%** of system's wells are located within a critically overdrafted basin.	0	N/A	0	None
	Threshold 1 = **25% or greater** of system's wells are located within a critically overdrafted basin.	1	2	2	High
Source Capacity Violations	**Threshold 0 = 0** source capacity violations or service connection moratoriums within the past 3 years.	0	N/A	0	None
	Threshold 1 = 1 or more source capacity violation or service connection moratorium within the past 3 years.	1	3	3	High
Bottled or Hauled Water Reliance	**Threshold 0 = 0** occurrences of bottled or hauled water reliance within the past 3 years.	0	N/A	0	None
	Threshold 1 = 1 or more occurrences of bottled or hauled water reliance within the past 3 years.	Automatically At-Risk	N/A	At-Risk	Very High
Percent of Median Household Income	**Threshold 0** = **Less than 1.49%**	0	N/A	0	None
	Threshold 1 = **1.5% - 2.49%**	0.75	3	2.25	Medium
	Threshold 2 = **2.5% or greater**	1	3	3	High
Extreme Water Bill	**Threshold 0** = **Below 149.99%** of the statewide average.	0	N/A	0	None

Risk Indicator	Thresholds	Score	Weight	Max Score	Risk Level
	Threshold 1 = **150% - 199.99%** of the statewide average.	0.5	1	0.5	Medium
	Threshold 2 = **200% or greater** of the statewide average.	1	1	1	High
Household Socio-economic Burden	**Threshold 0** = Combined score **0 – 0.125**	0	N/A	0	None
	Threshold 1 = Combined score **0.25 – 0.5**	0.5	2	1	Medium
	Threshold 2 = Combined score **0.625 – 1.0**	1	2	2	High
Operator Certification Violations	**Threshold 0** = **0** Operator Certification violations over the last three years.	0	N/A	0	None
	Threshold 1 = **1 or more** Operator Certification violations over the last three years.	1	3	3	High
Monitoring & Reporting Violations	**Threshold 0** = **1 or less** Monitoring & Reporting violations over the last three years.	0	N/A	0	None
	Threshold 1 = **2 or more** Monitoring & Reporting violations over the last three years.	1	2	2	High
Significant Deficiencies	**Threshold 0** = **0** Significant Deficiencies over the last three years.	0	N/A	0	None
	Threshold 1 = **1 or more** Significant Deficiencies over the last three years.	1	3	3	High

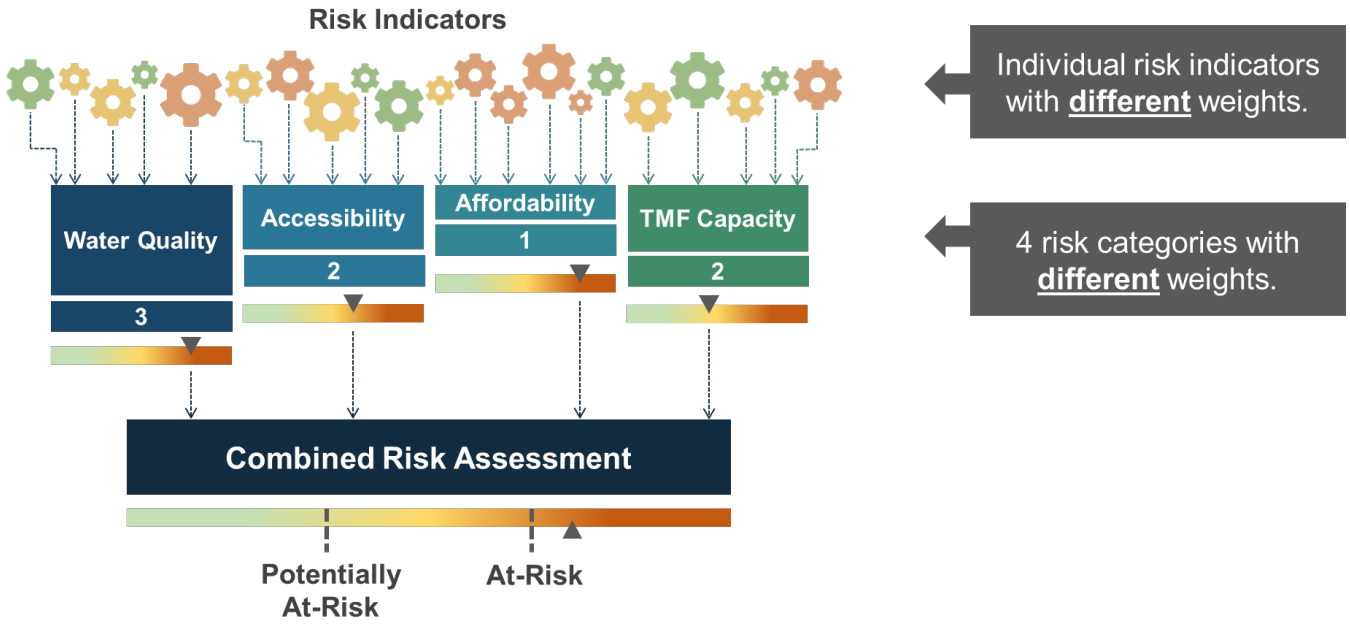
Risk Indicator	Thresholds	Score	Weight	Max Score	Risk Level
Operating Ratio	**Threshold 0** = **1 or greater**	0	N/A	0	None
	Threshold 1 = **Less than 1**	1	1	1	High
Total Annual Income	**Threshold 0** = **Greater than $0** total annual income.	0	N/A	0	None
	Threshold 1 = $0 total annual income.	0.5	1	0.5	Medium
	Threshold 2 = **Less than $0** total annual income.	1	1	1	High
Days Cash on Hand	**Threshold 0** = **90 days or more** cash on hand.	0	N/A	0	None
	Threshold 1 = **30 days or greater** and **less than 90 days** cash on hand.	0.5	1	0.5	Medium
	Threshold 2 = **Less than 30 days** cash on hand.	1	1	1	High

RISK INDICATOR CATEGORY WEIGHTS

Public feedback during the initial Risk Assessment methodology development workshops indicated that the Risk Assessment should include risk indicator category weights. An analysis of how the application of risk indicator category weights impacts the performance of Failing: HR2W list systems was shared with the public for feedback with white paper *Recommendations for Risk Assessment 2.0 Thresholds, Scores, & Weights for Public Water Systems*[43] and a December 14, 2021 webinar,[44] which ultimately supported the final inclusion category weights in the Risk Assessment.

Weights between 1 and 3 were applied to each risk indicator category, with a weight of 3 indicating the highest level of criticality (Figure A3). Risk indicator category weights were developed through stakeholder workshops and with the professional opinion of State Water Board staff, as well as an internal advisory group of District Engineers.

Figure A3: Aggregated Risk Assessment Methodology with Category Weights



[43] December 14, 2020 White Paper:
Recommendations for Risk Assessment 2.0 Thresholds, Scores, & Weights for Public Water Systems
https://www.waterboards.ca.gov/safer/docs/draft_white_paper.pdf

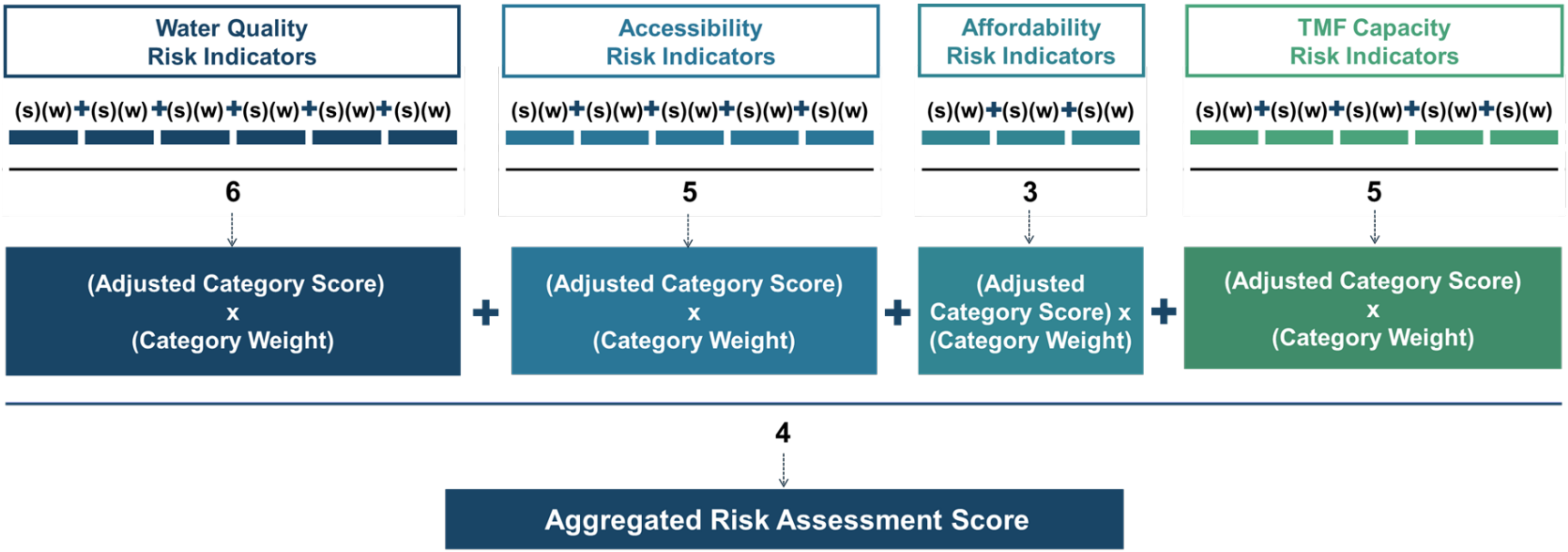
[44] December 14, 2020 Webinar Presentation
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/safer_risk_assessment_webinar_accessible.pdf
December 14, 2020 Webinar Recording
https://www.youtube.com/embed/6XDak8R5IDk?cc_load_policy=1&modestbranding=1&rel=0&autoplay=1

AGGREGATED RISK ASSESSMENT CALCULATION METHODOLOGY

The assessment of individual risk indicators within each category and for the aggregated risk assessment relies on: (1) the amount of risk scores or points each system accrues per indicator, (2) the number of indicators that system is assessed for in each category, and (3) the weights applied to individual risk indicators and categories. Figure A4 provides an illustration of the aggregated Risk Assessment calculation method.

The aggregated Risk Assessment methodology takes the standardized score, between 0 and 1, for each risk indicator and applies a criticality weight to each indicator, between 1 and 3. Then a criticality weight is also applied to each risk indicator category (*e.g.,* Water Quality, Accessibility, *etc.*), between 1 and 3. The final score is an average of the weighted category scores.

Figure A4: Illustration of the Risk Assessment Calculation Methodology with Risk Indicator Scores (s) and Risk Indicator and Categories Weights (w)



ADJUSTING FOR MISSING DATA

It is important that the Risk Assessment methodology adapt for where data may be missing for certain water systems, either because a system failed to report necessary data or because the system may not have data to report. For example, some water systems do not charge for water. Therefore, those systems do not have the necessary data (*i.e.,* customer charges) for two of the three risk indicators in the Affordability category. On the other hand, a system may be missing data because the water system did not report the required data point to the State Water Board. The Risk Assessment methodology accommodates for these two scenarios differently.

Missing Data – Not Applicable

If a risk indicator is not application to a water system and data is unavailable for logical reasons, the water system will be assigned a risk score of 0 for the indicator. No other adjustments are made to the system's aggregated risk score.

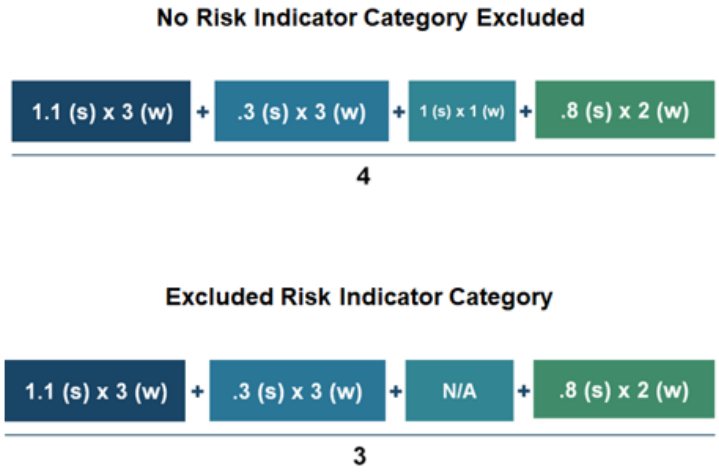
Missing Data – Non-Reporting

A water system that is missing necessary data for a risk indicator will have the indictor weights within the risk category redistributed (Figure A5). This increases the calculated impact the other risk indicators have on the category's risk score. This approach allows the analysis to compare systems without complete data to systems with complete data. It also ensures water systems are not assigned lower aggregated risk scores for not reporting data.

Figure A5: Example of How the Aggregated Risk Assessment Adjusts for Missing Risk Indicator Data

Historically, there have been water systems that were missing risk indicator data for a whole category, particularly the Affordability category. Many of these systems were unconventional community water systems in the sense that they had a stable population base, but no ratepayer base (for example, schools, prisons, parks). These systems, where identifiable, were excluded from the Affordability category of the Risk Assessment altogether and given a risk score of 0 for this category. The Risk Assessment redistributed the weights/score of a missing risk indicator category to the other categories when an entire category is excluded from the assessment, as illustrated in Figure A6. Currently, there are no occurrences where a system is missing risk indicator data for an entire category.

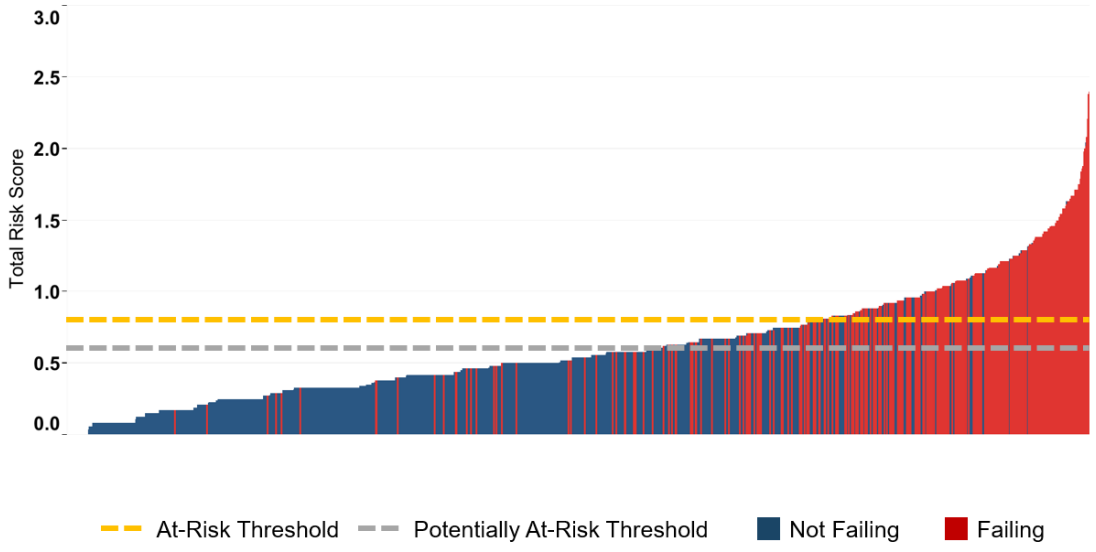
Figure A6: How the Aggregated Risk Assessment Adjusts for a Missing Risk Indicator Category



AGGREGATED RISK ASSESSMENT THRESHOLDS

The 2023 Risk Assessment thresholds are 0.8 for At-Risk water systems and 0.6 for Potentially At-Risk water systems. These thresholds remain unchanged from the 2022 Risk Assessment. The aggregated Risk Assessment thresholds were originally developed based on the distribution of Failing and non-Failing water systems.

Figure A7: Distribution of 2023 Total Risk Scores for Water Systems (n=3,053)



AGGREGATED RISK ASSESSMENT RESULTS ANALYSIS

The 2023 Risk Assessment was conducted for 3,053 public water systems. After removing the 381 Failing list systems, the Assessment results identified 512 (17%) At-Risk water systems, 453 (15%) Potentially At-Risk water systems, and 1,707 (56%) Not At-Risk water systems

(Figure 2). Of the 381 Failing water systems 302 (79%) meet the At-Risk threshold. If these systems come off the Failing list, they will be considered At-Risk systems.

Compared to the 2022 Risk Assessment results, the 2023 Assessment identifies 113 more At-Risk water systems and a statewide increase in total average risk scores from 0.56 to 0.61. The increase in the number of At-Risk water systems and total average statewide risk scores can be attributed to the following:

(1) 119 (4%) of At-Risk systems were automatically at-risk, regardless of their performance across all risk indicators because they have relied on bottled and/or hauled water to meet customer demand within the last three years or have 0 active sources. This is 30 more systems when compared to the 2022 Risk Assessment results, which had 89 (3%) of systems automatically At-Risk.
(2) The addition of the new affordability risk indicator 'Household Socioeconomic Burden' and removal of two affordability indicators resulted in an increase in risk scores accumulated for systems in the Affordability Category. The section below further explains how the impact of this change on the Risk Assessment results.

EXPLANATION OF THE CHANGES IN THE RISK ASSESSMENT RESULTS FROM 2022 TO 2023

The State Water Board has conducted an analysis to explain the increase in the number of At-Risk systems in the 2023 Risk Assessment results. A comparison of water system performance in each risk category was conducted between the 2022 and 2023 Assessments (Figure A8 and Table A4).

Figure A8: Changes in the Average Risk Score per Category

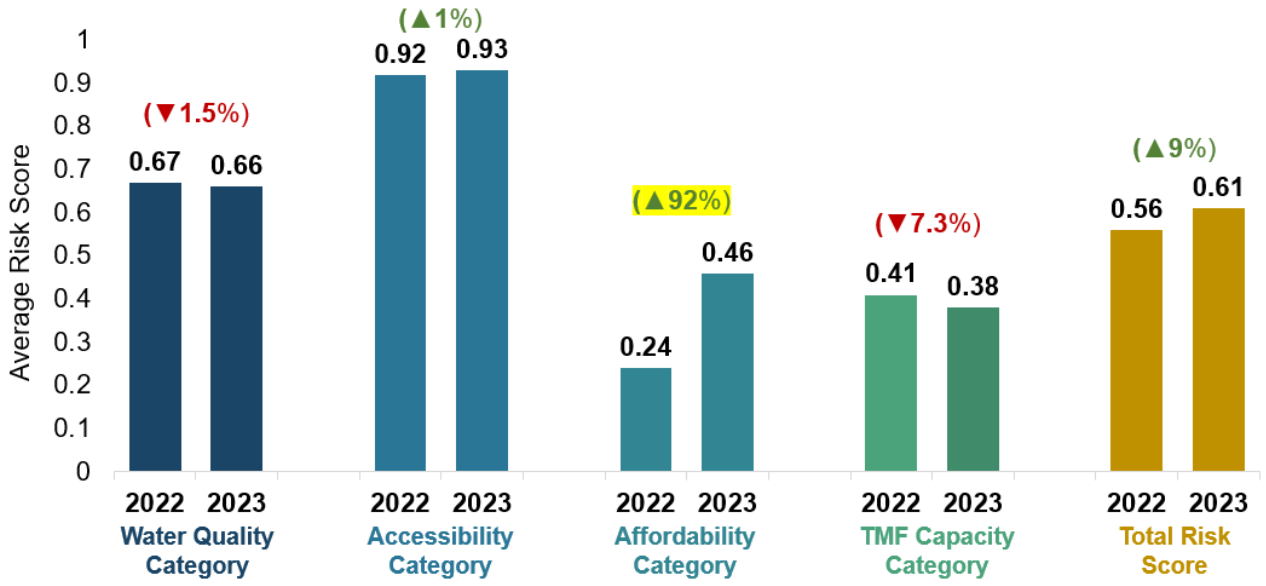


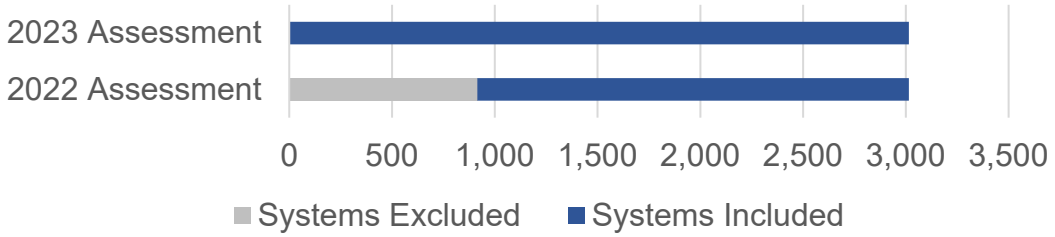
Table A4: 2022 and Final 2023 Risk Assessment Weighted Score Comparison[45]

Weighted Score Difference	Water Quality Category	Accessibility Category	Affordability Category	TMF Capacity Category	Total Score of Risk Assessment
# Systems **risk score unchanged**	2,264 (75%)	2,217 (73%)	910 (30%)	1,461 (48%)	**359 (12%)**
# Systems **risk score increased**	382 (13%)	419 (14%)	1,519 (50%)	716 (24%)	**1,648 (55%)**
# Systems **risk score decreased**	371 (12%)	381 (13%)	588 (19%)	840 (28%)	**1,010 (33%)**
Total	**3,017**	**3,017**	**3,017**	**3,017**	**3,017**

The analysis indicates the increase in the number of At-Risk water systems is a result of water system performance in the Affordability category of the Risk Assessment. In the 2023 results, 50% more water systems received higher risk scores in the Affordability category than they did in the 2022 Risk Assessment. This increase is driven by two factors:

1. In 2022, 947 water systems were excluded from the Affordability category of the Risk Assessment because they do not charge customers directly for water (Figure A9). All the Affordability risk indicators in 2022 were rate-based indicators. The inclusion of a non-rate-based affordability indicator "Household Socioeconomic Burden" meant these previously excluded systems are included in the analysis for this category in the 2023 Assessment, thus driving up the total average risk score in the preliminary results.

Figure A9: Number of Water Systems Included in the Affordability Risk Category

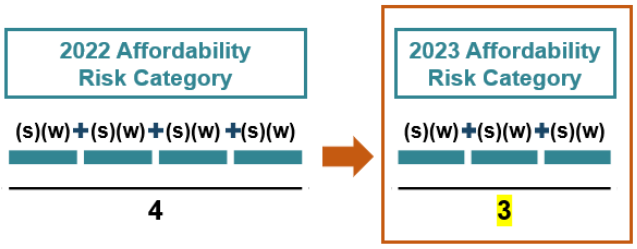


2. Due to the removal of two affordability risk indicators and the addition of one new indicator, the average scoring for the Affordability category is adjusted, where the denominator is

[45] This analysis excluded 19 water systems that were not included in ***both*** the 2022 and 2023 Risk Assessments.

decreasing from four to three (Figure A10). This results in a higher overall category risk score for systems accruing risk points for the affordability risk indicators.

Figure A10: Affordability Category Calculation Method Changes from 2022 to 2023



RISK INDICATOR DETAILS

IDENTIFICATION OF WATER SYSTEMS ASSESSED

The State Water Board conducts the Risk Assessment for a specific inventory of drinking water systems determined annually. In 2021, the State Water Board conducted a Risk Assessment for K-12 schools and community water systems with 3,300 service connections or less. In 2022, the inventory of systems included in the Assessment expanded to include systems with 30,000 service connections or less and less than 100,000 population served.

The following section summarizes the methodology employed to identify which water systems are included in the Risk Assessment using SDWIS data:

- Identify all active[46] water systems with a Federal Water System Type of "Community" and exclude systems with a primary service area of "Wholesaler." Does not exclude systems with multiple service areas and one of the non-primary service areas are designated as "Wholesaler." Some schools will be included in this category if they are designated as "Community" type.
- Identify all active water systems with a Federal Water System Type of "Non-Transient Non-Community" and with a primary service area of "School." Excluding schools that are not K-12 (i.e., colleges and pre-schools).
- Remove water systems that are larger than the determined service connection or population cutoffs for the Risk Assessment.

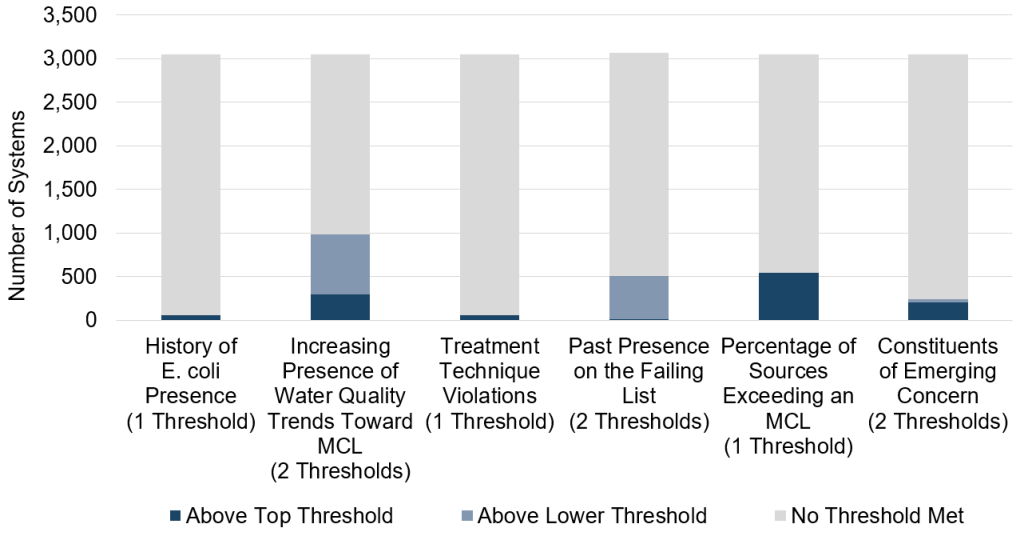
WATER QUALITY RISK INDICATORS

This section provides full details on each Water Quality risk indicator used in the Risk Assessment. Water Quality risk indicators measure current water quality and trends to identify

[46] "Active" means the water system was active at the time the data was pulled.

compliance with regulatory requirements, as well as frequency of exposure to drinking water contaminants. Figure A11 illustrates the number of water systems that exceeded the risk indicator thresholds within the Water Quality category. The range of potential thresholds for each risk indicator are summarized in the respective risk indicator label and detailed below.

Figure A11: Number of Systems Exceeding Thresholds for Each Water Quality Risk Indicator



HISTORY OF E. COLI PRESENCE

The presence of *E. coli* in drinking water suggests that the water supply may be contaminated with human or animal waste, and in turn, that other pathogens could be present. The presence of this contaminant could also suggest that water treatment is inadequate, interrupted, or intermittent. Water systems are required to conduct a Level 1 and/or a Level 2 Assessment if conditions indicate they might be vulnerable to bacteriological contamination.

A Level 1 Assessment is performed by a water system owner or operator when laboratory results indicate that bacteriological threats may exist, an assessment form must be filled and submitted to the state within 30 days. A Level 1 Assessment is triggered by any of the following conditions.[47]

- A public water system collecting fewer than 40 samples per month has two or more total coliform positive routine/repeat samples in the same month.
- A public water system collecting at least 40 samples per month has greater than 5.0 percent of the routine/repeat samples in the same month that are total coliform positive.

[47] Revised Total Coliform Rule
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/rtcr.html

- A public water system fails to take every required repeat sample after any single total coliform positive sample.

A Level 2 Assessment is performed by the state or state-approved entity, but the water system is responsible for ensuring the completion of the assessment regardless of the entity conducting it. The water system must notify the local regulating agency by the end of the business day to schedule a Level 2 assessment. A Level 2 Assessment is triggered by the following conditions:[48]

- A water system incurs an *E. coli* MCL violation.
- A water system has a second Level 1 Assessment within a rolling 12-month period.

Water systems must fix any sanitary defects within a required timeframe.

Calculation Methodology
Required Risk Indicator Data Points & Sources:

- *E. coli* violations – Analyte Code 3014: Safe Drinking Water Information System (SDWIS).
  - Query systems that only have *E. coli* related treatment technique and/or MCL violations. See list of violation codes below:

Table A5: Identified Violation Types Related to *E. coli*

Violation Number	Violation Type	Description
01*	**MCL, Single Sample**	MCL violation based on a single sample, or an organic analyte that is 10X the MCL.
1A	**MCL, *E. coli*, Positive *E. coli* (RTCR)**	*E. coli* MCL violation based on a single sample.
02*	**MCL, Numeric Average of Samples Taken**	A violation for an inorganic, organic, or radiological constituent where compliance is based on a running annual average or more monitoring period average.
T1*	**State Violation – Treatment Technique**	A violation where the water system failed to treat water using the treatment process the state has primacy to regulate (*i.e.,* treatment failed per the system's permit).

*These violations were inadvertently used to record an *E. coli* violation and therefore are being shown in this Table. Violation Number 1A is the code that should be used to record these violations.

- Level 2 Assessments

[48] Level 2 Assessment: A Quick Reference Guide
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/rtcr.html

- Violation Type Code (2B): SDWIS.
- Level 2 Assessment Activities Spreadsheet: Maintained by State Water Board's Data Support Unit (DSU).

Risk Indicator Calculation Methodology:

- Determine which systems have had *E. coli* violations within the last three years with a SOX (State Compliance Achieved) Enforcement Action.
- Determine which systems have had a Level 2 Assessment over the last three years.

Threshold Determination
The State Water Board has adopted a threshold for *E. coli* violations for the expanded Failing list criteria which relies on whether the water system has an open enforcement action for the violation.[49] For the Risk Assessment, a modified version of the expanded Failing list criteria threshold was developed for the "History of *E. coli* Presence" risk indicator. Systems that have had an *E. coli* violation or Level 2 Assessment within the last three years are considered more at risk than systems that have not.

Correlational and regression analysis between the risk indicator as defined with this threshold and water system failure to deliver safe drinking water as defined in the Failing list shows a statistically significant relationship.

Risk Indicator Scoring & Weighting
To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 3 is applied to the "History of *E. Coli* Presence" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 3. Table A6 summarizes the thresholds, scores, and weight for this risk indicator.

Table A6: "History of *E. coli* Presence" Thresholds & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**No** history of *E. coli* presence over the last three years.	0	N/A	0	None
1	**Yes**, history of *E. coli* presence (*E. coli* violation and/or Level 2 Assessment) over the last three years.	1	3	3	High

[49] Systems that meet the Failing list criteria will not be included in the Risk Assessment.

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

History of E.coli Presence: https://tabsoft.co/40baWOm

INCREASING PRESENCE OF WATER QUALITY TRENDS TOWARD MCL

This risk indicator identifies sources with an increasing presence of one or more regulated contaminants, especially those attributable to anthropogenic causes, that are detected at or greater than 80% of the MCL within the past nine years. Water systems with 25% of their sources or more experiencing upwards trends in contaminant concentrations are at-risk of exceeding regulatory water quality requirements and are therefore assigned risk points in the Risk Assessment.

Calculation Methodology

Important Note: *In 2022, the State Water Board adjusted the calculation of this risk indicator from the approach used in the 2021 Needs Assessment to account for the inclusion of medium-size water systems that have many sources. Specifically, the analysis excluded systems from accruing risk points for this indicator if less than 25% of their active sources were meeting the risk criteria detailed below.*

In 2023, the State Water Board adjusted the calculation of this risk indicator from the approach used in the 2022 Needs Assessment. The update adjusted the accounting of how impaired source thresholds are determined. Rather than assessing water quality source risk per contaminant group individually (acute, primary, and secondary), it is now done across all groups simultaneously. This improves the identification of water systems that are experiencing trends towards MCL in more than 25% of their sources regardless of contaminant group.

Required Risk Indicator Data Points & Sources:

- Dataset - SDWIS:
    - Data Point(s) - Water System Inventory
        - Active Source Water Facilities including[50]
            - Consecutive Connection (CC)
            - Infiltration Gallery (IG)
            - IN – Intake (IN)
            - Roof Catchment (RC)
            - Spring (SP)
            - WL Well (WL)
        - Active Water System Sampling Points for above Source Water Facilities[51]

[50] Source Water Facility Types not included in the list are excluded from analysis (ex. hauled water).
[51] Source Water Facility Types with no active sample points are excluded from analyses.

- Data point(s) - Water System Water Quality[52]
  - Water Quality Monitoring Sample Results and Dates for above sample points.
  - Water Quality Contaminants for Sample Results for above sample point.
  - List of eligible contaminants described below in Table A7, Table A8, and Table A9.

- Dataset – Water Quality Inquiry Replacement (WQIR):
  - Data point(s) for Contaminant Information:
    - Regulatory threshold information including:
      - Maximum Contaminant Levels (MCL)
      - Detection Limits for purposes of Reporting (DLR)
      - Notification Levels (NL)

Analyte names and codes for the contaminants of interest per contaminant category in SDWIS are listed in Table A7, Table A8, and Table A9.

Acute Contaminants[53] – Per the Tier 1 public notification rule[54]

Table A7: Acute Contaminants with a Primary MCL

Contaminant	SDWIS Analyte Code
Nitrate	1040
Nitrate-Nitrite	1038
Nitrite	1041
Perchlorate	1039
Chlorite	1009
Chlorine Dioxide	1008

Non-Acute Primary Contaminants

Table A8: Non-Acute Constituents that have a Primary MCL

Contaminant	SDWIS Analyte Code
Aluminum	1002
Antimony, Total	1074
Arsenic	1005
Asbestos	1094

[52] Water Quality Data that is flagged as False Positive (FP), Invalid (IV), or Questionable (QQ) is excluded from the analysis. Water Quality Data that was also outside of the desired time frame is excluded.
[53] CCR section 64400. Acute Risk. "Acute risk" means the potential for a contaminant or disinfectant residual to cause acute health effects, *i.e.,* death, damage or illness, as a result of a single period of exposure of a duration measured in seconds, minutes, hours, or days.
[54] CCR section 64463.1. Tier 1 Public Notice

Contaminant	SDWIS Analyte Code
Barium	1010
Beryllium	1075
Cadmium	1015
Chromium	1020
Cyanide	1024
Fluoride	1025
Mercury	1035
Nickel	1036
Selenium	1045
Thallium, Total	1085
Benzene	2990
Carbon Tetrachloride	2982
O-Dichlorobenzene	2968
P-Dichlorobenzene	2969
1,1-Dichloroethane	2978
1,2-Dichloroethane	2980
1,1-Dichloroethylene	2977
cis-1,2-Dichloroethylene	2380
trans-1,2-Dichloroethylene	2979
Dichloromethane	2964
1,2-Dichloropropane	2983
1,3-Dichloropropene	2413
Ethylbenzene	2992
Methyl-tert-butyl ether	2251
Chlorobenzene	2989
Styrene	2996
1,1,2,2-Tetrachloroethane	2988
Tetrachloroethylene	2987
Toluene	2991
1,2,4-Trichlorobenzene	2378
1,1,1-Trichloroethane	2981
1,1,2-Trichloroethane	2985
Trichloroethylene	2984
Trichlorofluoromethane	2218
Vinyl Chloride	2976
Xylenes, Total	2955
Lasso (Alachlor)	2051

Contaminant	SDWIS Analyte Code
Atrazine	2050
Bentazon	2625
Benzo(a)pyrene	2306
Carbofuran	2046
Chlordane	2959
2,4-D	2105
Dalapon	2031
1,2-dibromo-3-chloropropane	2931
Di(2-ethylhexyl)adipate	2035
Di(2-ethylhexyl)phthalate	2039
Dinoseb	2041
Diquat	2032
Endothall	2033
Endrin	2005
Ethylene Dibromide	2946
Glyphosate	2034
Heptachlor	2065
Heptachlor Epoxide	2067
Hexachlorobenzene	2274
Hexachlorocyclopentadiene	2042
BHC-GAMMA	2010
Methoxychlor	2015
Molinate	2626
Oxamyl	2036
Pentachlorophenol	2326
Picloram	2040
Total Polychlorinated Biphenyls (PCB)	2383
Simazine	2037
Thiobencarb (Bolero)	2727
Toxaphene	2020
1,2,3-Trichloropropane	2414
2,3,7,8-TCDD	2063
2,4,5-TP	2110
Combined Radium (–228 & –226)	4010
Gross Alpha particle Activity	4109
Combined Uranium	4006
Gross Beta particle activity	4100

Contaminant	SDWIS Analyte Code
38-Strontium-90	4174
Tritium	4102

Secondary Contaminants

Table A9: Constituents that have a Secondary MCL*

Contaminant	SDWIS Analyte Code
Aluminum	1002
Color	1905
Copper, Free	1022
Foaming Agent (Surfactants)	2905
Iron	1028
Manganese	1032
Methyl tert-butyl ether (MTBE)	2251
Odor	1920
Silver	1050
Thiobencarb (Bolero)	2727
Turbidity	0100
Turbidity, Field	C254
Zinc	1095

*Total Dissolved Solids, Specific Conductance, Chloride, and Sulfate are excluded.

Prepare Primary and Secondary Data:

Compliance for non-acute contaminants is typically based on calculations of the Running Annual Average (RAA) because they are focused on long-term health risks over time. Therefore, to assess the risk for potential failure of a maximum contaminant for non-acute primary and secondary contaminants calculations of the RAAs are needed.

Below is how the Running Annual Average is calculated for the purposes for the Needs Assessment:

- Step 1 - Calculate RAA for each sample point:
    - Define a search period that eligible sample results dates must occur in.
    - Calculate all quarters between the start and end date of the search period.
        - Example:
            - Start Date: 1/1/2012 - End Date: 1/1/2021
            - Number of Years = 9 Years = 36 Quarters
                - 2012-Quarter 1, 2012-Quarter 2, 2012-Quarter 3, 2012-Quarter 4, 2013-Quarter 1, etc.

- For every sample result date, determine what quarter it falls in and assign that a sample result value. If there are multiple sample result dates per quarter, then those sample results will be averaged so that only one sample result value per quarter exists.

- Step 2 - RAA Periods are calculated by averaging four consecutive quarters of data.
  - Example: (2012-Quarter 2 + 2012-Quarter 3 + 2012-Quarter4 + 2013-Quarter 1)/4
  - Some water systems do not always have four quarters of data in every RAA period. Therefore, the number of quarters used in each RAA calculation is based on the data available during that RAA period. For example, if only three quarters of data are available during a particular RAA period, then only those three quarters will be used to calculate the RAA.
    - Example: (2012-1 + MISSING + 2012-3 + 2012-4)/3

Threshold Determination

The increasing presence of water quality trends toward an MCL violation, as defined here or a similar measure, has not been assessed in other previous studies as related to water system failure or employed by other regulatory agencies or stakeholders as a threshold of concern. The State Water Board's workgroup of District Engineers determined the draft tiered thresholds for this risk indicator based on their experience working with water systems throughout the state. These draft thresholds were shared with the public through workshops and white papers in 2020 and 2021 and ultimately incorporated into the Risk Assessment.

Contaminant Group Thresholds

The first step in this analysis involves analyzing historical water quality sample results (up to 9 years) for each system's active sources. Water quality data is analyzed by three contaminate groups: secondary contaminants, primary non-acute contaminants, and primary acute contaminates. The analysis utilizes the thresholds described in Table A10 to determine if any of the system's active sources may be experiencing declining water quality. For each source, the analysis identifies the highest threshold met if the source is meeting more than one contaminant group threshold.

Table A10Table A10: "Increasing Presence of Water Quality Trends Toward MCL" Contaminant Group Thresholds

Threshold Number	Threshold
1	**Secondary Contaminants**: 9-year average of running annual averages is at or greater than 80% of MCL and the running annual average has increased by 20% or more
2	**Primary Non-Acute Contaminants**: 9-year average of running annual averages is at or greater than 80% of MCL and the running annual average has increased by 5% or more.
3	**Acute Contaminants**: • 9-year average (no running annual average) is at or greater than 80% of MCL; or

Threshold Number	Threshold
	• Most recent 24-month average is at or greater than 80% of MCL; or • Any one sample over the MCL.

Percentage of Source Impairment Threshold
The analysis then determines if 25% or more of the water system's sources are meeting the contaminant group thresholds. If less than 25% of the system's sources are meeting the contaminant group thresholds, the water system will receive no (zero) risk points for this risk indicator. If 25% or more of the system's sources are exceeding any of the contaminant group thresholds, then it will receive risk points. Table A11 is an example of how this determination is made.

Table A11: Example of 25% or Greater Source Impairment Threshold Determination for a System with 6 Sources

Source	Threshold Exceedance	Contaminant Group	Impaired (Y/N)	Impaired Count
Well 01	9-year Average ≥ 80% MCL	Acute	Yes	1
Well 02	24-month Average ≥ 80% MCL	Acute	Yes	1
Well 03	24-month Average ≥ 80% MCL	Acute	Yes	1
Well 04	9-year Average ≥ 80% MCL	Secondary	Yes	1
Well 05	9-year Average ≥ 80% MCL	Non-Acute	Yes	1
Well 06	Below thresholds	N/A	No	0

Determining if the 25% threshold is met across the system's 6 active sources:
- # of impaired Source Water Facilities = 5
- Total Number of Source Water Facilities = 6
- (5/6) * 100 = 83.33%
- 83.33% > 25% = system will accrue risk points

Risk Indicator Scoring & Weighting
To determine the risk score for this indicator, each active source that is meeting one or more of the contaminant group thresholds will be assigned a risk score (Table A12). If a source is meeting more than one contaminant group threshold. See example in Table A13.

Table A12: "Increasing Presence of Water Quality Trends Toward MCL" Scores Per Source

Threshold Number	Contaminant Group	Score per Source
1	**Secondary Contaminants**	0.25
2	**Primary Non-Acute Contaminants**	0.5
3	**Acute Contaminants**	1

Table A13: Example of Selection of Max Score per Source

	Source #1	Source #2	Source #3	Source #4	Source #5	Source #6
Acute Risk Score	1.0	1.0	1.0	0	0	0
Non-Acute Risk Score	0.5	0.5	0.5	0.5	0	0
Secondary Risk Score	0	0	0.25	0.25	0.25	0
Max Score Per Source	**1**	**1**	**1**	**0.5**	**0.25**	**0**

After selecting the maximum score for each source, an average of all the non-zero risk scores is calculated. See example below:

$$\frac{1 + 1 + 1 + 0.5 + 0.25}{5} = \mathbf{0.75}$$

Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on feedback from the State Water Board's internal stakeholder group, the weight of 2 is applied to the "Increasing Presence of Water Quality Trends Toward MCL" risk indicator. Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 2. Table A14 summarizes the total risk score ranges and weights applied to this risk indicator.

Table A14: "Increasing Presence of Water Quality Trends Toward MCL" Total Risk Scores & Weights

Total Score Range	Weight	Max Risk Score	Risk Level
0	0	0	None
0 < n ≤ 0.5	2	1	Medium
0.5 < n ≤ 1	2	2	High

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Increasing Presence of Water Quality Trends Toward MCL: https://tabsoft.co/3JZd3Pv

TREATMENT TECHNIQUE VIOLATIONS

According to U.S. EPA and State Water Board regulations, systems must carry out specified treatment when there is no reliable or feasible method to measure the concentration of a contaminant to determine if there is a public health concern. A treatment technique is an enforceable procedure or level of technological performance, which public water systems must follow to ensure control of a contaminant. The treatment technique rules also list the best available technology for meeting the standard, and the compliance technologies available for small systems. Some examples of treatment technique rules are the following:

- Surface Water Treatment Rule[55] (disinfection and filtration)
- Ground Water Rule[56]
- Lead and Copper Rule (optimized corrosion control)
- Acrylamide and Epichlorohydrin Rules (purity of treatment chemicals)

This type of violation (which is distinct from more commonly known MCL or monitoring and reporting violations) is incurred when a water system does not follow required treatment techniques to reduce the risk from contaminants, *e.g.,* exceeding the maximum allowable turbidity or flow rate of a surface water treatment plant.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- Treatment Technique violations: SDWIS

Table A15: Treatment Technique Violation Codes

Violation Type Code	SDWIS Violation Name
07	Treatment Techniques (Other)
12	Qualified Operator Failure
33	Failure to Submit Treatment Requirement Report
37	Treatment Tech. No Prior State Approval
40	Treatment Technique (FBRR)
41	Failure to Maintain Microbial Treatment
42	Failure to Provide Treatment
43	Single Turbidity Exceed (Enhanced SWTR)
44	Monthly Turbidity Exceed (Enhanced SWTR)
45	Failure to Address a Deficiency
46	Treatment Technique Precursor Removal

[55] Title 22 CCR, Division. 4, Chapter 17 Surface Water Treatment https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I501543B0D4BA11DE8879F88E8B0DAAAE&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)

[56] Title 22 CCR, Division 4, Chapter 15, Article 3.5 Groundwater Rule https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I729BEDE0B98711E0B493EB23F8012672&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)

Violation Type Code	SDWIS Violation Name
47	Treatment Technique Uncovered Reservoir
48	Failure to Address Contamination
57	OCCT/SOWT Recommendation
58	OCCT/SOWT Install Demonstration
59	WQP Level Non-Compliance
63	MPL Level Non-Compliance
64	Lead Service Line Replacement (LSLR)
65	Public Education
2A	Level 1 Assessment Treatment Technique
2B	Level 2 Assessment Treatment Technique
2C	Corrective Actions/Expedited Actions TT
2D	Start-up Procedures Treatment Technique
T1	State Violation-Treatment Technique

Risk Indicator Calculation Methodology:

- Determine which systems have had one or more Treatment Technique violations within the last three years using the Treatment Technique violation codes listed in Table A15 and excluding the following scenarios below:
  - Systems with an open Enforcement Action are excluded from the Risk Assessment because they meet the criteria for the expanded Failing list.
  - Systems that have had three or more Treatment Technique violations within the last three years are also excluded from the Risk Assessment because they meet the criteria for the Failing list.

Threshold Determination

The State Water Board has developed a threshold for Treatment Technique violations (in lieu of an MCL) for the expanded Failing list criteria that relies on: (1) whether the water system has an open enforcement action for the violation or (2) the system has had three or more Treatment Technique violations in the past three years.[57] For the Risk Assessment, a modified version of the expanded Failing list criteria threshold was developed for the "Treatment Technique Violations" risk indicator. Systems that have one or more treatment technique violations within the last three years are considered more at risk than systems that have not.

Correlational and regression analysis between the risk indicator as defined with this threshold and water system failure to deliver safe drinking water as defined in the Failing list shows a statistically significant relationship.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk

[57] Systems that meet the HR2W list criteria will not be included in the Risk Assessment.

Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 1 is applied to the "Treatment Technique Violations" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 1. Table A16 summarizes the thresholds, scores, and weight for this risk indicator.

Table A16: "Treatment Technique Violations" Thresholds & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**0** Treatment Technique violation over the last three years.	0	N/A	0	None
1	**1 or more** Treatment Technique violations over the last three years.	1	1	1	High

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Treatment Technique Violations: https://tabsoft.co/3mPTjEL

PAST PRESENCE ON THE FAILING LIST

This indicator reflects past presence on the Failing list within the last three years. The expanded Failing list includes systems that have an open enforcement action for a primary MCL violation, secondary MCL violation, *E. coli* violation, monitoring and reporting violation (15 months or more), a current treatment technique violation, and/or systems that have had three of more treatment technique violations in the past 3 years. A system is removed from the Failing list after they have come back into compliance and a return to compliance enforcement action has been issued and/or the system has less than three treatment technique violations or monitoring and reporting violations over the last three years.

Calculation Methodology
Required Risk Indicator Data Point & Source:

- Violation Data: SDWIS
- Enforcement Action Data: SDWIS

Refer to State Water Board's Failing water system website[58] for detailed criteria and methodology for the Failing list.

> ***Important Note***: In 2021, the State Water Board corrected the historical Failing list using a new and improved query methodology to analyze historical violation and enforcement data to better identify Failing list occurrence start and end dates.

Threshold Determination
Peer-reviewed studies suggest that past presence of drinking water quality violations is associated with subsequent present-day violations.[59] Therefore, tiered thresholds were developed, where more occurrences on the Failing list is associated with greater risk.

Risk Indicator Scoring & Weighting
To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's District Engineers, the maximum weight of 2 is applied to the "Past Presence on the Failing List" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 2. Table A17 summarizes the thresholds, scores, and weight for this risk indicator.

Table A17: "Past Presence on the Failing List" Thresholds & Scores

Threshold Number	Threshold	Score	Weight	Max Score	Risk Level
0	**0** Failing list occurrence over the last three years.	0	N/A	0	None
1	**1** Failing list occurrence over the last three years.	0.5	2	1	Medium
2	**2** or more Failing list occurrences over the last three years.	1	2	2	High

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

[58] Human Right to Water | California State Water Resources Control Board https://www.waterboards.ca.gov/water_issues/programs/hr2w/
[59] See McDonald, Yolanda J., and Nicole E. Jones. "Drinking water violations and environmental justice in the United States, 2011–2015." *American journal of public health* 108.10 (2018): 1401-1407.

Past Presence on the Failing List: https://tabsoft.co/42mMjPX

PERCENTAGE OF SOURCES EXCEEDING AN MCL

This indicator reflects the percentage of sources that exceeded any primary drinking water MCL within the past three years. Water systems with impaired water sources make it more difficult to provide safe drinking water, particularly in the event of a drought or treatment failure.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- Dataset - SDWIS:
  - Data Point(s) - Water System Inventory
    - Active Source Water Facilities including[60]
      - Consecutive Connection (CC)
      - Infiltration Gallery (IG)
      - IN – Intake (IN)
      - Roof Catchment (RC)
      - Spring (SP)
      - WL Well (WL)
    - Active Water System Sampling Points for above Source Water Facilities[61]
  - Data point(s) - Water System Water Quality[62]
    - Water Quality Monitoring Sample Results and Dates for above sample points.
    - Water Quality Contaminants for Sample Results for above sample points.
      - List of eligible contaminants described below in Table A18.
- Dataset – Water Quality Inquiry Replacement (WQIR):
  - Data point(s) for Contaminant Information:
    - Regulatory threshold information including:
      - Maximum Contaminant Levels (MCL)
      - Detection Limits for purposes of Reporting (DLR)
      - Notification Levels (NL)

Table A18: Analytes in WQIR Chemical Table

Analyte Name	SDWIS Analyte Code
1,1,1-Trichloroethane	2981
1,1,2,2-Tetrachloroethane	2988

[60] Source Water Facility Types not included in the list is excluded from analysis (ex. hauled water).
[61] Source Water Facility types with no active sample points is excluded from analyses.
[62] Water Quality Data that is flagged as False Positive (FP), Invalid (IV), or Questionable (QQ) is excluded from the analysis. Water Quality Data that was also outside of the desired time frame is excluded.

Analyte Name	SDWIS Analyte Code
Trichlorofluoromethane	2218
1,1,2-Trichloroethane	2985
1,1-Dichloroethane	2978
1,1-Dichloroethylene	2977
1,2,3-Trichloropropane	2414
1,2,4-Trichlorobenzene	2378
O-Dichlorobenzene	2968
1,2-Dichloroethane	2980
1,2-Dichloropropane	2983
1,3-Dichloropropene	2413
P-Dichlorobenzene	2969
2,3,7,8-TCDD	2063
2,4,5-TP	2110
2,4-D	2105
Lasso (Alachlor)	2051
Aluminum	1002
Antimony, Total	1074
Arsenic	1005
Asbestos	1094
Atrazine	2050
Barium	1010
Bentazon	2625
Benzene	2990
Benzo(a)pyrene	2306
Beryllium, Total	1075
Bromate	1011
Cadmium	1015
Carbofuran	2046
Carbon Tetrachloride	2982
Chlordane	2959
Chlorite	1009
Chromium (Total)	1020
CIS-1,2-Dichloroethylene	2380
CIS-1,3-Dichloropropene	2228
Combined Radium (-226 & -228)	4010
Cyanide	1024
Dalapon	2031
Di(2-Ethylhexyl) Phthalate	2039
1,2-Dibromo-3-Chloropropane	2931
Dichloromethane	2964
Dinoseb	2041
Diquat	2032
Endothall	2033

Analyte Name	SDWIS Analyte Code
Endrin	2005
Ethylbenzene	2992
Ethylene Dibromide	2946
Fluoride	1025
Glyphosate	2034
Gross Alpha Particle Activity	4109
Gross Beta Particle Activity	4100
Total Haloacetic Acids (HAA5)	2456
Heptachlor	2065
Heptachlor Epoxide	2067
Hexachlororobenzene	2274
Hexachlorocyclopentadiene	2042
BHC-Gamma	2010
Manganese, Dissolved	1034
Mercury	1035
Methoxychlor	2015
Methyl-tert-butyl ether	2251
Molinate	2626
Chlorobenzene	2989
Nickel	1036
Nitrate	1040
Nitrate-Nitrite	1038
Nitrite	1041
Oxamyl	2036
Pentachlorophenol	2326
Perchlorate	1039
Picloram	2040
Total Polychlorinated Biphenyls (PCB)	2383
Selenium	1045
Simazine	2037
38-Strontium-90	4174
Styrene	2996
Tetrachloroethylene	2987
Thallium, Total	1085
Thiobencarb (Bolero)	2727
Toluene	2991
Trihalomethanes (TTHM)	2950
Toxaphene	2020
Trans-1,2-Dichloroethylene	2979
Trans-1,3-Dicholropropene	2224
Tricholoroethylene	2984

Analyte Name	SDWIS Analyte Code
Trichlorofluoromethane	2218
Tritium	4102
Combined Uranium	4006
Vinyl Chloride	2976
Xylenes, Total	2955

Risk Indicator Calculation Methodology:

- Determine the number of impaired sources. Impaired sources with any sample results above their respective MCL for the chemicals listed above.
- Determine the total number of sources. Based on the source types listed above.
- Calculate the percentage of impaired sources by dividing the total number of sources with MCL exceedances by the total number of sources and then multiply that number by 100.

Threshold Determination

The percentage of sources exceeding an MCL, as defined here or a similar measure, has not been assessed in other previous studies as related to water system failure or employed by other regulatory agencies or stakeholders as a threshold of concern. However, this lack of precedent likely reflects that this indicator threshold is hard to obtain and analyze without significant expertise and experience with source water quality data and data processing capability. The State Water Board's workgroup of district engineers determined the draft tiered thresholds for this risk indicator based on their experience working with water systems throughout the state. These draft thresholds were shared with the public in 2020 and ultimately incorporated into the Risk Assessment.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 3 is applied to the "Percentage of Sources Exceeding MCL" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 3. Table A19 summarizes the thresholds, scores, and weight for this risk indicator.

Table A19: "Percentage of Sources Exceeding MCL" Thresholds & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**Less than 50%** of sources exceed an MCL.	0	N/A	0	None

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
1	**50% or greater** of sources exceed an MCL.	1	3	3	High

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Percentage of Sources Exceeding MCL: https://tabsoft.co/3LwX0JO

CONSTITUENTS OF EMERGING CONCERN

Constituents of emerging concern (CEC) are unregulated chemicals[63] that are potentially imposing adverse health effects and are likely present (i.e., known or anticipated to occur) at public water systems or in groundwater sources. The purpose of this risk indicator is to identify water systems that could potentially come out of compliance if certain constituents of emerging concern (CECs) were to be regulated by a primary and/or secondary maximum contaminant level (MCL).

While there are many CECs, the State Water Board is proposing a limited list of CECs for inclusion in the calculation of this risk indicator based on the likelihood that a MCL will be developed. This risk indicator would only assess water systems that have water quality sample results associated with hexavalent chromium (CrVI), 1,4-dioxane, and/or the 18 chemicals pertaining to per- and polyfluoroalkyl substances (PFAS) chemical group. The selection of these chemicals was influenced by monitoring data coverage and current regulatory priorities. More chemicals may be included in future iterations of the Risk Assessment.

Hexavalent chromium (CrVI): Chromium is a heavy metal that occurs throughout the environment. The trivalent form is a required nutrient and has very low toxicity. The hexavalent form, also commonly known as Chromium-6, is more toxic and has been known to cause cancer when inhaled. In recent scientific studies in laboratory animals, CrVI has also been linked to cancer when ingested. Much of the low level CrVI found in drinking water is naturally occurring, reflecting its presence in geological formations throughout the state. However, there are areas of contamination in California from historic industrial use, such as the manufacturing of textile dyes, wood preservation, leather tanning, and anti-corrosion coatings, where CrVI contaminated waste has migrated into the underlying groundwater.

1,4-Dioxane: 1,4-dioxane has been used as a solvent and stabilizer for other solvents in a number of industrial and commercial applications. In 1988, 1,4-dioxane was added

[63] Chemicals that are not regulated by the National/State Primary & Secondary Drinking Water Regulations.

to the list of chemicals known to the state to cause cancer[64] and is also considered to pose a cancer risk by U.S. EPA. Over the past decade, 1,4-dioxane has been found in a number of wells, mostly in southern California. The drinking water notification level for 1,4-dioxane is 1 microgram per liter (µg/L). More information can be found at the State Water Board webpage.[65]

Per- and polyfluoroalkyl substances (PFAS): PFAS are a large group of synthetic fluorinated chemicals widely used in industrial processes and consumer products. These synthetic compounds are very persistent in the environment. People are exposed to these compounds through food, food packaging, textiles, electronics, personal hygiene products, consumer products, air, soils, and drinking water. PFAS contamination is typically localized and associated with an industrial facility that manufactured these chemicals or an airfield at which they were used. Studies indicate that continued exposure to low levels of PFAS may result in adverse health effects.

Calculation Methodology

Important Note: *In 2023 the State Water Board adjusted the calculation of this risk indicator from the approach used in the 2022 Needs Assessment. The update adjusted the accounting of how impaired source thresholds are determined. Rather than assessing water quality source risk per* emerging contaminate *individually (*hexavalent chromium, 1,4-Dioxane, or PFAS*), it is now done across all contaminates simultaneously. This improves the identification of water systems that are experiencing trends towards MCL in more than 25% of their sources regardless of which contaminant is exceeding a threshold.*

Required Risk Indicator Data Points & Sources:

- Dataset - SDWIS:
  - Data Point(s) - Water System Inventory
    - Active Source Water Facilities Including[66]
      - Consecutive Connection (CC)
      - Infiltration Gallery (IG)
      - IN – Intake (IN)
      - Roof Catchment (RC)
      - Spring (SP)
      - WL Well (WL)
    - Active Water System Sampling Points for above Source Water Facilities[67]
  - Data Point(s) - Water System Water Quality[68]
    - Water Quality Monitoring Sample Results and Dates for above sample points.

[64] Office of Environmental Health Hazard Assessment - Proposition 65 (California Code of Regulations, Title 27, § 27001): https://oehha.ca.gov/proposition-65

[65] California State Water Resources Control Board - 1,4-Dioxane https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/14-Dioxane.html

[66] Source Water Facility Types not included in the list are excluded from analysis (e.g., hauled water).

[67] Source Water Facility Types with no active sample points are excluded from analyses.

[68] Water Quality Data that is flagged as False Positive (FP), Invalid (IV), or Questionable (QQ) is excluded from the analysis. Water Quality Data that was also outside of the desired time frame is excluded.

        - Water Quality Contaminants for Sample Results for above sample points.
        - List of eligible contaminants described below in Table A20.

- Dataset – Water Quality Inquiry Replacement (WQIR):
    - Data point(s) for Contaminant Information:
        - Regulatory thresholds information including:
            - Maximum Contaminant Levels (MCL)
            - Detection Limits for purposes of Reporting (DLR)
            - Notification Levels (NL)

Analyte names and codes for the contaminants of interest in SDWIS are listed in Table A20.

Table A20: Analyte Names and Codes for CrVI, 1,4-Dioxane & PFAS

Analyte Name	SDWIS Analyte Code
Hexavalent Chromium (CrVI)	1080
1,4-Dioxane	2049
Per- and polyfluoroalkyl substances (PFAS)	
Perfluorobutanesulfonic Acid (PFBS)	2801
Perfluoroheptanoic Acid (PFHpA)	2802
Perfluorohexane Sulfonic Acid (PFHxS)	2803
Perfluorononanoic Acid (PFNA)	2804
Perfluoroctane Sulfonic Acid (PFOS)	2805
Perfluoroctanoic Acid (PFOA)	2806
Perfluorodecanoic Acid (PFDA)	2807
Perfluorododecanoic Acid (PFDoA)	2808
Perfluorohexanoic Acid (PFHxA)	2809
Perfluorotetradecanoic Acid (PFTA)	2810
Perfluorotridecanoic Acid (PFTrDA)	2811
Perfluoroundecanoic Acid (PFUnA)	2812
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	2813
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	2814
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	2815
Hexafluoropropylene Oxide Dimer Acid (HFPO-DA)	2816
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2817
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	2818

Risk Indicator Calculation Methodology:

Compliance for non-acute contaminants is typically based on calculations of the Running Annual Average (RAA) because they are focused on long-term health risks over time. Therefore, to assess risk for potential failure of a maximum contaminant for non-acute primary and secondary contaminants RAAs are needed.

Below is how the Running Annual Average is calculated for the purposes for the Needs Assessment:

Prepare CrVI Data:

- Step 1 - Calculate RAA for each sample point:
    - Define a search period that eligible sample results dates must occur in.
    - Calculate all quarters between the start and end date of the search period.
        - Example:
            - Start Date: 1/1/2012 - End Date: 1/1/2021
            - Number of Years = 9 Years = 36 Quarters
                - 2012-Quarter 1, 2012-Quarter 2, 2012-Quarter 3, 2012-Quarter 4, 2013-Quarter 1, etc.
    - For every sample result date, determine what quarter it falls in and assign that sample result value. If there are multiple sample result dates per quarter, then those sample results will be averaged so that only one sample result value per quarter exists.

- Step 2 - RAA Periods are calculated by averaging four consecutive quarters of data.
    - Example:(2012-Quarter 2 + 2012-Quarter 3 + 2012-Quarter 4 + 2013-Quarter 1)/4
    - Some water systems do not always have four quarters of data in every RAA period. Therefore, the number of quarters used in each RAA calculation is based on the data available during that RAA period. For example, if only three quarters of data are available during a particular RAA period, then only those three quarters will be used to calculate the RAA.
        - Example: (2012-1 + MISSING + 2012-3 + 2012-4)/3

Prepare PFAS Data:

- Define a search period that eligible sample results dates must occur in.
- Count the number of positive sample results (greater than detection limit) per PFAS chemical results during the search period for each water system.
- Count sample results above the Notification Level (NL) for chemicals that have an NL during the search period for each water system.
- Count the total number of positive sample results (greater than detection limit) over the search period for each water.

Table A21: PFAS Notification Levels

Analyte Name	Notification Level (NL)
PFOS	0.0065 µg/L
PFOA	0.0051 µg/L
PFBS	0.5 µg/L
PFHxS	3 ng/L

Prepare 1,4-Dioxane Data:

- Step 1 - Calculate RAA for each sample point:
  - Define a search period that eligible sample results dates must occur in.
  - Calculate all quarters between the start and end date of the search period.
    - Example:
      - Start Date: 1/1/2012 - End Date: 1/1/2021
      - Number of Years = 9 Years = 36 Quarters
        - 2012-Quarter 1, 2012-Quarter 2, 2012-Quarter 3, 2012-Quarter 4, 2013-Quarter 1, etc.
  - For every sample result date, determine what quarter it falls in and assign that sample result value. If there are multiple sample result dates per quarter, then those sample results will be averaged so that only one sample result value per quarter exists.

- Step 2 - RAA Periods are calculated by averaging four consecutive quarters of data.
  - Example:(2012-Quarter 2 + 2012-Quarter 3 + 2012-Quarter 4 + 2013-Quarter 1)/4
  - Some water systems do not always have four quarters of data in every RAA period. Therefore, the number of quarters used in each RAA calculation is based on the data available during that RAA period. For example, if only three quarters of data are available during a particular RAA period, then only those three quarters will be used to calculate the RAA.
    - Example: (2012-1 + MISSING + 2012-3 + 2012-4)/3

Threshold Determination

CrVI: On July 1, 2014, an MCL of 10 µg/L CrVI was approved by the Office of Administrative Law. On May 31, 2017, the Superior Court of Sacramento County issued a judgment invalidating the MCL on the basis that the state had not properly considered the economic feasibility of complying with the MCL. The State Water Board is currently working on the development of a new MCL for CrVI.[69] Until a new MCL is developed, the State Water Board is recommending using the previous MCL as part of a tiered

[69] Hexavalent Chromium Drinking Water MCL
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Chromium6.html

threshold for this risk indicator. Water systems with one or more RAA over a 5-year period are at or above 80% of the former MCL are considered medium risk and any RAA over a 5-year at or above the former MCL is considered high risk.

PFAS: Due to the ubiquitous nature of these contaminants, two positive samples are suggested as part of the tiered threshold to ensure that the water quality sample was not compromised. Since the risk related to each of the PFAS chemicals is not fully known, water quality is noted as a medium risk for any two positive samples of any PFAS contaminant. Three of the 18 PFAS chemicals have a notification level.[70] When two or more samples for these three PFAS chemicals are at or above their notification levels, they are considered to be at high risk for this indicator threshold.

1,4-Dioxane: The State Water Board is recommending a binary threshold for 1,4-Dioxane. The drinking water notification level for 1,4-dioxane is 1 microgram per liter (µg/L).[71] In January 2019, the State Water Board requested for the Office of Environmental Health Hazard Assessment (OEHHA) to establish a public health goal for 1,4-dioxane.[72] When one or more samples are detected at or above their notification level, they are considered to be at high risk for this indicator threshold.

Contaminants Thresholds

The first step in this analysis involves analyzing historical water quality sample results (up to 5 years) for each system's active sources. Currently, water quality data for this indicator is analyzed across three emerging contaminates: hexavalent chromium, PFAS, and 1,4-Dioxane. The analysis utilizes the thresholds described in Table A22 to determine if any of the system's active sources have elevated levels of these CECs. For each source, the analysis identifies the highest threshold met across all contaminants and if the source is meeting more than one threshold (example: a source that has met the threshold 1 for hexavalent chromium and threshold 3 for PFAS; the analysis will assign Threshold 3 to the source).

Table A22: "Constituents of Emerging Concern" Thresholds & Scores per Source

Threshold Number	Threshold
1	**CrVI: All** calculated RAA(s), over 5-year period, are below 80% of the former MCL (RAA < 8 µg/L); and **PFAS: Less than 2** samples, over 5-year period, are positive; and

[70] The State Water Board recognizes that more work is being done in this area and that the presence of any PFAS in drinking water may pose a public health risk. Notification levels are nonregulatory, health-based advisory levels established for contaminants in drinking water for which MCL have not been established. A notification level may be considered a candidate for the establishment of an MCL in the future, but it has not completed going through the regulatory standard setting process.

[71] 1,4-Dioxane
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/14-Dioxane.html

[72] Public Health Goals (PHGs) - OEHHA
https://oehha.ca.gov/water/public-health-goals-phgs

Threshold Number	Threshold
	1,4-Dioxane: 0 calculated RAA(s), over 5-year period, are at or above the notification level.
2	**CrVI: 1 or more** calculated RAA(s) over 5-year period are at or above 80% of the former MCL and below the former MCL (8 µg/L ≤ RAA < 10 µg/L); or **PFAS: 2 or more** samples over 5-year period are positive; this criterion applies to all 18 chemicals.
3	**CrVI: 1 or more** calculated RAA(s), over 5-year period, are at or above the former MCL (10 µg/L ≤ RAA); or **PFAS: 2 or more** samples, over 5-year period, are at or above the notification level; this criterion only applies to 3 chemicals that have notification level; or **1,4-Dioxane: 1 or more** calculated RAA(s), over 5-year period, are at or above the notification level (1 µg/L ≤ RAA).

Percentage of Source Impairment Threshold

The analysis then determines if 25% or more of the water system's sources are meeting the contaminant thresholds across all contaminants. If less than 25% of the system's sources are meeting the contaminant thresholds, the water system will receive no (zero) risk points for this risk indicator. If 25% or more of the system's sources are exceeding any of the contaminant thresholds across all contaminates, then it will receive risk points. Table A23 is an example of how this determination is made.

Table A23: Example of 25% or Greater Source Impairment Threshold Determination for a System with 5 Sources

Source	Threshold Exceedance	Contaminant	Impaired (Y/N)	Impaired Count
Well 01	Below thresholds	CrVI, 1,4-Dioxane, PFAS	No	0
Well 02	5-year RAA > 80% MCL	CrVI	Yes	1
Well 03	Below thresholds	CrVI, 1,4-Dioxane, PFAS	No	0
Well 04	Below thresholds	CrVI, 1,4-Dioxane, PFAS	No	0
Well 05	Below thresholds	CrVI, 1,4-Dioxane, PFAS	No	0

In this example, less than 25% of the system's active sources are meeting the thresholds summarized in Table A22. Therefore, this system would receive no (zero) risk points for this indicator. This occurs because of the following calculation:

- # of impaired Source Water Facilities = 1

- Total Number of Source Water Facilities = 5
- (1/5) * 100 = 20%

To meet the source impairment threshold, a water system must have 25% or more of its sources considered to be impaired.

Risk Indicator Scoring & Weighting
If a water system has more than 25% of its active sources meeting the thresholds in Table A22, the system's risk score for this indicator will be the average of the max risk score per source (Table A23). If a source is meeting more than one contaminant threshold (example: a source has met threshold 2 for hexavalent chromium and threshold 3 for 1,4-Dioxane; the analysis will assign Threshold 3 risk score to the source). See example in Table A24.

Table A23: "Constituents of Emerging Concern" Scores Per Source

Threshold Number	Contaminant Threshold	Score per Source
1	**CrVI: All** calculated RAA(s), over 5-year period, are below 80% of the former MCL (RAA < 8 µg/L); and **PFAS: Less than 2** samples, over 5-year period, are positive; and **1,4-Dioxane: 0** calculated RAA(s), over 5-year period, are at or above the notification level.	0
2	**CrVI:** 1 or more calculated RAA(s) over 5-year period are at or above 80% of the former MCL and below the former MCL (8 µg/L ≤ RAA < 10 µg/L); or **PFAS:** 2 or more samples over 5-year period are positive; this criterion applies to all 18 chemicals.	0.5
3	**CrVI:** 1 or more calculated RAA(s), over 5-year period, are at or above the former MCL (10 µg/L ≤ RAA); or **PFAS:** 2 or more samples, over 5-year period, are at or above the notification level; this criterion only applies to 4 chemicals that have notification level; or **1,4-**Dioxane: 1 or more calculated RAA(s), over 5-year period, are at or above the notification level (1 µg/L ≤ RAA).	1

Table A24: Example of Selection of Max Score Per Source

	Well 01	Well 02	Well 03	Well 04	Well 05
CrVI Risk Score	0.5	1	0.5	0	0
PFAS Risk Score	0.5	0.5	1	0.5	0
1,4-Dioxane Risk Score	1	1	1	0	0
Max Score per Source:	**1**	**1**	**1**	**0.5**	**0**

After selecting the maximum score for each source, an average of all the non-zero risk scores is calculated. See example below:

$$\frac{1+1+1+0.5}{4} = \mathbf{0.875}$$

Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 3 is applied to the "Constituents of Emerging Concern" risk indicator. Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 3. Table A25 summarizes the total risk score ranges and weights applied to this risk indicator.

Table A25: "Constituents of Emerging Concern" Total Risk Scores & Weights

Total Score Range	Weight	Max Risk Score	Risk Level
0	0	0	None
0 < n ≤ 0.5	3	1.5	Medium
0.5 < n ≤ 1	3	3	High

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

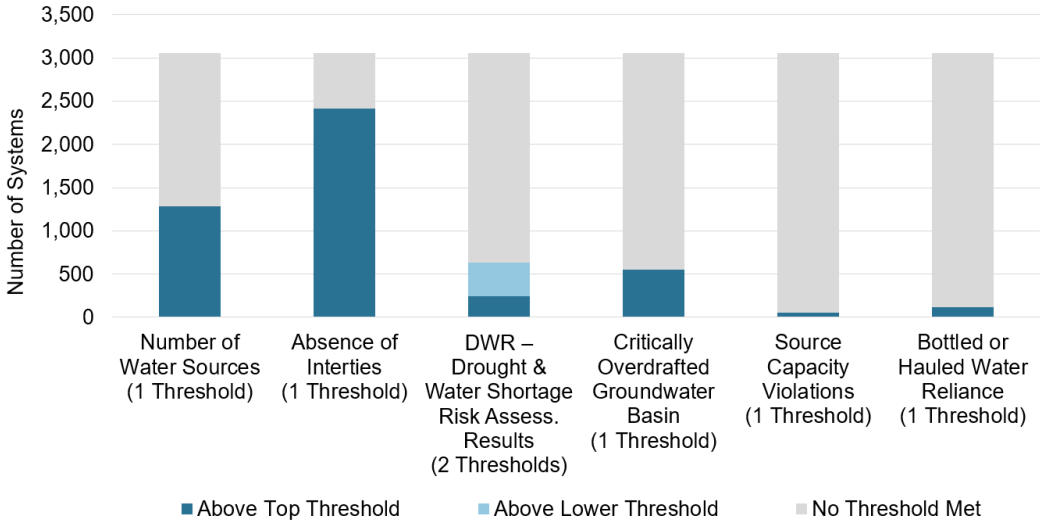
Constituents of Emerging Concern: https://tabsoft.co/3LwVSpy

ACCESSIBILITY RISK INDICATORS

This section provides full details on each Accessibility risk indicator used in the Risk Assessment. Accessibility risk indicators measure a system's ability to deliver safe, sufficient,

and continuous drinking water to meet public health needs. Figure A12 illustrates the number of water systems that exceeded the risk indicator thresholds within the Accessibility category. The range of potential thresholds for each risk indicator are summarized in the respective risk indicator label and detailed below.

Figure A12: Number of Systems Exceeding Thresholds for Each Accessibility Risk Indicator



NUMBER OF SOURCES

Total number of available water sources including surface water, wells, and imported/purchased water.

Calculation Methodology
Required Risk Indicator Data Point & Source:

- Water Source Facility Type: SDWIS
    a. CC – Consecutive Connection
    b. IG – Infiltration Gallery
    c. IN – Intake
    d. RC – Roof Catchment
    e. SP – Spring
    f. WL – Well
    g. ST – Storage Tank

Risk Indicator Calculation Methodology:

- Prepare data
    a. Combine two SDWIS tables (the Water System table and Water System Facility table).

i. Apply filters to prepared data and get counts of the total number of Water System Facilities for each Water System.
   - Filters applied
     a. Active Water Systems Only
     b. Active Water System Facilities Only
     c. Water System Facilities with a facility type of CC, IG, IN, RC, SP, and WL

Threshold Determination

The threshold developed for the number of sources risk indicator mostly aligns with the thresholds used by DWR's Drought & Water Shortage Risk Assessment. Peer-reviewed studies also suggest that single source reliance is associated with water system failure.[73] Moreover, Section 64554(c) of the California Code of Regulations (CCR) requires new community water systems using only groundwater sources to have a minimum of two approved sources capable to meet the maximum day demand of the water system.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 3 is applied to the "Number of Sources" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 3. Table A26 summarizes the thresholds, scores, and weight for this risk indicator.

Table A26: "Number of Sources" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
X	**0** source (automatically At-Risk).	N/A	N/A	N/A	Very High
0	**2 or more** sources.	0	N/A	0	None
1	**1** source.	1	3	3	High

Explore Water System Risk Indicator Performance

The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Number of Sources: https://tabsoft.co/3nfJn7E

[73] See Mullin, M. (2020). The effects of drinking water service fragmentation on drought-related water security. *Science, 368*(6488), 274-277.

ABSENCE OF INTERTIES

An intertie or interconnection is a connection between one or more water systems where systems can either supply or receive water from each other. The presence of interties is assumed to reduce the risk of a water outage by allowing water systems to switch sources and even governance structure support, if needed.

Calculation Methodology

Important Note: *In 2022 the State Water Board adjusted the calculation of this risk indicator from the approach used in the 2021 Needs Assessment to account for the inclusion of medium-size water systems that have many sources.*

Required Risk Indicator Data Points & Source:

In SDWIS, this type of data is stored as a water system facility with a consecutive connection designation. Additionally, these types of water system facilities can be described in terms of their availability of use. According to internal SDWIS procedure documents, only the receiving facility should have a consecutive connection (CC) water system facility represented in SDWIS. The procedure document does not indicate whether emergency or seasonal CCs should be entered. The purpose of this metric is to capture the number of interties per water system entered in SDWIS, regardless of availability.

- Water source facility type and availability: SDWIS
    a. CC – Consecutive Connection
        i. Availability:
            - I – Interim
            - E – Emergency
            - O – Other
            - P – Permanent
            - S – Seasonal

Risk Indicator Calculation Methodology:

- Prepare data:
    - Combine two SDWIS tables (the Water System table and Water System Facility table).
- Apply filters to prepared data and get counts for each Water Source Type per Water System.
    - Filters applied:
        - Active Water Systems Only
        - Active Water System Facilities Only
        - Water System Facilities with a facility type of CC

Threshold Determination

Interties can be a critical lifeline for water systems, especially when faced with an emergency.

A water system is at a higher risk of failure if their sources were to become contaminated, dry, collapse, or be taken out of service (i.e., for maintenance etc.), without an intertie to a nearby system for back-up supply. The State Water Board has adopted a binary threshold for "Absence of Intertie." Water systems without an intertie are assigned risk scores and those with an intertie receive 0 risk score. The developed threshold aligns with DWR's Drought & Water Shortage Vulnerability Assessment.[74] All water systems with 10,000 service connections or greater, that have more than one source are excluded and risk scores of 0 are assigned. If a water system with 10,000 service connections or more has only one source and it is not an intertie, they receive a risk score of 1. Water systems with 10 or more water sources are also excluded and risk scores of 0 are assigned.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 1 is applied to the "Absence of Interties" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 1. Table A27 summarizes the thresholds, scores, and weight for this risk indicator.

Table A27: "Absence of Interties" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	**Systems with 10,000 service connections or greater; or with 10 or more water sources**	0	N/A	0	None
0	**1 or more** interties.	0	N/A	0	None
1	**0** interties.	1	1	1	High

Explore Water System Risk Indicator Performance

The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

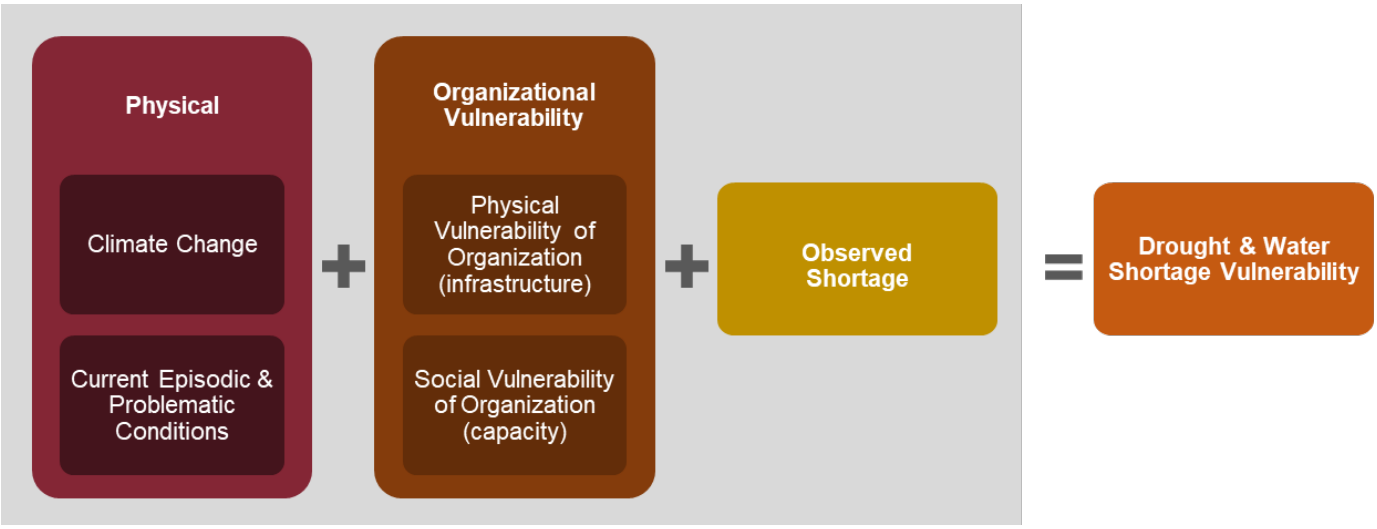
Absence of Interties: https://tabsoft.co/3Jqurv4

[74] Water Shortage Vulnerability Assessment of Small Water Systems: Update 2023 https://data.cnra.ca.gov/dataset/water-shortage-vulnerability-technical-methods

DWR – DROUGHT & WATER SHORTAGE RISK ASSESSMENT RESULTS

This indicator utilizes DWR's Drought and Water Shortage Risk Scoring Tool[75] results which identify small water suppliers and rural communities (defined as *Self-Supplied Communities* in the tool) that are potentially at-risk of drought and vulnerable to water shortages. For this tool, small water suppliers are considered publicly regulated systems with fewer than 3,000 service connections and using fewer than 3,000 acre-feet per year. Self-supplied communities are water systems with fewer than 15 service connections, which covers state small water systems (5 to 14 connections), local small water systems (2 to 4 connections), and domestic wells. This tool creates an aggregated, comparative risk score for each water system and community derived from a set of indicators that capture different dimensions of exposure to hazards, physical/social vulnerability, and observed supply shortages (29 indicators for small water suppliers and 29 indicators for self-supplied communities).

Figure A13: Grouping of Indicators (Components) Used to Estimate Water Shortage Vulnerability for Small Water Systems



Calculation Methodology

To improve the Water Shortage Vulnerability Assessment, in 2023 DWR updated the 2021 methodology to adjust the scoring to reflect existing knowledge, to align with policy-related research, and to accommodate newer data available. The full overview of changes is available online and summarized below in Table A28.[76]

[75] Drought and Water Shortage Risk Explorer Tool for Small Water Suppliers and Rural Communities
https://dwr.maps.arcgis.com/apps/MapSeries/index.html?appid=3353b370f7844f468ca16b8316fa3c7b
[76] Water Shortage Vulnerability Technical Methods
https://data.cnra.ca.gov/dataset/water-shortage-vulnerability-technical-methods

Table A28: Major Revisions Made to DWR's Water Shortage Vulnerability Assessment for Small Water Systems

Revision Description	2021 Version	2023 Version
Terminology Change: "Risk" changed to "vulnerability"	Referred to aggregated score as "drought risk"	Refers to aggregated scores as "water shortage vulnerability"
Vulnerability Scoring Weightings	Applied weightings by group of indicators	Apply weightings by indicator and by basin location
Vulnerability Scoring Null Values	Null values were accommodated in the aggregation equation by adjusting the denominator for their omission	By default, entries with missing data are treated as having a value of "0" (no vulnerability) for those indicators
Indicator added to account for estimate drought impacted systems	Not available	Incorporated
Indicator asses to account for multiple dry years	Not available	Calculated from PRISM data

For the *small water suppliers*, the 29 risk indicators utilized by DWR are weighted and aggregated similar to the approach used in the Risk Assessment. For scoring, the risk indicator variables are rescaled 0-1 numbers (1 is high and 0 is low) and combined with the other variables in their respective component. Individual indicator weights are applied to each variable and then the weighted component scores are aggregated.

Each group of variables is then combined with the other group scores for each component (Exposure, Vulnerability, and Observed Water Shortage). The final score for a water system is calculated with different weights depending on the system's source water composition ("Groundwater Only," "Surface Water Only," or "Both Groundwater and Surface Water"). Finally, the raw risk score from each component is summed and rescaled from 0 to 100 using a min-max scaling technique to calculate the final risk score.

The draft drought scoring for the small water suppliers and self-supplied communities can be found in the Drought and Water Shortage Risk Explorer Tool for Small Water Suppliers and Rural Communities.[77] Additional information is available on the DWR Water Shortage Vulnerability Scoring and Tool website.[78]

Threshold Determination

The State Water Board developed thresholds for this indicator (the top 10% and 25% of

[77] Drought and Water Shortage Risk Explorer Tool for Small Water Suppliers and Rural Communities
https://dwr.maps.arcgis.com/apps/MapSeries/index.html?appid=3353b370f7844f468ca16b8316fa3c7b
[78] Water Shortage Vulnerability Scoring and Tool | DWR
https://water.ca.gov/Programs/Water-Use-And-Efficiency/SB-552/SB-552-Tool

systems analyzed) based on the illustrative cutoff provided by DWR in its presentation of Drought & Water Shortage Vulnerability Assessment Results.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 2 is applied to the "DWR Assessment Results" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 2. Table A29 summarizes the thresholds, scores, and weight for this risk indicator.

Table A29: "DWR Assessment Results" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A*	**Systems not assessed by DWR**	0	N/A	0	None
0	**Below top 25%** of systems most at risk of drought and water shortage.	0	N/A	0	None
1	**Top 25%** of systems most at risk of drought and water shortage.	0.25	2	0.5	Low
2	**Top 10%** of systems most at risk of drought and water shortage.	1	2	2	High

** DWR's assessment includes community water systems with fewer than 3,000 service connections and less than 3,000 acre-ft in annual production. Water systems that do not have service area boundaries recorded in the California Drinking Water Systems Area Boundaries[79] were excluded.*

Explore Water System Risk Indicator Performance

The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

DWR Assessment Results: https://tabsoft.co/42kMN9g

[79] California Drinking Water System Area Boundaries
https://gis.data.ca.gov/datasets/fbba842bf134497c9d611ad506ec48cc_0/explore?location=36.912748%2C-119.242341%2C6.67

CRITICALLY OVERDRAFTED GROUNDWATER BASIN

Water systems reliant on groundwater wells in basins considered to be in Critical Overdraft per DWR's Bulletin 118 may be at greater risk of meeting demand, especially during drought conditions. A basin is subject to critical conditions of overdraft when continuation of current water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts.

Calculation Methodology

Important Note: *In the 2022 Needs Assessment the State Water Board adjusted the calculation of this risk indicator from the approach used in the 2021 Needs Assessment to account for the inclusion of medium-size water systems that have many sources.*

Required Risk Indicator Data Points & Sources:

- SGMA Basin Prioritization Statewide Summary Table:[80] DWR
- Water System Boundaries: State Water Board Service Area Boundary Layer (SABL)[81]
- Water Type Code: SDWIS
    - GW – Groundwater
    - SW – Surface Water
    - Both – GW and SW

Risk Indicator Methodology:

- Water System Boundaries – SABL – Water systems boundaries are overlaid with the critically overdrafted groundwater basins.
- Water System Source Water Identification – SDWIS – Water systems screened for source water (groundwater/surface water) to determine reliance on groundwater.

Threshold Determination

In the 2021 Risk Assessment, the State Water Board used 75% threshold of water system service area intersecting with a critically overdrafted groundwater basin. However, due to the data availability of water system well locations and source types, the thresholds for this risk indicator was updated in the 2022 Needs Assessment to reflect the percentage of a water system's groundwater sources within a critically overdrafted groundwater basin. A binary threshold is still utilized where a system that has at least 25% or more of its ground water sources within a critically overdrafted basin are assigned a risk score of 1 and those with less than 25% of their total sources within a critically overdrafted basin receiving a risk score of 0.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk

[80] SGMA Basin Prioritization Statewide Summary Table
https://data.cnra.ca.gov/dataset/13ebd2d3-4e62-4fee-9342-d7c3ef3e0079/resource/6347629e-340d-4faf-ae7f-159efbfbcdc9/download/final-515-table.xlsx

[81] California Drinking Water System Boundaries
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=fbba842bf134497c9d611ad506ec48cc

Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 2 is applied to the "Critically Overdrafted Groundwater Basin" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 2. Table A30 summarizes the thresholds, scores, and weight for this risk indicator.

Table A30: "Critically Overdrafted Groundwater Basin" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	**Systems with no groundwater sources**	0	N/A	0	None
0	**Less than 25%** of system's wells are located within a critically overdrafted basin.	0	N/A	0	None
1	**More than 25%** of system's wells are located within a critically overdrafted basin.	1	2	2	High

Explore Water System Risk Indicator Performance

The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Critically Overdrafted Groundwater Basin: https://tabsoft.co/3K0VH4T

SOURCE CAPACITY VIOLATIONS

The purpose of this risk indicator is to identify water systems that have violated source capacity standards as required in California Waterworks Standards[82] within the last three years. This violation criteria includes:

- Failure to maintain adequate source capacity (may include curtailment order and/or service connection moratorium).
- Failure to maintain adequate pressure leading to a water outage.
- Failure to complete a required source capacity planning study.

The State Water Board developed new source capacity violation codes in 2021 to better track and identify water systems failing to meet source capacity standards. Historically, the State Water Board has responded to source capacity violations with targeted citations, curtailment

[82] California Code of Regulations Title 22 Division 4 Chapter 16
https://bit.ly/40oNDjE

orders, and service connection moratoriums. Since the new source capacity violations only reflect recent actions, this risk indicator will also include water systems that have had active connection moratoriums within the last three years.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- Service Connection Moratoriums: SDWIS
- Source Capacity Violations: Violation Type Code in SDWIS (Table A31): WW – Waterworks Standards

Table A31: Source Capacity Violation Analyte Codes

Violation Criteria	Analyte Code	Description
Failure to Maintain Adequate Source Capacity	C277 – CCR section 64554 – SRC CAPACITY	If a water system fails to have adequate source capacity pursuant to CCR section 64554[83]
Failure to Maintain Adequate Source Capacity	C278 – CCR section 64554 – SRC CAPACITY (CURTAILMENT)	If a water system fails to have adequate source capacity pursuant to CCR section 64554 AND a curtailment order has been issued (i.e., the failure is directly related to curtailments)
Failure to Maintain Adequate Pressure Leading to a Water Outage[84]	C279 – CCR section 64602 – WATER OUTAGE (DROUGHT)	If a water system fails to maintain the minimum required pressure of 20 pounds per square inch in its distribution system due to inadequate capacity caused by drought
Failure to Maintain Adequate Pressure Leading to a Water Outage[85]	C295 – CCR section 64602 – WATER OUTAGE	If a water system fails to maintain the minimum required pressure of 20 pounds per square inch in its distribution system due to inadequate capacity not caused by drought

[83] At all times, public water system's water source(s) shall have the capacity to meet the system's maximum day demand (MDD).
1. ≥ 1,000 service connections – source capacity, storage capacity, and/or emergency source connections must meet 4 hours of peak hourly demand (PHD)
2. < 1,000 service connections – storage capacity ≥ MDD

[84] This violation criterion is used for repeated, long-term water outages, consistent, repeated low-pressure event. This is not for routine main breaks or short-term outages.

[85] This violation criterion is used for repeated, long-term water outages, consistent, repeated low-pressure event. This is not for routine main breaks or short-term outages.

Violation Criteria	Analyte Code	Description
Failure to Complete A Source Capacity Planning Study	C280 – CCR section 64558 – SRC CAPACITY STUDY FAILURE	If a water system fails to complete a source capacity planning study required as part of an enforcement action

Risk Indicator Calculation Methodology:

- Source capacity violations - Identify systems that have had one or more source capacity violations within the past three years using the violation type code and analyte codes listed in Table A31.
- Service connection moratoriums (SCM) - Identify water systems that have had one or more SCM, based on referrals from State Water Board District staff, within the past three years.
    - Start Date & End Date
        - Historical SCM – have both the Start Date & End Date
        - Current (Active) SCM – have only Start Date

Threshold Determination

The State Water Board has developed a binary threshold for the Source Capacity Violations risk indicator. Any water systems that have not been able to meet source capacity water works standards within the last three years should receive risk points.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 3 is suggested for the "Source Capacity Violations" risk indicator. Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 3. Table A32 summarizes the thresholds, score, and weights for Source Capacity Violations.

Table A32: "Source Capacity Violations" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**0** source capacity violations within the past 3 years; and **0** service connection moratoriums within the past 3 years.	0	N/A	0	None
1	**1 or more** source capacity violations within the past 3 years; or **1 or more** service connection moratoriums within the past 3 years.	1	3	3	High

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Source Capacity Violations: https://tabsoft.co/3YYziJJ

BOTTLED OR HAULED WATER RELIANCE

The purpose of this risk indicator is to identify water systems that have had to supplement or replace their source of supply to meet customer demand with bottled water, and/or hauled water at any point within the past three years. A water system that is unable to meet the demand with their available sources due to water quality issues or source capacity challenges is at-risk of failing to provide water to the customers.

Calculation Methodology
Required Risk Indicator Data Points & Sources:

To identify water systems that have had reliance on bottled water and/or hauled water at any point within the past 3 years, the following data points from multiple sources were used.

- Internal State Water Board Interim Solution Data Spreadsheet: Division of Financial Assistance (DFA)
    - Type of Assistance in “Regional Project” tab
        - Bottled Water
        - Hauled Water
    - Category in “All other funding” tab
        - Bottled Water
        - Hauled Water

- Water Source Facility: SDWIS
    - Water Source Facility Name – any facility names containing “Hauled”; or
    - Water Source Facility Type Code
        - NN – Non-Piped, Non-Purchased
        - NP – Non-Piped, Purchased

- Drought Tracking Spreadsheet: DDW
    - Drought Emergencies: Action
        - Bottled Water
        - Hauling Water

- Hauled Water and Severe Water Shortage Systems Tracking Spreadsheet: DDW
    - Actions In Progress – Hauled Water

- All Hazards Emergency Response Tracking Spreadsheet:[86] Water Boards Emergency Operations Center (WBEOC)/ DDW
    - Water System Actions - Water hauling
    - Comments - any description of the situation containing “Hauling”, “Hauler”, or “Hauled”

- Drought Projects Funding Commitments Data Spreadsheet:[87] Department of Water Resources (DWR)
    - Project Type - any project types containing “Bottled” and/or “Hauled”

Risk Indicator Calculation Methodology:

- Prepare DFA data – Identify water systems that have had one or more enrollments for receiving assistance of bottled water and/or hauled water. Some water systems may have multiple enrollments across different assistance types, funding sources and communities served.
- Prepare SDWIS data
    - Availability Codes reflect the availability for NN and NP facilities.
        - P – Permanent (the source is used all year round)
        - I – Interim (the source is used partly during the year)
        - E - Emergency (the source is used only during emergencies)
        - Other

Table A33: Preparation of SDWIS Hauled Water Data

Availability Code	Rely on hauled water only?	Include in the dataset?
P – Permanent	Yes	Include
P – Permanent	No	Include if system has been under hauled water reliance within the past 3 years.
I – Interim	Yes	Include
I – Interim	No	Include if system has been under hauled water reliance within the past 3 years.
E – Emergency	Yes or No	Include if system is listed in DFA Interim Solution Data*
Other	Yes or No	Include if system is listed in DFA Interim Solution Data*

[86] The DDW Public Water Systems All Hazards Emergency Response Tracking spreadsheet is designed to work on the Water Boards' Emergency Preparedness and Response Toolkit (EmPART)

[87] DWR’s funding commitments up to November 2022 was provided to the State Water Board. Any projects with a county applicant were excluded from the analysis because these projects are typically designed to support private domestic wells, not public water systems. After applying this filter there were four applicants that are public water systems. The State Water Board reached out to those systems to validate the data and determine if they have had bottled/hauled water reliance within the past 3-year.

** If a water system is not listed in DFA Interim Solution Data, data validation was performed by contacting the water system and/or regulating agency.*

- Prepare DDW Drought Tracking Data – Identify water systems that have had bottled/hauled water in response to water outage or shortage due to drought and cross-reference with DFA Interim Solution Data. Validate the data through water systems and/or regulating agencies for any systems that are not listed in DFA's data.

- Prepare DDW Hauled Water and Severe Water Shortage Systems Tracking Data – Identify water systems that have had hauled Water in response to water shortage and cross-reference with DFA Interim Solution Data. Validate the data through water systems and/or regulating agencies for any systems that are not listed in DFA's data.

- Prepare WBEOC/DDW All Hazards Emergency Response Tracking Data – Identify water systems that have had hauled water as an emergency response, or the description of their situation indicates potential use of hauled water. Cross-reference with DFA Interim Solution Data and validate the data through water systems and/or regulating agencies for any systems that are not listed in DFA's data.

- Prepare DWR Drought Projects Funding Commitments Data – Identify water systems that have applied for bottled water and/or hauled water funding and cross-reference with DFA Interim Solution Data. Validate the data through water systems and/or regulating agencies for any systems that are not listed in DFA's data.

- Combine two DFA spreadsheet tabs, SDWIS data, and other data validated through the water systems.

- Remove any duplicates of the water systems to identify unique systems.

Threshold Determination

The State Water Board analyzed how water systems performed for this risk indicator by 2021 SAFER status: Failing, At-Risk, Potentially At-Risk, and Not At-Risk. This analysis concluded that the majority of water systems that have relied on bottled water or hauled water over the last three years are either currently failing or at risk of failing (Table A34). Since there is a strong correlation between this risk indicator and failing, the State Water Board has developed a binary threshold of at least one or more occurrences.

Table A34: 2021 SAFER Status of Systems that Have Bottled Water or Hauled Water Reliance

TOTAL	Failing: HR2W List[88]	At-Risk	Potentially At-Risk	Not At-Risk
88	57 (65%)	18 (20%)	9 (10%)	4 (5%)

Risk Indicator Scoring & Weighting

[88] Failing list retrieved from the State Water Board SAFER Clearinghouse database on January 3, 2022

Due the strong correlation between this risk indicator and failing, the State Water Board has determined that any water systems that has relied on bottled or hauled water over the last three years to supplement their sources should **automatically be classified as At-Risk** if they are not currently on the Failing list.

Table A35: "Bottled or Hauled Water Reliance" Thresholds & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**0** occurrences of bottled water or hauled water reliance within the last three years.	0	N/A	0	None
1	**1 or more** occurrences of bottled water or hauled water reliance within the last three years.	Automatically At-Risk	N/A	N/A	Very High

Explore Water System Risk Indicator Performance

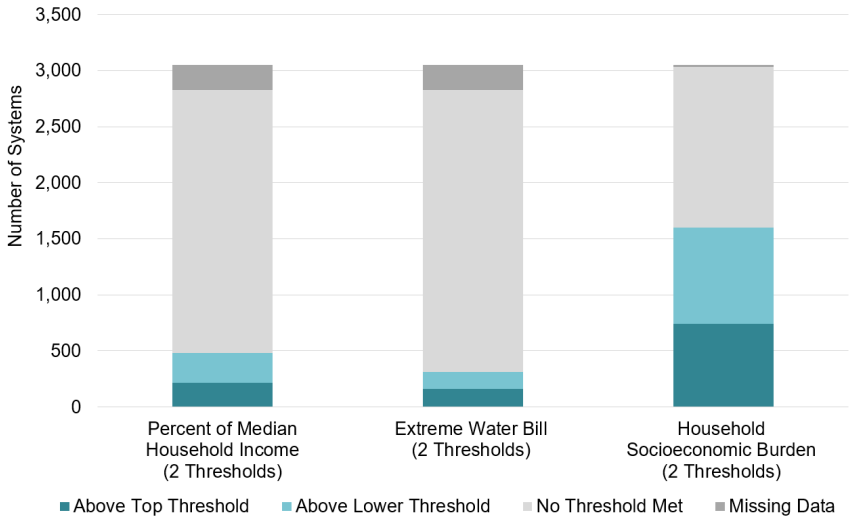
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Bottled or Hauled Water Reliance: https://tabsoft.co/3TrGKM9

AFFORDABILITY RISK INDICATORS

This section provides full details on each Affordability risk indicator used in the Risk Assessment. Affordability risk indicators measure the capacity of households and the customer base as a whole to supply the revenue necessary for a water system to pay for necessary capital, operations, and maintenance expenses. Figure A14 illustrates the number of water systems that exceeded the risk indicator thresholds within the Affordability category. The range of potential thresholds for each risk indicator are summarized in the respective risk indicator label and detailed below.

Figure A14: Number of Systems Exceeding Thresholds for Each Affordability Risk Indicator



PERCENT OF MEDIAN HOUSEHOLD INCOME (%MHI)

This indicator measures the annual system-wide average residential water bill for six hundred cubic feet (HCF) per month relative to the annual Median Household Income (MHI) within a water system's service area.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- Water system service area boundaries: SABL[89]
- Block group-Income in the Past 12 Months: 2021 5-year estimate U.S. Census Bureau's American Community Survey[199]
- Drinking Water Customer Charges: 2021 electronic Annual Report (eAR)
- Other Customer Charges: 2021 eAR

Average monthly drinking water customer charges are collected through the eAR. Historically this data has not been required for reporting leading to poor data coverage and accuracy issues. Extensive changes have been made to the 2020 electronic Annual Report making reporting customer charges mandatory with checks in place to improve the data quality. Due to the improvements made to the 2021 eAR this year we had a substantial decrease in customer charges reporting errors.

[89] California Drinking Water System Boundaries
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=fbba842bf134497c9d611ad506ec48cc
[199] 2021 American Community Survey 5 Year estimate Median Household Income
https://data.census.gov/table?t=Income+(Households,+Families,+Individuals)&y=2021&d=ACS+5-Year+Estimates+Detailed+Tables&tid=ACSDT5Y2021.B19013

Risk Indicator Calculation Methodology:
Median household income (MHI) is determined for a water system using American Community Survey data for household income. Community water system boundaries typically do not align with census boundaries where per capita income data is regularly collected. To assign an average median household income to a community water system, spatially weighted income data is aggregated by census block group within the water system service area.

The methodology for this indicator was based on the Division of Financial Assistance (DFA) MHI methodology. While the MHI calculation methodology for the Affordability Assessment generally aligns with DFA's MHI determination methodologies, there are slight differences. The differences are found in the calculation of MHI's for cities and census designated places, and in the application of the Margin of Error (MOE).

The DFA methodology dictates that when it is determined that a system boundary exactly matches city boundaries or closely matches a census designated place boundary, the MHI for the entire city or census designated place should be directly applied to the system rather than using areally-interpolated block group data. This likely leads to more accurate MHI estimation in these cases. However, this method was not used in the Needs Assessment given that a case-by-case determination of matching of cities and census designated places to system boundaries was not feasible for the entire state. The MHI for each water system is a population weighted MHI, using census block group area and population data. A population factor is generated based on the area of each census block group that falls within the water system boundary. The water system MHI is then calculated using population adjusted MHIs for each census block group that falls within the water system boundary using the formula below:

Equation A1: MHI Calculation

$$\sum \frac{(Block\ Group\ MHI) \times (Adjusted\ Block\ Group\ Population)}{(Total\ Adjusted\ Block\ Groups\ Population)}$$

MOE for MHI American Community Survey data is also included in the MHI calculation. A population adjusted MOE is found using the same methodology described for MHI. The lower range of the MOE will be applied to a community's estimated MHI up to a maximum MOE value of $7,500 for communities with more than 500 people and $15,000 for communities with 500 or fewer people. The MOE will be subtracted from the estimated MHI.

The DFA methodology uses a lower bound MHI by subtracting the block group MOE from the block group MHI, with limits based on community size prior to applying the population factor to MHI and MOE. The methodology applied in the Needs Assessment set margin of error limits and then applied them to population adjusted MHI figures, resulting in slightly different community water system MHI calculations than the DFA methodology.

As a result of these slight variations and the changing nature of household income, all funding related financial assessments must be completed by the DFA as their assessments are water

system specific as opposed to the aggregated analysis done for the purposes of the Needs Assessment.

Average monthly drinking water customer charges are calculated using:

- Drinking water service costs are estimated at six HCF per month. This level of consumption is in line with statewide conservation goals of 55 gallons per capita per day, in an average 3-person household.
- When data becomes available, additional approximated customer charges (not collected through a customer's bill) will be added to this figure to calculate Total Drinking Water Customer Charges.

Equation A2: %MHI Calculation

$$\%\text{MHI} = \frac{Average\ Monthly\ Drinking\ Water\ Charges\ (6\ HCF)}{\text{Water System Service Area MHI}}$$

Threshold Determination

%MHI is commonly used by state and federal regulatory agencies and by water industry stakeholders for assessing community-wide water charges affordability for decades. %MHI is utilized by the State Water Board (at 1.5% threshold) and the U.S. EPA (at 2.5% threshold) for assessing affordability. The State Water Board and DWR use %MHI to determine Disadvantaged Community (DAC) status, among other income-related metrics. DAC status is often used to inform funding eligibilities for different financial programs offered by the State and other agencies. OEHHA's Human Right to Water (HR2W) Tool also utilizes[90] the thresholds determined by the State Water Board for this indicator.[91] Other states, including North Carolina,[92] presently or have recently used 1.5% of MHI spent on water and sewer costs as a threshold for water system funding decisions.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the

[90] There has been criticism of this metric by academics, water system associations, and the broader water sector mostly around its accuracy in measuring household affordability for those truly in need and the setting of arbitrary %MHI thresholds, limitations which the U.S. EPA has recently acknowledged.

[91] Arkansas Natural Resources Commission (2020). Safe Drinking Water Fund Intended Use Plan SFY 2019 https://www.agriculture.arkansas.gov/wp-content/uploads/2020/05/0_-_2019_DWSRF_IUP_-_AMENDED_January_2019_01082019_1156hrs.pdf

[92] North Carolina Department of Environmental Quality. Joint Legislative Economic Development and Global Engagement Oversight Committee (March 17, 2016) https://www.ncleg.gov/DocumentSites/Committees/JLEDGEOC/2015-2016/Meeting%20Documents/3%20-%20March%2017,%202016/2%20%20DEQ_Kim%20Colson%20Water%20Infrastructure%20JLOC%20EDGE%20160317.pdf

maximum weight of 3 is applied to the "Percent Median Household Income" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 3. Table A36 summarizes the thresholds, scores, and weight for this risk indicator.

Table A36: "Percent Median Household Income" Thresholds & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	**System does not charge customers directly for water**	0	N/A	0	None
0	**Less than 1.5%**	0	N/A	0	None
1	**1.5% or greater**	0.75	3	2.25	Medium
2	**2.5% or greater**	1	3	3	High
*Missing**	**No data available due to non-reporting**	"--"	N/A	"--"	Unknown

**A water system may be missing necessary data for this indicator due to eAR non-reporting or because the data the system submitted is outside a reasonable range. For this indicator, monthly customer charges less than $5 or greater than $500 for 6 HCF were excluded. Refer to the section above on how the Risk Assessment accommodates for missing data in the calculation of a system's aggregated risk score.*

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Percent Median Household Income: https://tabsoft.co/3Zc6sWt

EXTREME WATER BILL

This indicator measures drinking water customer charges that meet or exceed 150% of statewide average drinking water customer charges at the six hundred cubic feet (HCF) level of consumption.

Calculation Methodology
Required Risk Indicator Data Points & Sources:

- Drinking Water Customer Charges: 2021 eAR
- Other Customer Charges: 2021 eAR

Risk Indicator Calculation Methodology:

Extreme Water Bill for a water system is determined using Average Monthly six HCF Drinking Water Customer Charges and Other Customer Charges divided by the State's Monthly

Average Drinking Water Charges. The Risk Assessment is applied to water systems with less than 3,300 service connections; however, this methodology utilizes the statewide average customer charges to calculate extreme water bill, which includes systems with greater than 3,300 service connections. Due to data quality concerns, water systems that reported less than $5 or greater than $500 in monthly customer charges for six HCF were excluded from the analysis and the calculated statewide average.

Threshold Determination
The State Water Board's AB 401 report[93] recommended statewide low-income rate assistance program elements utilize the two recommended tiered indicator thresholds of 150% and 200% of the state average drinking water bill for six HCF.

Risk Indicator Scoring & Weighting
To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 1 is applied to the "Extreme Water Bill" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 1. Table A37 summarizes the thresholds, scores, and weight for this risk indicator.

Table A37: "Extreme Water Bill" Thresholds, Weights & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	**System does not charge customers directly for water**	0	N/A	0	None
0	**Below 150%** of the statewide average.	0	N/A	0	None
1	**Greater than 150%** of the statewide average.	0.5	1	0.5	Medium
2	**Greater than 200%** of the statewide average.	1	1	1	High
*Missing**	**No data available due to non-reporting**	"--"	N/A	"--"	Unknown

** A water system may be missing necessary data for this indicator due to non-reporting or because the data the system submitted is outside a reasonable range. For this indicator, monthly customer charges less than $5 or greater than $500 for 6 HCF were excluded. Refer to the section above on how the Risk Assessment accommodates for missing data in the calculation of a system's aggregated risk score.*

[93] AB 401 Final Report: https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/assistance/docs/ab401_report.pdf

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Extreme Water Bill: https://tabsoft.co/3mXWURk

HOUSEHOLD SOCIOECONOMIC BURDEN

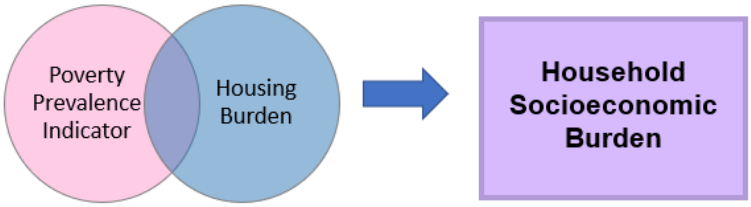
The purpose of this risk indicator is to identify water systems that serve communities that have both high levels of poverty and high housing costs for low-income households. These communities may be struggling to pay their current water bill and may have a difficult time shouldering future customer charge increases when their limited disposable income is constrained by high housing costs. This indicator is a composite indicator of two data points: Poverty Prevalence and Housing Burden.

- **Poverty Prevalence Indicator (PPI)** measures the percent of the population living below two times the federal poverty level and can be represented reliably at the census block group, tract, and county level.

- **Housing Burden Indicator** measures the percent of households in a census tract that are both low income (making less than 80% of the Housing and Urban Development (HUD) Area Median Family Income) and severely burdened by housing costs (paying greater than 50% of their income to housing costs).

The combination of these two variables creates a more comprehensive picture of socioeconomic vulnerability while accounting for the varying levels of income and cost burdens throughout California.

Figure A15: PPI and Housing Burden Components Combined to Create Household Socioeconomic Burden Indicator



Calculation Methodology
Required Risk Indicator Data Points & Sources:

- Poverty Prevalence Indicator: From the 2017-2021 American Community Survey (ACS),[94] a dataset containing the number of individuals above 200 percent of the federal poverty level (FPL) was downloaded by block groups for the state of California (25,607 in the state).
- Housing Burden Indicator data: From the 2015-2019 U.S. Department of Housing and Urban Development (HUD) Comprehensive Housing Affordability Strategy (CHAS),[95] a dataset containing cost burdens for households by HUD-adjusted median family income (HAMFI) category was downloaded by census tract for the state of California (8,057 in the state).

Risk Indicator Calculation Methodology:

Prepare Poverty Prevalence Indicator data: The number of individuals below 200 percent of the FPL was calculated by subtracting the reported estimate of individuals in poverty (2x FPL) by the total estimate. The number of individuals below 200% of the poverty level was divided by the total population for whom poverty status was determined.

Prepare Housing Burden Indicator data: CHAS— a special analysis of census data specific to housing— is only available at the census tract and other larger geographies. For each census tract, the data were analyzed to estimate the number of households with household incomes less than 80% of the county median and renter or homeowner costs that exceed 50% of household income. The percentage of the total households in each tract that are both low-income and housing-burdened was then calculated. Each census tract was associated with the block groups within it to maintain consistency with the PPI indicator, which is at the block group level.

PPI and Housing Burden at the block group level were area-weighted to CWS boundaries. These boundaries were downloaded from the System Area Boundary Layer (SABL).[96] Using the Intersect Tool in ArcPro, the area was determined for each portion of a water system boundary that intersected with a block group boundary. A weighted average, using area as the weight, was calculated for both PPI and Housing Burden for all water systems in the assessment.

The ACS and CHAS estimates come from a sample of the population and suppression criteria were assessed to flag estimates considered statistically unreliable.

[94] American Community Survey
https://data.census.gov/cedsci/
[95] HUD CHAS Data
https://www.huduser.gov/portal/datasets/cp.html
[96] California Drinking Water System Boundaries
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=fbba842bf134497c9d611ad506ec48cc

Suppression Criteria for PPI

- Unlike the U.S. Census, ACS estimates come from a sample of the population and may be unreliable if they are based on a small sample or population size. The standard error (SE) and relative standard error (RSE) were used to evaluate the reliability of each estimate.
- The SE was calculated for each block group using the formula for approximating the SE of proportions provided by the ACS.[97] When this approximation could not be used, the formula[98] for approximating the SE of ratios was used instead.
- The RSE is calculated by dividing a tract's SE by its estimate of the percentage of the population living below twice the federal poverty level and taking the absolute value of the result.
- Block group estimates that met either of the following criteria were considered reliable and included in the analysis:
    - RSE less than 50 (meaning the SE was less than half of the estimate); or
    - SE was less than the mean SE of all California block group estimates for poverty.
- Block groups with unreliable estimates were flagged as potentially unreliable. All block groups with scores were included in the indicator.

Suppression Criteria for Housing Burden

- Like ACS estimates, CHAS data come from a sample of the population and may be unreliable if they are based on a small sample or population size. The standard error (SE) and relative standard error (RSE) were used to evaluate the reliability of each estimate.
- The SE was calculated for each census tract using the formula for approximating the SE of proportions provided by the ACS.[99] When this approximation could not be used, the formula[100] for approximating the SE of ratios was used instead.
- The RSE was calculated by dividing a tract's SE by its estimate of the percentage of housing-burdened low-income households and taking the absolute value of the result.
- Census tract estimates that met either of the following criteria were considered reliable and included in the analysis:
    - RSE less than 50 (meaning the SE was less than half of the estimate); or
    - SE was less than the mean SE of all California census tract estimates for housing burdened low-income households.
- All census tract level Housing Burden scores were associated with the block groups within them.
- Block groups with unreliable estimates were flagged as potentially unreliable. All block group with scores were included in the indicator.

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[97] American Community Survey Office, 2013, equation 4
https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2011.pdf
[98] American Community Survey Office, 2013, equation 3
https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2011.pdf
[99] American Community Survey Office, 2013, equation 4
https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2011.pdf
[100] American Community Survey Office, 2013, equation 3
https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2011.pdf

Component Thresholds

Poverty Prevalence (PPI): For PPI, various thresholds have been explored by other organizations and researchers including the use of 30%[101] or multiple categories such as less than 10%, 10% to 30%, 30% to 50%, and greater than 50%.[102] However, the most widely used PPI thresholds by organizations and researchers was first suggested by Raucher et al. in a report prepared for the American Water Works Association[103,104,105,106]. In the Raucher et al. report entitled 'Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector,' the following PPI thresholds are recommended: low risk less than 20%, medium risk between 20% to 35%, and high risk greater than 35%. The State Water Board and OEHHA evaluated these thresholds as it relates to California data and propose to use these thresholds for the PPI component of the Household Socioeconomic Burden indicator.

Table A38: PPI Component Threshold Scores

Component	Threshold	Score	Risk Level
PPI	**Threshold N/A =** Missing or not reliable PPI data	N/A	Unknown
	Threshold 0 = < 20%	0	Low
	Threshold 1 = 20% - 35%	0.25	Medium
	Threshold 2 = > 35%	1	High

Housing Burden: Based on a nationwide literature review, consistent thresholds for Housing Burden have not yet been established by other organizations or identified in the scientific literature. A report by the University of North Carolina on housing conditions in North Carolina identified census tracts in the top 20% of state as severely burdened.[107] Additionally, a recently published Master's Thesis about housing challenges in California identified census tracts in the

[101] Lauren Patterson (2021): Water Affordability https://internetofwater.org/wp-content/uploads/2021/12/Blog010_WaterAffordability_Patterson.pdf
[102] David Mitchell, and Elizabeth Stryjewski (2020): Technical Memorandum on Water/Sewer Service Affordability Analysis https://www.cityofsantacruz.com/home/showpublisheddocument/83950/637553072866376248
[103] Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector (2019) https://www.awwa.org/Portals/0/AWWA/ETS/Resources/DevelopingNewFrameworkForAffordability.pdf?ver=2020-02-03-090519-813
[104] American Water Works Association: Measuring Water Affordability and the Financial Capability of Utilities https://awwa.onlinelibrary.wiley.com/doi/full/10.1002/aws2.1260
[105] Alliance for Water Efficiency (2020): An Assessment of Water Affordability and Conservation Potential in Detroit, Michigan https://www.allianceforwaterefficiency.org/sites/www.allianceforwaterefficiency.org/files/highlight_documents/AWE_Water_Affordability_Detroit_Final_2020_0.pdf
[106] Duke University, Nicholas Institute: Exploring the Affordability of Water Services within and across Utilities https://nicholasinstitute.duke.edu/water-affordability/affordability/Affordability_Preprint.pdf
[107] William Rohe, Todd Owen, and Sarah Kerns; The University of North Carolina at Chapel Hill, Center for Urban and Regional Studies (2017): Extreme Housing Conditions in North Carolina https://curs.unc.edu/wp-content/uploads/sites/400/2017/02/Extreme-Housing-Conditions-in-North-Carolina.pdf

top quartile of the state as being the ”most impacted.”[108] Lastly, one study showed that 16% of children in Los Angeles County live in severe housing-cost burdened households, but this was based on survey data.[109] Given the lack of peer-reviewed literature, consistency, and relevance among these limited examples, the census tracts were grouped into three categories (or tertiles), based on the overall distribution of 2019 housing burden data in the state to identify three levels of risk. The three categories were rounded to the nearest whole number.

Based on this statewide data, low risk corresponds with fewer than 14% of total households experiencing housing burden. Medium risk is between 14% and 21%, and high risk is greater than 21%, respectively. Using a matrix scoring approach, first each bin was assigned a score of 0 for “low vulnerability,” 0.25 for “medium vulnerability” and 1 for “high vulnerability.” The State Water Board will analyze water system arrearage, shut-off, and other affordability indicators over time to determine if the recommended Housing Burden thresholds should be adjusted in the future.

Table A39: Housing Burden Component Threshold Scores

Component	Threshold	Score	Risk Level
Housing Burden	**Threshold N/A =** Missing or not reliable Housing Burden data	**N/A**	**Unknown**
	Threshold 0 = <14%	**0**	**Low**
	Threshold 1 = 14% - 21%	**0.25**	**Medium**
	Threshold 2 = >21%	**1**	**High**

Threshold Determination

The two components of Household Socioeconomic Burden were combined using a matrix approach and following the same methodology as the Risk Assessment for state small water systems and domestic wells.[110] The normalized scores for PPI and Housing Burden components were added together and divided by the number of components (two). Below is the calculation used for each water system’s Household Socioeconomic Burden score and Figure A16 shows how much each calculated score represents a degree of PPI and Housing Burden within the matrix.

[108] Lucresia Graham(2021): A Cartographic Exploration of Census Data on Select Housing Challenges Among California Residents
https://spatial.usc.edu/wp-content/uploads/formidable/12/Lucresia-Graham-thesis-compressed.pdf
[109] Tabashir Z. Nobari, Shannon E. Whaley, Evelyn Blumenberg, Michael L. Prelip, and May C. Wanga (2018): Severe Housing-Cost Burden and Obesity Among Preschools-aged Low-Income Children in Lost Angeles County.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6305808/
[110] 2022 Needs Assessment.
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2022needsassessment.pdf

Equation A3: Calculating Household Socioeconomic Burden Score

$$\textit{Household Socioeconomic Burden} = \frac{\textit{PPI Score} + \textit{Housing Burden Score}}{2}$$

Figure A16: Household Socioeconomic Burden Scores Within the Matrix Represents Varying Degrees of PPI and Housing Burden

Poverty (PPI)	**High Risk** ≥ 35%	Score = 1	*Missing*	**0.5**	**0.625**	**1**
	Med Risk 20% - 35%	Score = 0.25	*Missing*	**0.125**	**0.25**	**0.625**
	None < 20%	Score = 0	*Missing*	**0**	**0.125**	**0.5**
	Unknown	Score = *Missing*	*Missing*	*Missing*	*Missing*	*Missing*
			Score = *Missing*	Score = 0	Score = 0.25	Score = 1
			Unknown	**None** < 14%	**Med Risk** 14% - 21%	**High Risk** ≥ 21%
			Housing Burden			

These combined scores are converted into threshold risk designations, as shown in Table A40.

Table A40: Thresholds for Household Socioeconomic Burden

Threshold Number	Threshold	Risk Level
0	Combined score of **0 – 0.125**	**None**
1	Combined score of **0.25 – 0.5**	**Medium**
2	Combined score of **0.625 – 1.0**	**High**

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on feedback from an internal State Water Board, Division of Drinking Water workgroup, the weight of 2 is applied to the "Household Socioeconomic Burden" risk indicator. Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 2. Table A41 summarizes the thresholds, score, and weights for Household Socioeconomic Burden.

Table A41: "Household Socioeconomic Burden" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**Combined score of 0 – 0.125**	0	N/A	0	None
1	**Combined score of 0.25 – 0.5**	0.5	2	1	Medium
2	**Combined score of 0.625 – 1.0**	1	2	2	High
*Missing**	**Missing PPI and/or Housing Burden data**	"--"	N/A	"--"	Unknown

*** American Community Survey and/or CHAS data may be missing for the water system's service area.**

Explore Water System Risk Indicator Performance

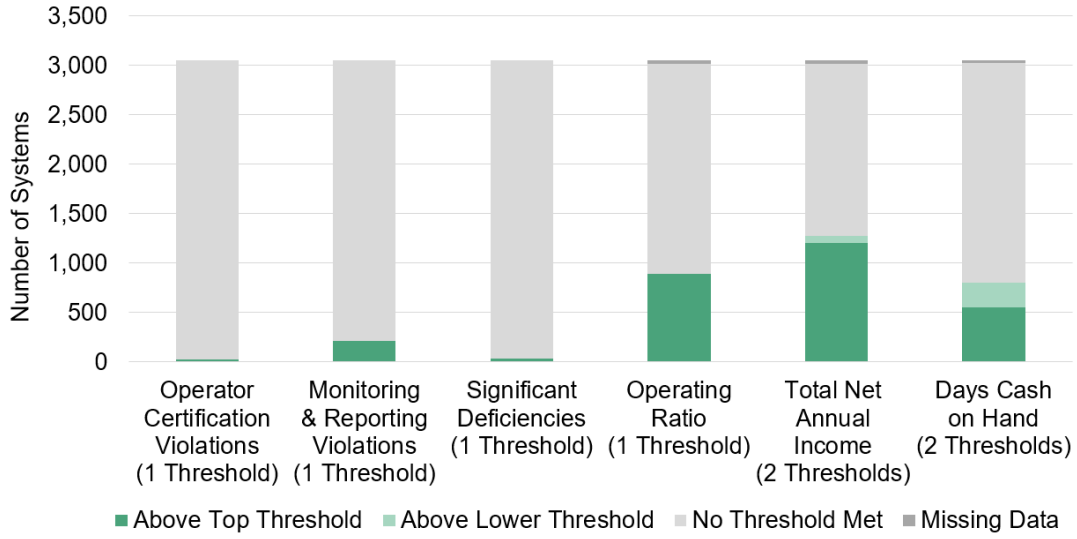
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Household Socioeconomic Burden: https://tabsoft.co/3n1SskA

TMF CAPACITY RISK INDICATORS

This section provides full details on each TMF Capacity risk indicator used in the Risk Assessment. TMF Capacity risk indicators measure a system's technical, managerial and financial (TMF) capacity to plan for, achieve, and maintain long term compliance with drinking water standards, thereby ensuring the quality and adequacy of the water supply. Figure A17 illustrates the number of water systems that exceeded the risk indicator thresholds within the TMF Capacity category. The range of potential thresholds for each risk indicator are summarized in the respective risk indicator label and detailed below.

Figure A17: Number of Systems Exceeding Thresholds for Each TMF Capacity Risk Indicator



OPERATOR CERTIFICATION VIOLATIONS

Operator certification violations are issued to water systems that do not have an appropriately certified water treatment or distribution operator. A lack of adequately trained water treatment or distribution operators may be indicative of larger technical and managerial risks borne by the system. Research shows that poorly trained staff and managers working on water systems can result in avoidable waterborne disease outbreaks. Chief and shift operators must possess valid operator certificates pursuant to CCR sections 63765 and 63770.

Calculation Methodology

Required Risk Indicator Data Point & Source:

- Operator Certification Violations: SDWIS Violation Codes:
  - 12
  - OP

Risk Indicator Methodology:

- Determine which systems have had an Operator Certification Violation within the last three years.
  - Systems that are currently out of compliance or have returned to compliance are included.

Threshold Determination

Peer-reviewed studies suggest that the absence of a certified operator is associated with water

system failure.[111] Moreover, operator certification violations are an established threshold for additional regulatory oversight by states, such as Illinois.[112] Therefore, a threshold of 1 or more operator certification violations over the last three years was determined.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 3 is applied to the "Operator Certification Violations" risk indicator. Therefore, the minimum risk score is 0 and the maximum risk score is 3. Table A42 summarizes the thresholds, scores, and weight for this risk indicator.

Table A42: "Operator Certification Violations" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**0** Operator Certification violations over the last three years.	0	N/A	0	None
1	**1 or more** Operator Certification violations over the last three years.	1	3	3	High

Explore Water System Risk Indicator Performance

The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Operator Certification Violations: https://tabsoft.co/3lnVpeS

MONITORING & REPORTING VIOLATIONS

A water system is required to monitor and verify that the levels of contaminants present in the drinking water supplies do not exceed an MCL. A monitoring violation occurs when a water system fails to have its water tested as required within the legally prescribed time frame. A water system that fails to perform required monitoring for a group of chemicals (such as synthetic organic chemicals or volatile organic chemicals) would incur a monitoring violation for each of the individual chemicals within the group.

[111] See Oxenford, J. L., & Barrett, J. M. (2016). Understanding small water system violations and deficiencies. *Journal-American Water Works Association, 108*(3), 31-37.

[112] Office of the Illinois State Fire Marshal (2012.). "Notification of New NOV for Operator Certification Violations." Retrieved from: https://www2.illinois.gov/sites/sfm/SFMDocuments/Documents/NoticeRedTagOperators.pdf

A reporting violation occurs when a water system fails to report test results in a timely manner to the regulatory agency or fails to provide certification that mandated information was provided to the public, such as through the issuance of a public notice or the annual Consumer Confidence Report. A system may also receive a reporting violation for not submitting an Annual Report the State Water Board.

This indicator measures the total number of monitoring and reporting violations during a 3-year compliance cycle.

Calculation Methodology
Required Risk Indicator Data Point & Source:

- Monitoring and Reporting violations: SDWIS

Table A43: Monitoring & Reporting Violation Codes

Violation Type Code	SDWIS Violation Name
03	Monitoring, Regular
04	Monitoring, check, repeat, or confirmation
19	Failure to Conduct Assessment Monitoring
23	Monitoring, Routine Major (TCR)
24	Monitoring, Routine Minor (TCR)
25	Monitoring, Repeat Major (TCR)
26	Monitoring, Repeat Minor (TCR)
27	Monitoring, Routine (DBP)
29	Failure Submit Filter Profile/CPE Report
30	Monitoring, Routine (IDSE)
31	Monitoring of Treatment (SWTR-Unfilt/GWR)
32	Monitoring, Source Water (LT2)
34	Monitoring, Source Water (GWR)
35	Failure Submit IDSE/Subpart V Plan Rpt
36	Monitoring of Treatment (SWTR-Filter)
38	Monitoring, Turbidity (Enhanced SWTR)
39	Monitoring and Reporting (FBRR)
51	Initial Tap Sampling for Pb and CU
52	Follow-Up or Routine LCR Tap M/R
53	Water Quality Parameter M/R
56	Initial, Follow-Up, or Routine SOWT M/R
66	Lead Consumer Notification
3A	Routine Monitoring
3B	Additional Routine Monitoring

Violation Type Code	SDWIS Violation Name
3C	TC Samples (triggered by turbidity exceedance) Monitoring
3D	Monitoring, Lab Cert/Method Errors
4A	Assessment Forms Reporting
4B	Sample Result/Fail to Monitor Reporting
4C	Start-up Procedures Certification Form Reporting
4D	EC+ Notification Reporting
4E	*E. coli* MCL Reporting
4F	L1/L2 TT Vio or Correct Action Reporting
S1	State Violation-M&R (Major)
AR	Failure to Complete an Annual Report
RR	State Reporting Requirement Violation

Risk Indicator Methodology:

- Determine which systems have had Monitoring & Reporting violations over the last 3-year compliance period using the Monitoring & Reporting violation codes in Table A43. This excludes MCL and TT related Monitoring & Reporting violations described below that are included in the expanded Failing list criteria:
  - Systems that have three or more Monitoring and Reporting violations within the last three years where at least one violation has an Enforcement Action that has been open for 15 months or greater.

Threshold Determination
The State Water Board has developed a threshold for Monitoring & Reporting violations (related to an MCL or Treatment Technique) as criteria for the Failing list. The Failing list criteria threshold is three or more MCL/TT-related Monitoring & Reporting violations within the last three years where at least one violation has an open enforcement action greater than 15 months. For the Risk Assessment, the State Water Board developed a slightly modified version of the Failing list criteria threshold. Systems that have had two or more Monitoring & Reporting violations over the last three years are more at-risk.[113]

Risk Indicator Scoring & Weighting
To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more “critical” as they relate to a water system’s ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board’s engineers, the maximum weight of 2 is applied to the “Monitoring and Reporting Violations” risk indicator.

[113] Systems that meet the Failing list criteria are not included in the Risk Assessment results.

Therefore, the minimum risk score is 0 and the maximum risk score is 2. Table A44 summarizes the thresholds, scores, and weight for this risk indicator.

Table A44: "Monitoring and Reporting Violations" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**1 or less** Monitoring & Reporting violations over the last three years.	0	N/A	0	None
1	**2 or more** Monitoring & Reporting violations over the last three years.	1	2	2	High

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Monitoring and Reporting Violations: https://tabsoft.co/3Jum2XD

SIGNIFICANT DEFICIENCIES

Significant Deficiencies are identified by State Water Board staff or a Local Primacy Agency (LPA) during a Sanitary Survey and other water system inspections. Significant Deficiencies include, but are not limited to, defects in the design, operation, or maintenance, or a failure or malfunction of the sources, treatment, storage, or distribution system that U.S. EPA determines to be causing or have the potential for causing the introduction of contamination into the water delivered to consumers. Significant Deficiencies can be identified for both groundwater and surface water systems, although the compliance deadlines and requirements differ depending on the applicable rule (Groundwater Rule vs. Long Term 2 Enhanced Surface Water Treatment [LT2] Rule).

State Water Board and LPA staff must enter these deficiencies into SDWIS and must follow-up on the addressing actions taken by the water system to correct the deficiencies. The State Water Board and LPA must provide written notification of a Significant Deficiency within 30 days and require the water system to respond within 30 days with a corrective action plan. Scheduled return to compliance dates should be noted in the plan and approved by the State Water Board or LPA. The water system must implement the appropriate corrective action within 120 days of notification or be in compliance with a State-approved plan for correcting the deficiency at the end of the same 120-day period. The State Water Board and LPAs must then confirm that the deficiency has been addressed within 30 days after the scheduled date of correction.

A water system can incur a violation for failing to respond to or correct a Significant Deficiency (Title 22 CCR § 64430 and 40 CFR § 141.404 (s) for systems subject to the Groundwater

Rule, or Title 22 CCR § 64650(f) and 40 CFR § 141.723 having for systems subject to LT2 Rule). The State Water Board and LPAs may take additional enforcement action as necessary to correct the deficiency.

Calculation Methodology
Required Risk Indicator Data Point & Source:

- Significant Deficiencies: Table in SDWIS with a SIG (Significant) severity designation.

Risk Indicator Calculation Methodology:

- Determine which systems have had a Significant Deficiency **within the last three years** using the visit date in SDWIS (date the State Water Board became aware of the Significant Deficiency).
  - Systems that are currently out of compliance or have returned to compliance are included.

Threshold Determination
As described above, the presence of Significant Deficiencies has already been defined as a threshold for State Water Board action. Moreover, peer-reviewed studies suggest that the presence of Significant Deficiencies is associated with water system failure.[114] Finally, similar measures of significant deficiencies are used as an established threshold of concern by states such as Alaska and Nevada,[115] Connecticut,[116] and New Mexico,[117] among others. Therefore, the threshold of one or more Significant Deficiencies within the last three years has been determined to be an appropriate threshold for risk.

Risk Indicator Scoring & Weighting
To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Public feedback during the Risk Assessment methodology development process indicated that some risk indicators should be weighted higher than others because they may be more "critical" as they relate to a water system's ability to stay in compliance. Risk indicator weights between 1 and 3 were applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the maximum weight of 3 is applied to the "Significant Deficiencies" risk indicator. Therefore, the

[114] See Oxenford, J. L., & Barrett, J. M. (2016). Understanding small water system violations and deficiencies. Journal-American Water Works Association, 108(3), 31-37.
[115] State Strategies to Assist Public Water Systems in Acquiring and Maintaining Technical, Managerial, and Financial Capacity." Retrieved from: https://books.google.com/books?id=MK64VtYz-SsC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
[116] Systems that meet the Failing list criteria will not be included in the Risk Assessment. McPhee, Eric (n.d.). "Significant Deficiencies." Connecticut Department of Public Health: Drinking Water Division. Retrieved from: https://portal.ct.gov/-/media/Departments-and-Agencies/DPH/dph/drinking_water/pdf/CTAWWAGWRTraining2009SigDefpdf.pdf?la=en
[117] New Mexico Environment Department: Drinking Water Bureau (2016). "Surface Water Rule and Interim Enhanced Surface Water Treatment Rule: Significant Deficiency Policy." Retrieved from: https://www.env.nm.gov/wp-content/uploads/sites/5/2018/11/RE_Surface-Water-Rule-Significant-Deficiency_Policy_020816.pdf

minimum risk score is 0 and the maximum risk score is 3. Table A45 summarizes the thresholds, scores, and weight for this risk indicator.

Table A45: "Significant Deficiencies" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
0	**0** Significant Deficiencies over the last three years.	0	N/A	0	None
1	**1 or more** Significant Deficiencies over the last three years.	1	3	3	High

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Significant Deficiencies: https://tabsoft.co/42x7RJS

OPERATING RATIO

Operating Ratio is a measure of whether a water system's revenues are sufficient to cover the costs of operating the water system. Specifically, "Operating Ratio" is a ratio of the water system's annual revenues compared to annual operating expenses. To be self-supporting, a water system should have at least as much annual revenue as it has operating expenses, e.g., an operating ratio equal to or greater than 1.0. The operating ratio does not include planned investments in future years. Therefore, a water system should collect revenues greater than expenses to accommodate for future investments by building up their financial reserves.

> **Annual Revenue:** includes total annual revenues generated from customer charges and fees (meter fees, base service charges, fixed charges, late fees, penalties, shutoff fees, reconnection fees, etc.); intergovernmental fund transfers (i.e., city or county tax revenues etc.); revenues generated through rent, land lease, or other revenue-generating activities.
>
> **Operations and Maintenance Expenses:** expenses incurred during the system's normal operation during the reporting year. It may include salaries, benefits for employees, utility bills, system repair and maintenance, supplies (e.g., treatment chemicals), insurance, water purchased for resale, etc.

Calculation Methodology
Required Risk Indicator Data Points & Sources:

- Electronic Annual Report, Total Annual Revenue – Section 8B1.8

- Total Annual Revenue for the Reporting Year = Residential Water Rate Revenue (B1.1) + Non-Residential Water Rate Revenue (B1.2) + Residential Fees and Charges Revenue (B1.3) + Non-Residential Fees and Charges Revenue (B1.4) + Interfund or Governmental Revenue (B1.5.2) – Interfund or Government Revenue Lost (B1.6) + Other Revenue (B1.7)
- Electronic Annual Report, Total Annual Operating Costs – Section 8B2.1

Risk Indicator Calculation Methodology:

Equation A4: Operating Ratio

$$\frac{Annual\ Revenue\ (\$)}{Annual\ Operating\ Expenses\ (\$)}$$

Threshold Determination

The threshold for this risk indicator was developed through an analysis of industry, academic, and state publications (Table A46). Feedback was also solicited from the Division of Drinking Water's internal stakeholder group. Many have suggested that a viable water system should have a current ratio of at least 1 or greater. An operating ratio of 1 is the lowest level for a self-supporting water system. A ratio below one means expenses are higher than revenues. If a water system has outstanding debt, an operating ratio above one is required. Usually, the higher the debt/equity ratio, the higher the operating ratio required.

Table A46: Industry Recommended Operating Ratio

Organization	Recommended Operating Ratio	Resources
Community Resource Group, Inc.	1	Small System Guide: Understanding Utility Financial Statements[118]
University of North Carolina Environmental Finance Center	≥ 1.2	California Small Water Systems Rates Dashboard[119]
Rural Community Assistance Partnership (RCAP)	≥ 1	Financial Management Guide[120]
University of Georgia	≥ 1.2	Evaluating Water System Financial Performance and Financing Options[121]

[118] See Small System Guide: Understanding Utility Financial Statements (2011). Community Resource Group, Inc. https://www.in.gov/iurc/files/small_system_guide_to_understanding_financial_statments.pdf
[119] See California Small Water Systems Rates Dashboard (2021). Environmental Finance Center at the University of North Carolina, Chapel Hill. https://dashboards.efc.sog.unc.edu/ca
[120] The Basics of Financial Management for Small-community Utilities http://www.rcapsolutions.org/wp-content/uploads/2013/06/RCAP-Financial-Management-Guide.pdf
[121] See Jeffrey L. Jordan. Issue 3: Evaluating Water System Financial Performance and Financing Options. University of Georgia Department of Agricultural & Applied Economics. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.195.4657&rep=rep1&type=pdf

Organization	Recommended Operating Ratio	Resources
Brookings	> 1	Appendix B: Investing in water: Comparing utility finances and economic concerns across U.S. cities[122]
Arizona Department of Environmental Quality	≥ 1	Capacity Development Application for a New Public Water System[123]
State of Florida Public Service Commission	≥ 1.25	Docket No. 20 180141-WS - Proposed adoption of Rule 25-30.4575, F.A.C., Operating Ratio Methodology[124]

Based on the industry standards summarized above, the State Water Board adopted a binary threshold for "Operating Ratio" as summarized in Table A47.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the minimum weight of 1 is suggested for the "Operating Ratio" risk indicator due to data quality concerns. Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 1. Table A47 summarizes the thresholds, score, and weights for Operating Ratio.

Table A47: "Operating Ratio" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A*	**Systems serving military bases; non-transient non-community systems that are K-12 schools**	0	N/A	0	None
0	**1 or greater**	0	N/A	0	None
1	**Less than 1**	1	1	1	High
*Missing***	**No data available due to non-reporting**	"--"	N/A	"--"	Unknown

[122] See Joseph W. Kane (2016). Investing in water: Comparing utility finances and economic concerns across U.S. cities. Brookings. https://www.brookings.edu/research/investing-in-water-comparing-utility-finances-and-economic-concerns-across-u-s-cities/

[123] See Capacity Development Application for a New Public Water System. Arizona Department of Environmental Quality. https://legacy.azdeq.gov/environ/water/dw/download/appe.pdf

[124] See Office of the General Counsel (Harper), Division of Accounting and Finance (Galloway), Division of Economics (Guffey) (2018). Docket No. 20 180141-WS - Proposed adoption of Rule 25-30.4575, F.A.C., Operating Ratio Methodology. State of Florida Public Service Commission http://www.psc.state.fl.us/library/filings/2018/06300-2018/06300-2018.pdf

** Water systems serving military bases were excluded from the Risk Assessment's financial indicators. Non-transient non-community systems that are K-12 schools were excluded because they were not required to report the necessary data for this indicator.*
*** A water system may be missing necessary data for this indicator due to eAR non-reporting.*

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Operating Ratio: https://tabsoft.co/3JCl4Zk

TOTAL ANNUAL INCOME

The purpose of this risk indicator is to identify water systems whose total annual revenue is unable to cover their total annual expenses. A water system should generate enough revenue to cover all incurred expenses (including operational expenses) throughout the year. Total Net Annual Income of a water system should be a positive (+) value. If more money is spent than is brought in, then the water system will have to make adjustments in order to maintain operations. If the expenditures are outpacing revenue too quickly, then the water system may have to cut costs or decrease its level of service. Reserves or available cash savings allow for a financial cushion in times when expenses are greater than revenues.

A water system may generate enough revenue to cover their annual operating and maintenance costs (operating ratio = 1 or greater), but in some cases revenues may fall short in covering a water system's total annual expenses. These additional expenses that fall outside of general operating and maintenance costs typically include debt/loan repayments, new/upgraded infrastructure investments, unforeseen emergency costs, etc.

Calculation Methodology
Required Risk Indicator Data Points & Sources:

- Electronic Annual Report, Total Annual Revenue - 8B1.8
- Electronic Annual Report, Total Annual Expenses - 8B2.5

Risk Indicator Calculation Methodology:

Equation A5: Total Annual Income

$$\boldsymbol{Total\ Annual\ Income = Total\ Annual\ Revenue - Total\ Annual\ Expenses}$$

Threshold Determination
Water systems may have emergencies they must respond to or a large capital investment that occurs within a year which may lead to negative total annual income. Based on industry

standards and recommendations by State Water Board engineers, the tiered thresholds in Table A48 were developed for Total Annual Income.

Risk Indicator Scoring & Weighting
To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on feedback from the State Water Board's engineers, the minimum weight of 1 is suggested for the "Total Annual Income" risk indicator due to data quality concerns. Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 1. Table A48 summarizes the thresholds, score, and weights for Total Annual Income.

Table A48: "Total Annual Income" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A*	**Systems serving military bases; non-transient non-community systems that are K-12 schools**	0	N/A	0	None
0	**Greater than $0** total annual income	0	N/A	0	None
1	**$0** total annual income	0.5	1	0.5	Medium
2	**Less than $0** total annual income	1	1	1	High
*Missing***	**No data available due to nonreporting**	"--"	N/A	"--"	Unknown

** Water systems serving military bases were excluded from the Risk Assessment's financial indicators. Non-transient non-community systems that are K-12 schools were excluded because they were not required to report the necessary data for this indicator.*

*** A water system may be missing necessary data for this indicator due to eAR non-reporting.*

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Total Annual Income: https://tabsoft.co/3YXvyI8

DAYS CASH ON HAND

Days cash on hand is the estimated number of days a water system can cover its daily operations and maintenance costs, relying only on their current cash or liquid reserves, before running out of cash. This metric measures a system's financial capacity and is an estimate of how long a system can operate *without* new revenues or additional funding. It is a helpful measure of how long a system can operate if it has a sudden and dramatic reduction in

operating income, perhaps from a large customer leaving or an environmental emergency (fire, drought restrictions, etc.).[125]

According to Moody's definition, "Cash is the most important resource utilities have to meet expenses, deal with emergencies, and survive temporary disruptions to cash flow without missing required payments."[126] Days cash on hand is a ratio that is calculated by dividing a water system's unrestricted cash by the system's estimated daily expenses. This calculation approach allows for the comparison of water systems of different sizes by accounting for differences in operational expenses (Table A49). The higher the number, the more days an organization can sustain its operations without any additional cash inflows.

Table A49: Comparison Example Between Large and Small Water System

Large Water System	Small Water System
$\frac{Unrestricted\ Cash: \$\mathbf{5,000,000}}{Average\ Daily\ Operation\ Expenses: \$\mathbf{100,000}}$	$\frac{Unrestricted\ Cash: \$\mathbf{20,000}}{Average\ Daily\ Operation\ Expenses: \$\mathbf{400}}$
Days Cash on Hand = **50 Days**	Days Cash on Hand = **50 Days**

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- Electronic Annual Report, Section 8B.10

Risk Indicator Calculation Methodology:

- Risk indicator calculation formula (water system calculated and reported in the electronic Annual Report):
  - Calculate water system's **daily operating expenses**: [Annual Operating Expenses] / [365]
  - Calculate **days cash on hand**: [Total Unrestricted Cash] / [Daily Operating Expenses]

Equation A6: Days Cash on Hand

$$\frac{Unrestricted\ Cash\ (\$)}{Daily\ Operating\ Expenses\ (\$)}$$

Threshold Determination

The thresholds for the "Days Cash on Hand" risk indicator were developed by assessing peer-

[125] See Glenn Barnes (2015). Key Financial Indicators for Water and Wastewater Systems: Days of Cash on Hand. Environmental Finance Center at the University of North Carolina. https://efc.web.unc.edu/2015/06/24/days-cash-on-hand/

[126] See Edward Damutz, Leonard Jones, (2017). Moody's Utility Revenue Bond Rating Methodology. Moody's Investors Services. https://www.moodys.com/research/Moodys-updates-its-methodology-for-rating-US-municipal-utility-revenue--PR_373942

reviewed publications and soliciting feedback from the State Water Board's Division of Drinking Water internal stakeholder group. Table A50 and
Table A51 summarize recommendations made by industry groups and rating agencies for minimum days cash on hand.

Table A50: Industry Recommended Days Cash on Hand

Organization	Recommended Days Cash on Hand	Resources
University of North Carolina Environmental Finance Center	90+ days	California Small Water Systems Rates Dashboard[127]
Utility Financial Solutions, LLC	90+ days; Higher bond rating 200+ days	Managing Your Community's Stimulus Money[128]
International City/County Management Association (ICMA)	30 - 60 days	Capital Budgeting and Finance: A Guide for Local Governments[129]
Government Finance Officers Association	45+ days	Overview of GFOA's Best Practices in Budgeting[130]
American Water Works Association	270 - 365 days	Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector[131]

Table A51: Financial Scoring Criteria for Major Rating Agencies

Moody's[132]					
Aaa	**Aa**	**A**	**Baa**	**Ba**	**B & Below**
> 250 days	250 ≥ n > 150 days	250 ≥ n > 150 days	150 ≥ n > 35 days	35 ≥ n > 15 days	≤ 7 days

[127] See California Small Water Systems Rates Dashboard (2021). Environmental Finance Center at the University of North Carolina, Chapel Hill. https://dashboards.efc.sog.unc.edu/ca

[128] See Sally Duffy, P.E., Ian Robinson, Dawn Lund (2021). Managing Your Community's Stimulus Money. MI - AWWA, MWEA, and MRWA. https://cdn.ymaws.com/www.mi-water.org/resource/resmgr/docs/Managing_Stimulus_webinar_07.pdf

[129] See Robert L. (Bob) Bland, Michael R. Overton, (2019). A Budgeting Guide for Local Government, Fourth Edition. ICMA. https://icma.org/publications/budgeting-guide-local-government-fourth-edition

[130] See John Fishbein (2019). Overview of GFOA's Best Practices in Budgeting. Technical Services Center, Government Finance Officers Association (GFOA). https://nesgfoa.org/wp-content/uploads/2019/05/overview_of_gfoas_best_practices_in_budgeting_april_4_2019.pdf

[131] See R. Raucher, E. Rothstein, J. Mastracchio (2017): Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector. The American Water Works Association (AWWA). https://www.awwa.org/Portals/0/AWWA/Government/DevelopingNewFrameworkForAffordabilityReport.pdf

[132] See Moody's Investors Service, US Municipal Utility Revenue Debt. October 19, 2017. https://www.moodys.com/researchdocumentcontentpage.aspx?docid=PBM_1095545

S&P Global[133]					
1: Extremely Strong	2: Very Strong	3: Strong	4: Adequate	5: Vulnerable	6: Highly Vulnerable
> 150 days	150 ≥ n > 90 days	90 ≥ n > 60 days	60 ≥ n > 30 days	15 ≥ n > 30 days	≤ 15 days

Fitch[134] Liquidity Cushion		
Stronger	Neutral	Weaker
> 120 days	120 ≥ n > 90 days	< 90 days

Based on the industry standards summarized above, the State Water Board developed a tiered threshold for "Days Cash on Hand" as summarized in Table A52.

Risk Indicator Scoring & Weighting

To enable the evaluation and comparison of risk indicators, a standardized scale between 0 and 1 for risk scores has been applied to each threshold. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on feedback from the State Water Board's Division of Drinking Water internal stakeholder group, the minimum weight of 1 is suggested for the "Days Cash on Hand" risk indicator. Table A52 summarizes the thresholds, score, and weights for Days Cash on Hand.

Table A52: "Days Cash on Hand" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A*	**Systems serving military bases; non-transient non-community systems that are K-12 schools**	0	N/A	0	None
0	**90 days or more** cash on hand.	0	N/A	0	None
1	**Less than 90 days** cash on hand.	0.5	1	0.5	Medium
2	**Less than 30 days** cash on hand.	1	1	1	High
*Missing***	**No data available due to non-reporting**	"--"	N/A	"--"	Unknown

** Water systems serving military bases were excluded from the Risk Assessment's financial indicators. Non-transient non-community systems that are K-12 schools were excluded because they were not required to report the necessary data for this indicator.*

[133] S&P Global, Criteria | Governments | U.S. Public Finance: U.S. Public Finance Waterworks, Sanitary Sewer, And Drainage Utility Systems: Rating Methodology and Assumptions. January 19, 2016; last update October 11, 2021; Accessed December 30, 2021 at https://disclosure.spglobal.com/ratings/en/regulatory/article/-/view/type/HTML/id/2735324

[134] Fitch Ratings, U.S. Water and Sewer Rating Criteria, March 18, 2021. https://www.fitchratings.com/research/us-public-finance/us-water-sewer-rating-criteria-18-03-2021

*** A water system may be missing necessary data for this indicator due to eAR non-reporting.*

Explore Water System Risk Indicator Performance
The distribution of how water systems have performed for this risk indicator is accessible using the hyperlink below. The results can be filtered by water system size (i.e., number of service connections).

Day Cash on Hand: https://tabsoft.co/3JpuOG3