2023

DRINKING WATER

NEEDS ASSESSMENT

RISK ASSESSMENT RESULTS FOR STATE SMALL WATER SYSTEMS & DOMESTIC WELLS

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

Contributors

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RISK ASSESSMENT RESULTS FOR STATE SMALL WATER SYSTEMS & DOMESTIC WELLS

OVERVIEW

Figure 1: Categories of Risk

The Risk Assessment methodology developed for state small water systems and domestic wells is focused on identifying areas where groundwater is at high-risk of containing contaminants that exceed safe drinking water standards, is at high-risk of water shortage, and where there is high socioeconomic risk. This information is presented as an online dashboard.[1] Water quality risk data is from the State Water Board's Aquifer Risk Map,[2] water shortage risk data is from the Department of Water Resources Water Shortage Vulnerability Tool for Self-Supplied Communities,[3] and socioeconomic risk data was developed by the Office of Environmental Health Hazard Assessment. Previous work is available on the State Water Board's Needs Assessment webpage.[4]

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[1] State Small Water System and Domestic Well Risk Assessment Dashboard
https://gispublic.waterboards.ca.gov/portal/apps/dashboards/4f7795ba4349464f9883827ad2e6b67a

[2] Aquifer Risk Map Webtool
https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=17825b2b791d4004b547d316af7ac5cb

[3] Drought and Water Shortage Risk for Self-Supplied Communities
https://tableau.cnra.ca.gov/t/DWR_IntegratedDataAnalysisBranch/views/DWRDroughtRiskExplorer-RuralCommunitesMarch2021/Dashboard?%3AshowAppBanner=false&%3Adisplay_count=n&%3AshowVizHome=n&%3Aorigin=viz_share_link&%3AisGuestRedirectFromVizportal=y&%3Aembed=y

[4] Drinking Water Needs Assessment Page
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/needs.html

RISK CATEGORY DATA

The State Water Board has limited water quality, water shortage, and location data for state small water systems and domestic wells, as these systems are not regulated by the state nor are maximum contaminant levels directly applicable to domestic wells.[5] Due to the lack of data from actual state small water systems and domestic wells, it is difficult to precisely determine the count of state small water systems and domestic wells that are At-Risk. To learn more, refer to data collection efforts from Counties in the 2022 Retrospective section of this report.

Water Quality
The risk analysis in the Water Quality category uses proxy groundwater quality data to identify areas where shallow groundwater quality may exceed primary drinking water standards. *These proxy data do not assess the compliance with state or federal water quality standards.* As a result, the presence of a given state small water system or domestic well within an "at-risk" area does not signify that they are known to be accessing groundwater with contaminants above drinking water standards.

Water Shortage
The risk analysis in the Water Shortage category, conducted by DWR, includes a suite of risk indicators that indicate where state small water systems and domestic wells may experience water shortage issues. The risk indicators utilize modeled data and observed data to assess for water shortage risk. As a result, the presence of a given state small water system or domestic well within an "at-risk" area does not signify that the well has gone dry or is experiencing water shortage issues.

NEW: Socioeconomic Risk
The socioeconomic risk is partially based on census data, which does not differentiate between state small water system and domestic well reliant communities. Therefore, the socioeconomic risk of an area may not represent the socioeconomic risk of individual homes or communities.

Physical monitoring and testing of state small water systems and individual domestic wells is needed to determine if those systems are unable to access safe drinking water. The State Water Board will continue to coordinate and support counties in their data collection, management, and sharing so that the Risk Assessment can improve its accuracy over time.

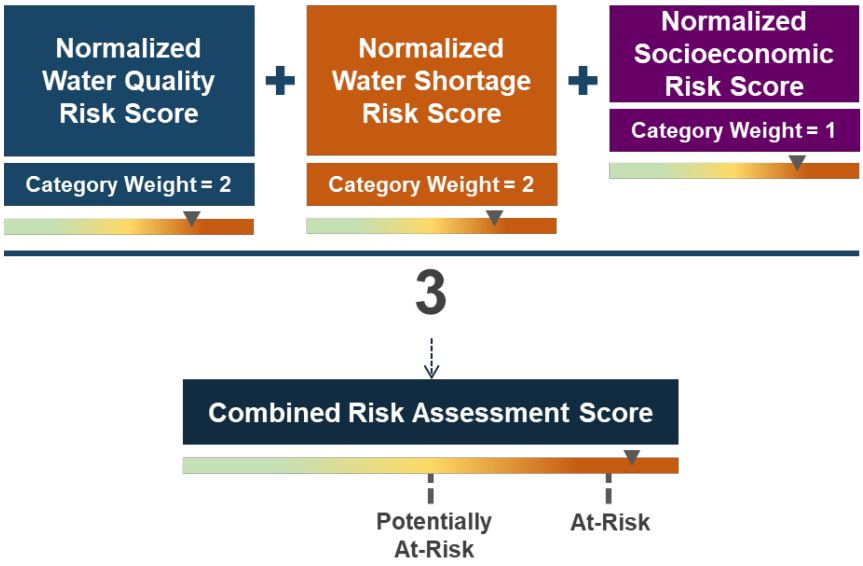
RISK ASSESSMENT METHODOLOGY

The three risk categories (water quality, water shortage, and socioeconomic risk) are combined following a similar methodology as the Risk Assessment for public water systems. Data from each category are normalized into four scores based on thresholds (Appendix B). The final combined risk score is calculated per square mile section. The score is calculated by multiplying the normalized category scores by the category weights, adding the weighted

[5] State small water systems are typically required to conduct minimal monitoring. If water quality exceeds an MCL, corrective action is required only if specified by the Local Health Officer. State small water systems provide an annual notification to customers indicating the water is not monitored to the same extent as public water systems.

scores for all three categories, and dividing by the number of categories with data. The final risk score is binned into three groups: “At-risk,” “Potentially At-Risk,” and “Not At-Risk.” Any area that serves a state small water systems or a domestic well with a high score in two or more categories is designated “At-Risk” and any area with a high score in either the water quality or water shortage categories is designated “At-Risk” or “Potentially At-Risk.”

Figure 2: Risk Assessment Methodology



The risk designation per square mile section is assigned to all state small water systems and domestic wells within that section. Location data for state small water systems were provided to the State Water Board through county reporting required through SB 200. Location data for domestic wells were sourced from the Online System for Well Completion Records[6] (managed by DWR) and consist of “domestic” type well records, excluding those drilled prior to 1970 and only including “New/Production or Monitoring/NA” completion record types. Combined risk scores are calculated for all areas of the state, but the risk assessment is only intended for areas with a state small water system or domestic well record. The online webtool includes a filter that only shows the risk scores for areas of the state with at least one domestic well or state small water system, although the data for all areas is available to download.

RISK ASSESSMENT RESULTS

Table 1 shows the approximate counts of state small water systems and domestic wells statewide located in different risk areas based on data from the 2023 Risk Assessment.

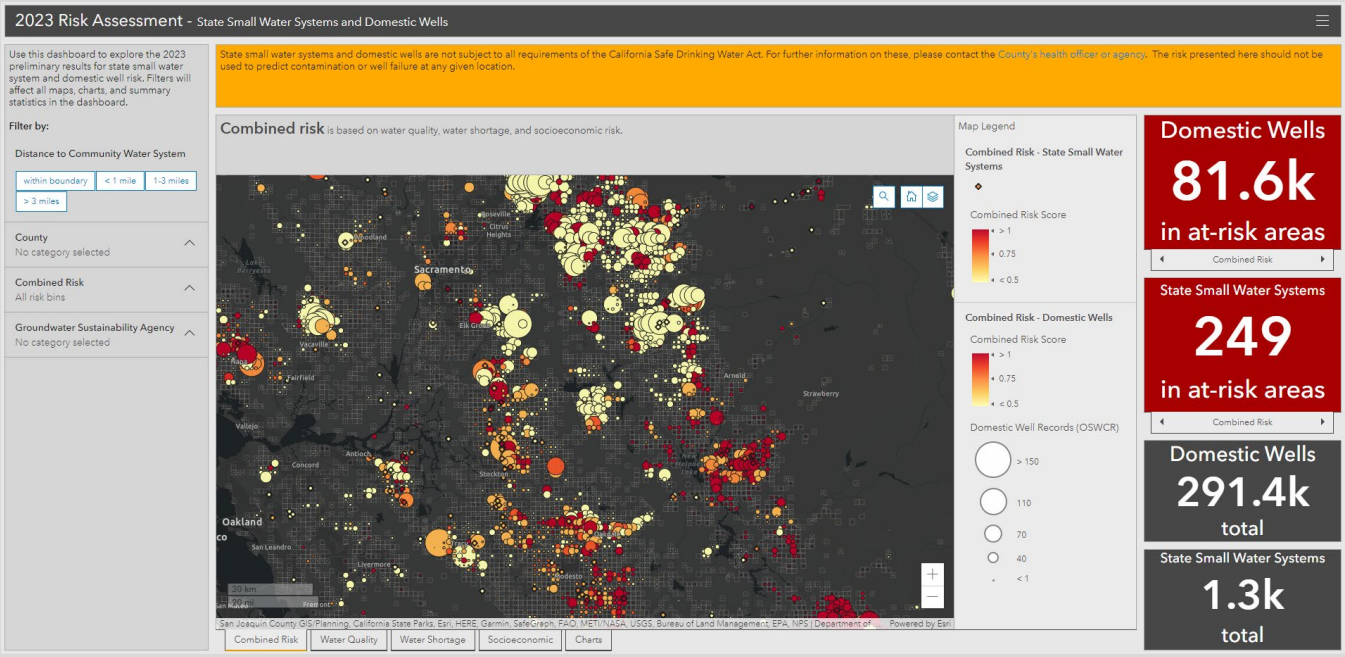
[6] Department of Water Resources OSWCR database https://services.arcgis.com/aa38u6OgfNoCkTJ6/arcgis/rest/services/i07_WellCompletionReports_Exported_v2_gdb/FeatureServer

Table 1: State Small Water System and Domestic Well Results (Statewide)

Systems	At-Risk	Potentially At-Risk	Not At-Risk
State Small Water Systems	245 (19%)	620 (48%)	432 (33%)
Domestic Wells	81,588 (28%)	103,986 (36%)	105,827 (36%)

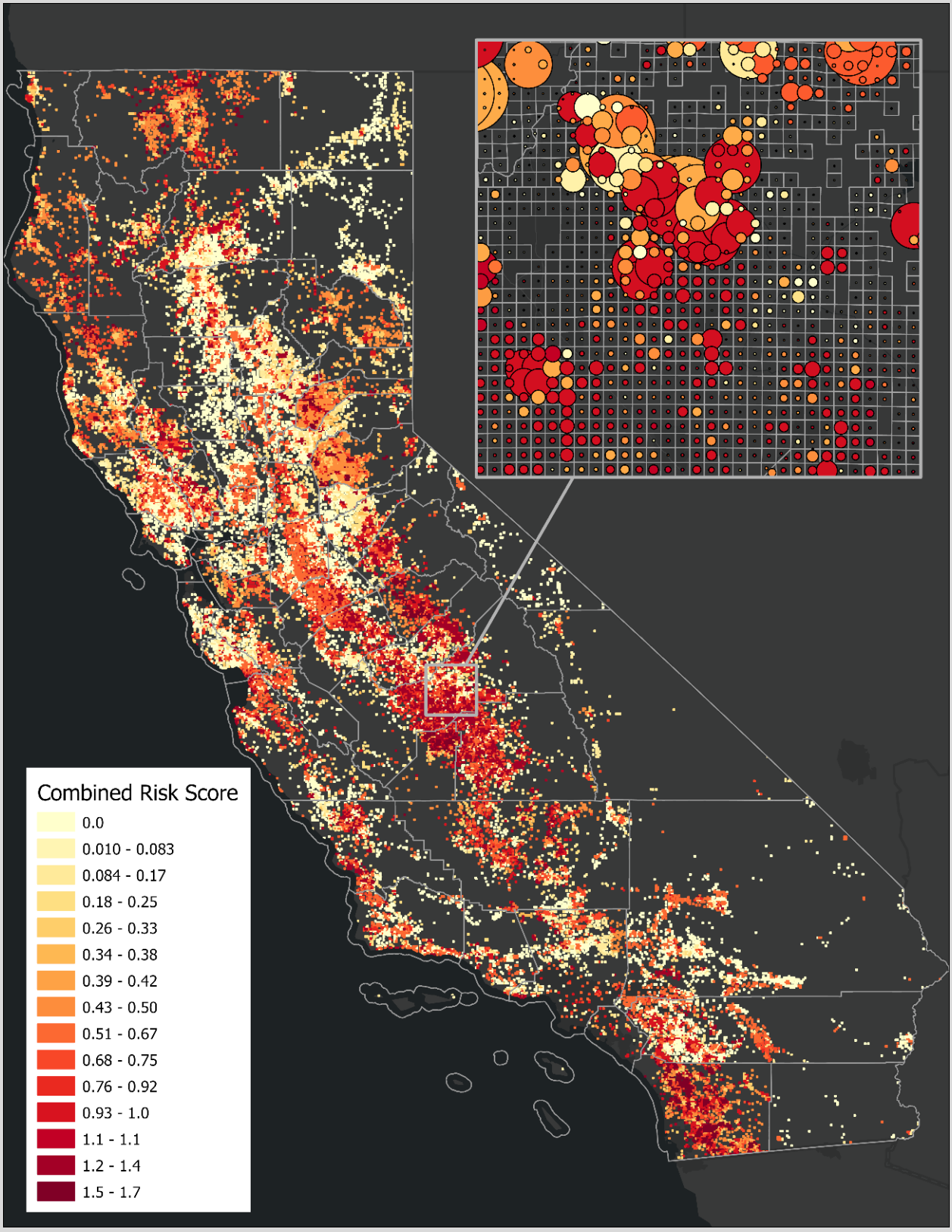
Figure 4 is a map that shows the combined risk for areas of the state with a state small water system or domestic well. To view this spatial data in more detail, and to see the state small water system and domestic well risk counts summarized by county please refer to the 2023 Risk Assessment – State Small Water System and Domestic Well Dashboard.[7]

Figure 3: Risk Assessment - State Small Water Systems and Domestic Well Dashboard



[7] State Small Water Systems & Domestic Wells Risk Assessment Dashboard
https://gispublic.waterboards.ca.gov/portal/apps/dashboards/4f7795ba4349464f9883827ad2e6b67a

Figure 4: Combined Risk for State Small Water Systems & Domestic Wells



COMBINED RISK ANALYSIS

Areas of highest combined risk are located in the Southern San Joaquin Valley, parts of the western Sierra Nevada foothills, and parts of San Diego County. The counties with the highest number of domestic wells in at-risk areas are Fresno, Nevada, San Diego, and Madera counties. The counties with the highest number of state small water systems in at-risk areas are Monterey, Tulare, Kern, and El Dorado counties.

Alluvial basins are less likely to contain at-risk domestic wells. For domestic wells in alluvial basins, 20% are at-risk while 36% of domestic wells outside of alluvial basins are at-risk. For state small water systems in alluvial basins, 14% are at-risk while 31% of state small water systems outside of alluvial basins are at-risk. This is likely due to the fact that although high water quality risk is associated with alluvial basins, both high water shortage risk and high socioeconomic risk are associated with areas outside alluvial basins.

Approximately 14,675 domestic wells (18% at-risk domestic wells) and 81 state small water systems (33% of at-risk state small water systems) are located within the boundary of a community water system. A further 26,579 domestic wells and 99 state small water systems are located within one mile of a community water system boundary.

Table 2: Distance of At-Risk Systems to Nearest Community Water System

Distance to Nearest Community Water System	At-Risk State Small Water Systems	At-Risk Domestic Wells
Within boundary	81 (33%)	14,675 (18%)[8]
< 1 mile	99 (40%)	26,579 (33%)
1 – 3 miles	39 (16%)	22,424 (27%)
> 3 miles	26 (11%)	17,910 (22%)

WATER QUALITY RISK ANALYSIS

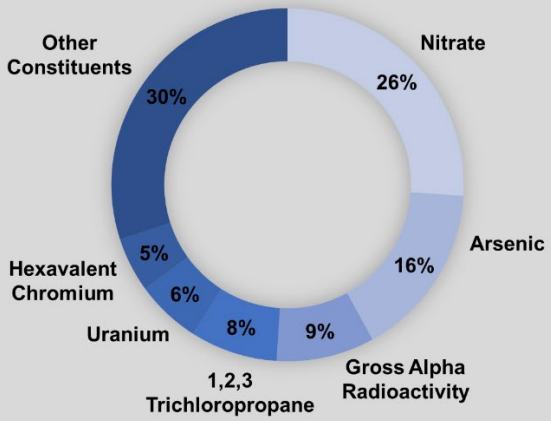
The Central Valley and the Salinas Valley contain the most areas at high water quality risk. The counties with the highest number of domestic wells in high water quality risk areas include Fresno, Sonoma, San Joaquin and Madera counties. The counties with the highest number of state small water systems in high water quality risk areas include Monterey, Kern, Riverside and Santa Clara counties.

Statewide, the top contaminants that contributed to higher risk designations in domestic wells and state small water systems are nitrate, arsenic, 1,2,3-trichloropropane, gross alpha, uranium, and hexavalent chromium. Figure 5 shows the proportion of domestic wells in high water quality risk areas where the contaminant may exceed drinking water standards. Note that multiple contaminants may exceed drinking water standards at a single location.

[8] Percentage represents the at-risk domestic wells that meet the distance criteria compared to the total number of at-risk domestic wells.

In comparison to water quality risk data from the previous year, the 2023 water quality risk results show that nitrate is contributing to a higher percentage of at-risk domestic wells than in 2022. This is likely due to nitrate water quality results from domestic wells collected during the 2022 calendar year under the Irrigated Lands Regulatory Program (ILRP). In 2022, over 600 ILRP domestic wells that had no water quality data prior to 2022 had nitrate results above the MCL.

Figure 5: Constituents Contributing to Shallow Water Quality Risk



WATER SHORTAGE RISK ANALYSIS

Areas of high-water shortage risk are concentrated in the Southern San Joaquin Valley, in the fractured rock areas of the western Sierra foothills, in parts of San Diego county and Northern California.

High water shortage risk areas are highly correlated with reported dry wells. Of the dry well reports[9] made to the Department of Water Resources within the past year, 85% are located within an area with high water shortage risk. 9% of reports are located within medium water shortage risk areas, and 6% of reports are located within low water shortage risk areas.

Nearly half of communities served by domestic wells with high water shortage risk are within the boundary of or within one mile of an existing community water system. Over two thirds of communities served by a state small water system with high water shortage risk are within the boundary of or within one mile or an existing community water system. Distance to existing community water systems is an important factor when considering water shortage risk because after a well has gone dry it can take a considerable amount of time for a long-term solution to be implemented.

[9] Households report well outages or issues to the Department of Water Resources https://mydrywatersupply.water.ca.gov/report/

Table 3: High Water Shortage Risk Areas Distance to a Nearby Community Water System

Distance to Nearest Community Water System	State Small Water Systems with High Water Shortage Risk	Domestic Wells with High Water Shortage Risk
Within boundary	62 (24%)	17,006 (17%)
< 1 mile	125 (48%)	32,435 (32%)
1 – 3 miles	48 (18%)	29,383 (29%)
> 3 miles	26 (10%)	22,579 (22%)

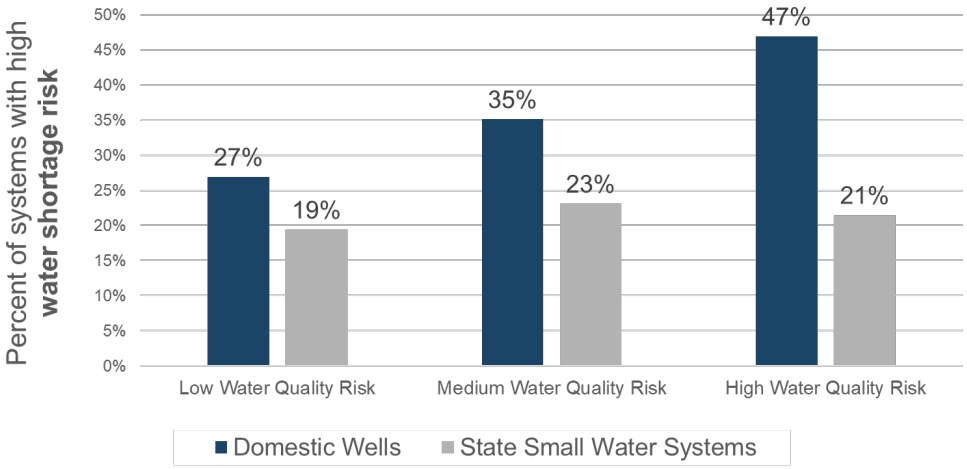
WATER QUALITY AND WATER SHORTAGE RISK ANALYSIS

There is some overlap between high water quality risk areas and high-water shortage risk areas, predominantly in the Southern San Joaquin Valley, in some upland (mountainous) areas of Madera and Fresno counties and in some upland areas of San Diego County. In other areas there is not as much overlap between high water quality risk and high-water shortage risk, with water shortage risk concentrated in upland, fractured rock areas and water quality risk concentrated in alluvial basins. Some examples of this separation between high water quality risk and high-water shortage risk areas are the Sacramento Valley, the Northern San Joaquin Valley, the Santa Rosa area and the Salinas Valley area.

In communities served by domestic wells there is however a positive correlation between increasing water quality risk and increased water shortage risk. Of domestic wells with low water quality risk only 27% have high water shortage risk. Of domestic wells with medium water quality risk, 35% have high water shortage risk, and of domestic wells with high water quality risk 47% also have high water shortage risk.

For communities served by state small water systems there is no correlation between high water quality risk and high-water shortage risk. For state small water systems with low water quality risk 19% have high water shortage risk, for state small water systems with medium water quality risk 23% have high water shortage risk, and for state small water systems with high water quality risk 21% have high water shortage risk.

Figure 6: Water Quality Risk Compared to Water Shortage Risk for Domestic Wells and State Small Water Systems



SOCIOECONOMIC RISK ANALYSIS

For socioeconomic scores assigned at the county level (testing type, testing impact, monitoring programs, administrative services, website quality, funding resources, replacement well cost and average number of wells per driller) higher average county scores do not always correlate with higher domestic well counts. The counties with the highest number of domestic wells (Fresno and Nevada counties) have extremely different county risk scores. Fresno county has one of the lowest county scores, while Nevada has among the highest. Some of the counties with the lowest number of domestic wells also have some of the highest county risk scores (Alameda, Humboldt, Contra Costa, Orange counties), while some counties with moderate numbers of domestic wells have very low county risk scores (San Joaquin, Tulare, San Bernardino).

The Central Valley does not have the highest overall socioeconomic risk scores, which could be because the county-level quality and administrative capacity indicator scores for the Central Valley are lower, indicating that many of these counties have more robust support for domestic wells than others. This lowers the overall socioeconomic risk scores in the Central Valley, even in areas with high census-level socioeconomic indicator scores. The areas with the highest socioeconomic risk scores are Nevada, Humboldt, San Diego, and Siskiyou counties.[10]

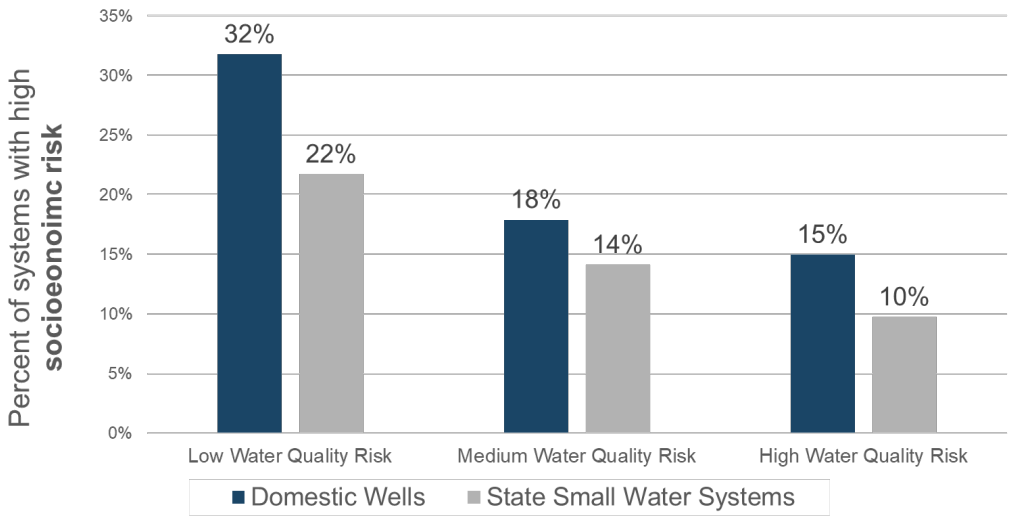
DAC/SDAC status does not appear to be associated with higher socioeconomic risk scores. The average socioeconomic risk score in DAC/SDAC areas is 0.7, compared with an average socioeconomic risk score in non-DAC/SDAC areas of 0.6. For areas with high socioeconomic risk, 36% are in DAC/SDAC areas and 64% are in non-DAC/SDAC areas. For areas with low socioeconomic risk, 27% of domestic wells are in DAC/SDAC areas and 73% are in non-DAC/SDAC areas.

[10] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

SOCIOECONOMIC AND WATER QUALITY RISK

Communities served by domestic wells and state small water systems with high water quality risk are less likely to have high socioeconomic risk as well. Of domestic wells with low water quality risk 32% have high socioeconomic risk, while of domestic wells with medium water quality risk 18% have high socioeconomic risk, and only 15% of high-water quality risk wells also have high socioeconomic risk (28% of domestic wells with unknown water quality risk have high socioeconomic risk). Of state small water systems with low water quality risk 22% have high socioeconomic risk, of state small water systems with medium water quality risk 14% have high socioeconomic risk, while only 10% of state small water systems with high water quality risk have high socioeconomic risk (26% of state small water systems with unknown water quality risk have high socioeconomic risk).

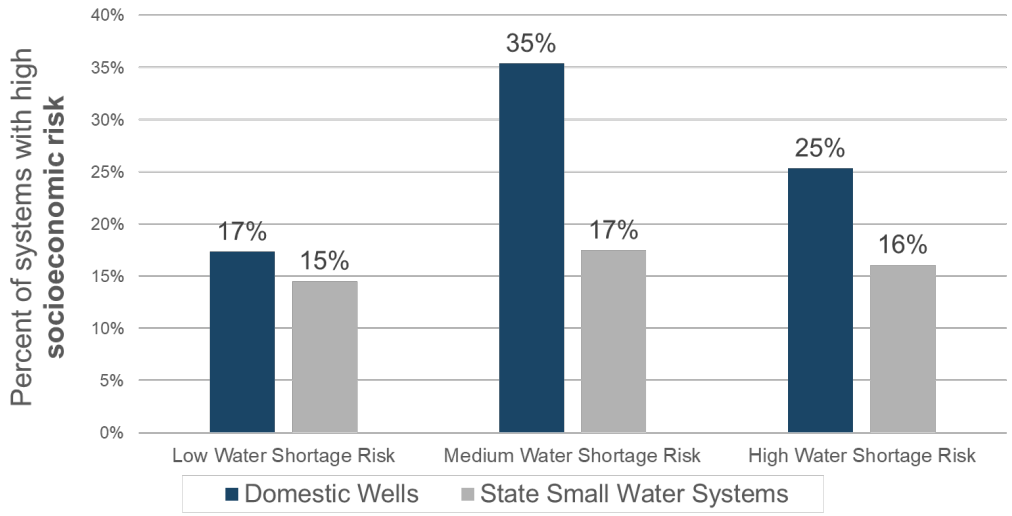
Figure 7: Water Quality Risk Compared to Socioeconomic Risk for Domestic Wells and State Small Water Systems



SOCIOECONOMIC AND WATER SHORTAGE RISK

For communities served by a domestic well or a state small water system there is no correlation between water shortage risk and socioeconomic risk. Of domestic wells with low water shortage risk 17% have high socioeconomic risk. Of domestic wells with medium water shortage risk 35% have high socioeconomic risk, and of domestic wells with high water shortage risk 25% have high socioeconomic risk. Of state small water systems with low water shortage risk 15% have high socioeconomic risk, of state small water systems with medium water shortage risk 17% have high socioeconomic risk, and for state small water systems with high water shortage risk 16% have high socioeconomic risk.

Figure 8: Water Shortage Risk Compared to Socioeconomic Risk for Domestic Wells and State Small Water Systems



DEMOGRAPHIC ANALYSIS OF AT-RISK STATE SMALL WATER SYSTEMS AND DOMESTIC WELL AREAS

Results for the 2023 Risk Assessment for state small water systems and domestic wells can be combined with demographic data to better understand the populations most at-risk for water shortage and water quality issues. However, there are several limitations to this demographic analysis. Demographic data is available 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 below may not represent the population served by state small water systems or domestic wells. 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) is from the 2021 American Community Survey. CalEnviroScreen 4.0 data is from OEHHA[11]. 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 demographic analysis for state small water systems was calculated by assigning census data to state small water systems using the census area overlying the point location of the state small water system. The demographic analysis for domestic wells was calculated by assigning census data to square mile sections using the census area overlying the section centroid, and using a weighted average to determine the average demographic information per risk bin.

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

When compared with not at-risk state small water systems areas, at-risk state small water system areas tend to have slightly higher CalEnviroScreen 4.0 scores, a slightly higher percentage of households in poverty, a lower percentage of limited English-speaking households, a similar household size, and are more likely to be in a DAC or SDAC area. State small water systems that are potentially at-risk are the most likely to be in a majority non-white census area.

Table 4: Demographic Analysis for Areas with Combined At-Risk State Small Water Systems[12]

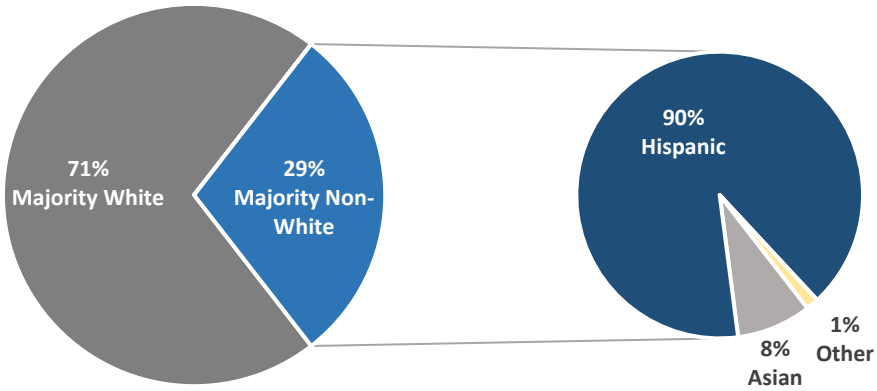
	Statewide (all areas)	Statewide (SSWS areas only)	Not At-Risk	Potentially At-Risk	At-Risk
Total Count of SSWS	**1,297**	**1,297**	**432**	**620**	**245**
Average CalEnviroScreen 4.0 Percentile	50.0	39.6	37.5	40.4	41.3
Average CalEnviroScreen 4.0 Population Characteristics Percentile	50.0	41.0	40.9	39.8	44.2
Average CalEnviroScreen 4.0 Pollution Burden Percentile	50.0	40.4	36.3	43.3	40.0
Average percentage of households 2x below federal poverty	28.2%	26.7%	26.3%	26.1%	29.3%
Average percentage of households with limited English speaking	8.6%	8.9%	7.1%	11.8%	4.8%
Average household size	2.9	2.8	2.7	3.0	2.7
Percent of SSWS in DAC/SDAC areas[13]	35.2% (457)	35.2% (457)	39.1% (169)	29.5% (183)	42.9% (105)

[12] The three CalEnviroscreen 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.

[13] 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).

	Statewide (all areas)	Statewide (SSWS areas only)	Not At-Risk	Potentially At-Risk	At-Risk
Percent of SSWS in majority non-white areas	42.7% (554)	42.7% (554)	30.3% (131)	56.8% (352)	29.0% (71)

Figure 9: Distribution of At-Risk State Small Water Systems by Majority Race/Ethnicity of Census Tract



When compared with not at-risk domestic well areas, at-risk domestic well areas tend to have higher CalEnviroScreen scores, a higher percentage of household poverty, a higher percentage of households with limited English speaking, larger household size, are more likely to be in a DAC or SDAC area and are more likely to be in a majority non-white census area.

Table 5: Demographic Analysis for Areas with Combined At-Risk Domestic Wells[14, 15]

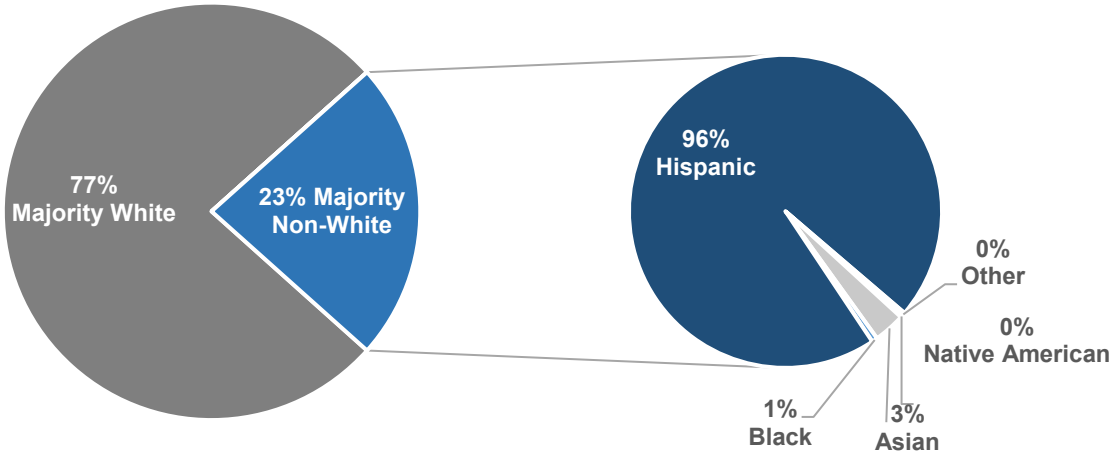
	Statewide (all areas)	Statewide (domestic well areas only)	Not At-Risk	Potentially At-Risk	At-Risk
Total Count of Domestic Wells	**291,401**	**291,401**	**105,827**	**103, 986**	**81,588**
Average CalEnviroScreen 4.0 Percentile	50.0	45.5	36.3	48.9	51.7
Average CalEnviroScreen 4.0 Population Characteristics Percentile	50.0	47.7	41.6	50.8	53.4
Average CalEnviroScreen 4.0 Pollution Burden Percentile	50.0	41.8	33.5	46.6	47.9
Average percentage of households 2x below federal poverty	28.2%	26.9%	23.9%	27.4%	31.4%
Average percentage of households with limited English speaking	8.6%	5.6%	4.1%	6.4%	6.8%

[14] CalEnviroScreen 4.0 data is available per census tract. Combined risk status for domestic wells is available per square mile section. To determine the CalEnviroScreen 4.0 percentile score average per combined risk category, each section was assigned the CalEnviroScreen 4.0 percentile score based on the tract that contains the centroid of the section. Some census tracts do not contain any section centroid and therefore do not contribute to the averages even if they overlap a section with a domestic well. The square mile sections are grouped by their combined risk status to determine the average score percentile using a weighted average approach. It is important to factor in the geographic relationship between tracts and sections. Without considering a weighting approach for averaging scores within each combined risk categories, scores of large census tracts would contribute more to the risk category average compared to small census tracts. For example, a tract with 600 sections contributes 600 of the same percentile scores while a tract with 20 sections only contributes 20 percentile scores. Instead, to reduce bias towards large rural areas, each section was assigned a weight of the inverse number of sections in the census tract. For example, a tract with 10 sections would be given a weight of 0.10. A one-way analysis of variance (ANOVA) showed a statistically significant difference in average scores between combined risk categories for CalEnviroScreen 4.0 percentile, Population Characteristics, Pollution Burden, Poverty, Average percentage of households with limited English speaking, and Household Size ($p<0.0001$).

[15] The three CalEnviroscreen 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)	Statewide (domestic well areas only)	Not At-Risk	Potentially At-Risk	At-Risk
Average household size	2.9	2.9	2.8	3.0	3.0
Percent of domestic wells in DAC/SDAC areas[16]	32.5% (94,579)	32.5% (94,579)	30.1% (31,937)	28.8% (29,936)	40.1% (32,706)
Percent of domestic wells in majority non-white areas	19.8%	19.8%	14.2%	22.9%	23.2%

Figure 10: Distribution of At-Risk Domestic Wells by Majority Race/Ethnicity of Census Tract



LIMITATIONS OF THE RISK ASSESSMENT FOR STATE SMALL WATER SYSTEMS & DOMESTIC WELLS

The state small water system and domestic well risk ranking developed using this methodology is not intended to depict actual groundwater quality conditions at any given domestic supply well or small water system location. The purpose of this risk map analysis is to prioritize areas that may not meet primary drinking water standards or have water shortage risk to inform additional investigation and sampling efforts. The current lack of available state small water system and domestic well water quality data makes it impossible to characterize the actual

[16] 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).

water quality for any individual state small water system or domestic well without directly testing them. The analysis described here thus represents a good faith effort at using readily available data to estimate water quality and water shortage risk for state small water systems and domestic wells.

REFINEMENT OPPORTUNITIES

Provisions under SB 200 require counties to provide location and any available water quality data for state small water systems and domestic wells. The State Water Board is assisting counties in complying with these provisions and is developing a new database to collect and validate this data as it is submitted.[17] Future iterations of the Aquifer Risk Map and Risk Assessment for state small water systems and domestic wells will incorporate the locational and water quality data collected through this effort.

[17] State Small Water System and Domestic Well Water Quality Data
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/small_water_system_quality_data.html

APPENDIX B:
RISK ASSESSMENT METHODOLOGY FOR STATE SMALL WATER SYSTEMS & DOMESTIC WELLS

INTRODUCTION

The 2021 Risk Assessment for state small water systems and domestic wells relied solely on modeled groundwater water quality risk to identify At-Risk communities. The 2021 Risk Assessment for *public water systems* used risk indicators beyond water quality, including accessibility, affordability, and technical, managerial, and financial capacity. In response to stakeholder feedback calling for a closer alignment of methodologies used for both Risk Assessments, the State Water Board worked in partnership with the Department of Water Resources (DWR) to develop a new combined Risk Assessment in 2022 with two risk categories; Water Quality which utilizes the State Water Board's Aquifer Risk Map[18] and Water Shortage which is based on analysis from DWR's Water Shortage Vulnerability Tool.[19] For the 2023 Risk Assessment, the State Water Board partnered with Office of Environmental Health Hazard Assessment (OEHHA) to develop a new Socioeconomic Risk category to include the Risk Assessment. This new category of risk aims to capture affordability, technical, and financial risk for communities served by state small water systems and domestic wells.

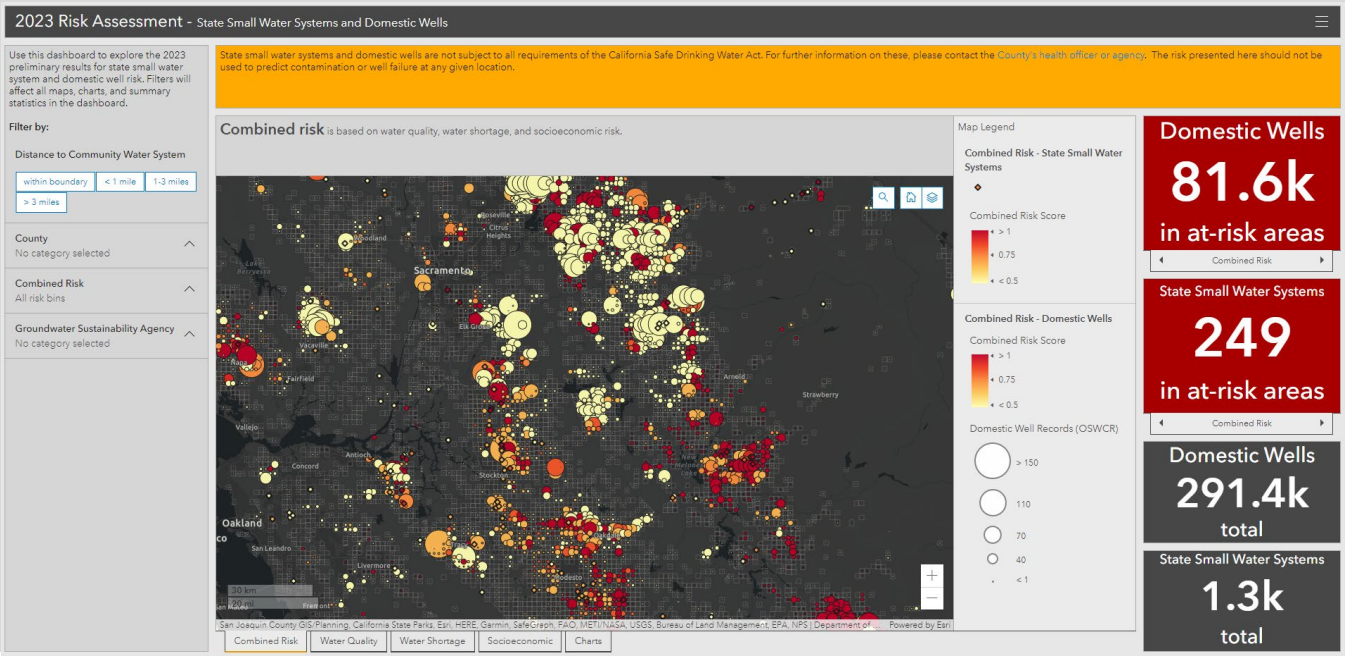
Figure B1: Risk Assessment Categories

[18] Aquifer Risk Map https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=17825b2b791d4004b547d316af7ac5cb

[19] https://water.ca.gov/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/County-Drought-Planning

As part of the 2023 Needs Assessment development, the State Water Board developed a new dashboard to display the results of the Risk Assessment for state small water systems and domestic wells. This dashboard is publicly available online and currently updated annually. Learn more about the Dashboard in Appendix F.

Figure B2: Risk Assessment – State Small Water System & Domestic Well Dashboard[20]



INTENDED USE OF THIS ANALYSIS

The risk rankings developed using this methodology are not intended to depict actual groundwater quality or quantity conditions at any given state small water system or domestic well location. The purpose of this risk map analysis is to prioritize areas that may not meet primary drinking water standards, may be at risk of water shortage, and/or may be experiencing affordability, technical, and financial risk to inform additional investigation and sampling efforts. The current lack of available state small water system and domestic well water quality data, water shortage data, and locational data makes it impossible to characterize the risk for individual state small water systems and domestic wells. The analysis described here thus represents a best effort at using the available data to estimate risk for state small water systems and domestic wells in a square mile section.

State small water systems and domestic wells are not subject to all requirements of the California Safe Drinking Water Act and are not regulated by the State Water Board. For further

[20] Risk Assessment Results for State Small Water Systems & Domestic Wells Dashboard
https://gispublic.waterboards.ca.gov/portal/apps/dashboards/4f7795ba4349464f9883827ad2e6b67a

information on local requirements for these systems, please contact the corresponding County's health officer or agency.

STATE SMALL WATER SYSTEMS & DOMESTIC WELLS ASSESSED

The 2023 combined Risk Assessment assessed 1,297 state small water systems and 291,401 known domestic wells. State small water system locations were provided to the State Water Board through county reporting required by SB 200. Domestic well locations were sourced from the Online System for Well Completion Records[21] (managed by DWR) and consist of "domestic" type well records, excluding those drilled prior to 1970 and only including" New" records.

RISK ASSESSMENT METHODOLOGY DEVELOPMENT PROCESS

The Risk Assessment methodology for state small water systems and domestic wells has been developed and refined through multiple stakeholder workshops since 2019:

2019 - 2021

The Aquifer Risk Map was developed from 2019-2020 with stakeholder feedback, including three public webinars held by the State Water Board over the course of 2020 to solicit feedback on the development of the aquifer risk map.[22] The Aquifer Risk Map work was influenced by previous work developing the Domestic Well Water Quality Tool, which provided an estimate of the number and location of domestic wells at-risk for water quality issues. Development of the Domestic Well Water Quality Tool involved a public workshop in 2019.[23]

2021 – 2022

For the 2022 Needs Assessment, a public webinar was held in October 2021 to solicit feedback on updates to the 2022 Aquifer Risk Map.[24] A public workshop was hosted on February 2, 2022 to present recommendations for a new Combined Risk Assessment

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[21] The Department of Water Resources Online System for Well Completion Reports (OSWCR) https://data.ca.gov/dataset/well-completion-reports

[22] April 17, 2020 SAFER Webinar: Methods for Determining "At-Risk" Public Water Systems, Domestic Wells, and State Small Water Systems; Webinar Recording (P.M. session): https://www.youtube.com/embed/6W_HtzzPnF4?modestbranding=1&rel=0&autoplay=1
July 22, 2020 SAFER Risk Assessment Webinar; Webinar Recording (P.M. session): https://www.youtube.com/embed/jdYSbU8Gn_A?modestbranding=1&rel=0&autoplay=1; Presentation: https://www.waterboards.ca.gov/drinking_water/programs/safer_drinking_water/docs/safer_at_risk_webinar_2_pm_session_aquifer_risk_map.pdf
October 9, 2020 SAFER Aquifer Risk Map: At-Risk Domestic Wells and State Small Systems Public Webinar: Webinar Recording: https://www.youtube.com/watch?v=onX3kV8IdNw; Presentation: https://www.waterboards.ca.gov/safer/docs/safer_aquifer%20risk%20map_10092020.pdf

[23] January 18, 2019 Domestic Well Needs Assessment Workshop: Recording: https://www.youtube.com/watch?v=TnUBQfwPywk

[24] October 20, 2021 SAFER Aquifer Risk Map Proposed Updates; Summary of updates: https://gispublic.waterboards.ca.gov/portal/home/item.html?id=62b116bb7e824df098b871cbce73ce3b; Webinar Recording: https://www.waterboards.ca.gov/safer/docs/video/risk-aquifer-map-10-20-2021.mp4

for state small water systems and domestic wells using both the Aquifer Risk Map and the Department of Water Resource's Water Shortage Vulnerability Assessment.[25]

2022 – 2023

For the 2023 Needs Assessment, the State Water Board partnered with OEHHA to develop a new category of the Risk Assessment for state small water systems and domestic wells that analyzed socioeconomic risk. Three workshops on measuring affordability were hosted in 2022 to develop a new proposed indicator, Household Socioeconomic Burden, that would be used to analyze affordability risk for public water systems and communities served by state small water systems and domestic wells. A workshop was hosted in February 2023 to provide an opportunity for stakeholders to recommend how this new affordability indicator and a suite of additional socioeconomic indicators could be combined into a new risk layer to be combine with water quality and water shortage risk to identify at-risk state small water systems and domestic well communities.[26]

RISK ASSESSMENT METHODOLOGY

OVERVIEW OF RISK CATEGORIES

The Risk Assessment for state small water systems and domestic wells utilizes three categories of data. These categories are calculated separately and analyzed together to identify At-Risk state small water systems and domestic wells. These categories align, but do not match, the categories used to identify At-Risk public water systems.

Water Quality Risk
Water quality risk is derived from the State Water Board's Aquifer Risk Map. The Aquifer Risk Map uses available raw source groundwater quality data to identify areas where state small water systems and domestic wells may be accessing groundwater that does not meet primary drinking water standards (maximum contaminant level or MCL).

Water Shortage Risk
The water shortage physical vulnerability risk scores are from DWR's "Water Shortage Vulnerability Assessment" scoring. DWR's assessment utilizes a suite of physical vulnerability

[25] February 2, 2022 Needs Assessment Workshop: Proposed Changes for the 2022 Needs Assessment: White Paper: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/needs-assessment-white-paper-draft.pdf; Presentation: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/proposed-changes-drinking-water-needs-assessment.pdf; Webinar Recording: https://www.youtube.com/embed/a-KJxB0YII8?modestbranding=1&rel=0&autoplay=1

[26] February 3, 2023 Needs Assessment Workshop: Proposed Changes for the 2023 Needs Assessment: White Paper: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimneedsassessment.pdf; Presentation: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023/2023-Preliminary-Needs-Assessment-Results-Webinar-Presentation.pdf

factors to assess drought and water shortage risk for square mile sections, including exposure to hazard, climate change, physical vulnerability, and record of outages.

Socioeconomic Risk
Socioeconomic risk is derived from two core datasets. The first contains county-level water quality and administrative services and the second is U.S. Census data. These datasets were compiled by the State Water Board and OEHHA to (1) assess a counties' overall administrative, technical, and managerial capacity to assist communities served by state small water systems and domestic wells and (2) assess the ability of communities served by these systems to access and pay for water at a neighborhood level, especially when faced with a well experiencing water quality or water shortage issues.

RISK INDICATORS

The Risk Assessment for state small water systems and domestic wells analyzes a diverse set of risk indicators across the three categories: Water Quality, Water Shortage, and Socioeconomic. Table B1 provides a summary of the risk indicators used in the assessment. Details on how these indicators are calculated and incorporated into the Assessment are detailed in subsequent sections in this Appendix.

Table B1: Risk Indicators for State Small Water Systems & Domestic Wells

Category	2023 Risk Indicators
Water Quality	Modeled Groundwater Water Quality at or Above MCL (Aquifer Risk Map)
Water Shortage	Temperature Shift
	Saline Intrusion Projected
	Projected Wildfire
	Current Year's Precipitation
	Consecutive Dry Years
	Geology - Fractured Rock Area
	Subsidence
	Basin Salt
	Overdrafted Basin
	Chronic Declining Water Levels
	Surrounding Land Use - Presence & Amount of Irrigated Agriculture
	Wildfire as Present Threat to Water Shortage
	Dry Domestic Well Susceptibility in Basins
	Domestic Well Density in Fractured Rock Areas
	Reported Household Outages on Domestic Well

Category	2023 Risk Indicators
Socioeconomic	Water Quality Testing Requirements for Domestic Wells
	Water Quality Testing Type Required for Domestic Wells
	Water Quality Test Results Impacts on Permitting for Domestic Wells
	Does the County Have a Water Quality Monitoring Program?
	County Administrative Services
	County Website Quality
	County Funding Resources Available to Domestic Well Owners
	Replacement Well Permit Cost
	Average Number of Wells Drilled Per Unique Driller in the Past Two Years
	Household Socioeconomic Burden
	Linguistic Isolation
	Unemployment
	Transportation Limitations

MAPPING RISK DATA

There is minimal data *directly* from state small water systems or domestic wells publicly available. Therefore, the Risk Assessment uses publicly available statewide datasets and develops risk scores spatially at a square mile section. The risk status for each area is applied to all state small water systems and domestic well locations within that square mile section. The total number of systems and wells within each risk area are summarized to determine the count of systems At-Risk.

THRESHOLDS

To develop thresholds for the risk indicators in the Risk Assessment, the State Water Board, DWR, and OEHHA 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 state small water system and/or domestic well risk were derived from sources beyond California legislative and regulatory definitions, given both the unique definition of risk employed in this assessment and the unique access to indicator data which this assessment enabled. However, similar indicators and associated thresholds were also identified across other sources and are documented in the individual indicator details provided in the following sections in this Appendix.

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 of state small water systems and domestic wells failing.

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 risk 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, DWR staff, and OEHHA staff.

WEIGHTS

When evaluating the risk indicators, the Risk Assessment methodology can either apply the same "weight" to each risk indicator or apply different weights. 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 risk. Weights between 1 and 3 were applied to individual risk indicators (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, DWR staff, and OEHHA staff.

RISK CATEGORY WEIGHTS

Public feedback during the initial Risk Assessment methodology development workshops indicated that the Risk Assessment should include risk category weights. Weights of 1 and 2 were applied to each risk category, with a weight of 2 indicating the highest level of criticality.

Table B2: Category Weights

Category	Category Weight
Water Quality Risk	2
Water Shortage Risk	2
Socioeconomic Risk	1

Table B3: Category Risk Thresholds for Communities Served by State Small Water Systems and Domestic Wells

Category	Threshold	Score	Weight	Max Score	Risk Level
Water Quality Risk	Contaminants less than 80% of MCL	0	2	0	**Low**
	Contaminants between 80% - 100% of MCL	0.25	2	0.5	**Medium**
	Contaminants above MCL	1	2	2	**High**

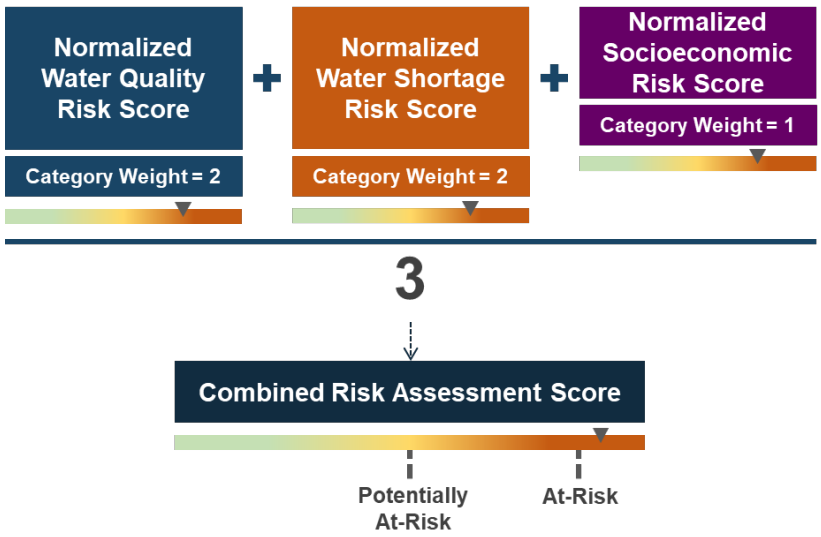
Category	Threshold	Score	Weight	Max Score	Risk Level
	No data available	N/A	N/A	N/A	N/A
Water Shortage Risk	Score below 60th percentile (< 0.452) of areas with a state small water systems and/or domestic well	0	2	0	Low
	Score in in 60-80th percentile (0.452-0.534) of areas with a state small water systems and/or domestic well	0.25	2	0.5	Medium
	Score above 80th percentile (>0.534) of areas with a state small water systems and/or domestic well	1	2	2	High
	No data available	N/A	N/A	N/A	N/A
Socioeconomic Risk	Score below 60th percentile (< 0.667) of areas with a state small water systems and/or domestic well	0	1	0	Low
	Score in 60-80th percentile (0.667-0.885) of areas with a state small water systems and/or domestic well	0.25	1	0.25	Medium
	Score above 80th percentile (>0.885) of areas with a state small water systems and/or domestic well	1	1	1	High
	No data available	N/A	N/A	N/A	N/A

COMBINED RISK ASSESSMENT CALCULATION METHODOLOGY

The final combined risk score per public land survey system (PLSS) section is determined by multiplying the normalized category score by the category weight, adding the weighted scores for all three categories, and dividing by the number of categories with data. The final risk score is binned into three groups: “At-risk” (score >= 1), “Potentially At-Risk” (score >= 0.5), and “Not At-Risk” (score < 0.5). These numeric cutoffs mean that any area with a high score in two or more categories is always “At-risk” and any area with a high score in either the water quality or water shortage categories is always “Potentially At-Risk” or “At-Risk.”

To calculate the state small water system and domestic well statewide results, the total number of system and well records in each combined risk designation bin are summed.

Equation 1: Combined Risk Score Calculation Method



ADJUSTING FOR MISSING DATA

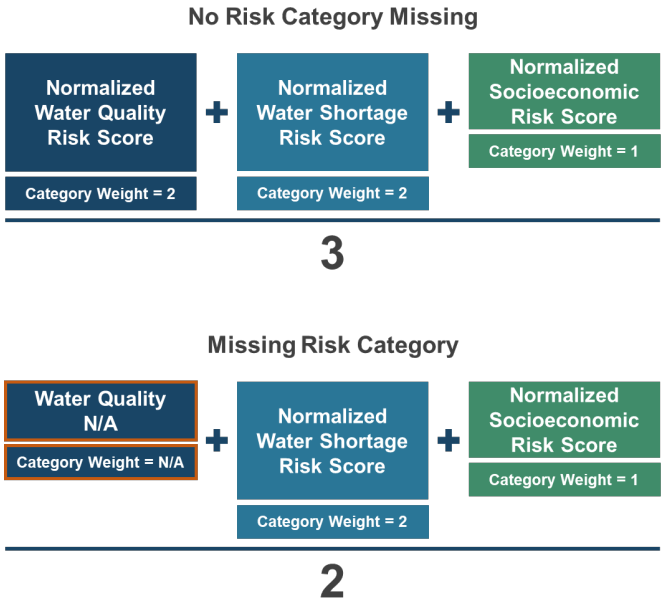
It is important that the Risk Assessment methodology adapts for where data may be missing for certain locations where state small water systems and domestic wells may be located. The methodology used to adjust for missing data replicates the approach taken in the Risk Assessment for public water systems. For the Socioeconomic Risk category, the methodology omits any value for a missing risk indicator and re-distributes the weights/scores to risk indicators within the same category which did have valid values (Figure B3). It is important to note that this approach is not used by DWR in their Water Shortage category.

Figure B3: Example of How the Assessment Adjusts for Missing Risk Indicator Data

For some locations, modeled groundwater quality data is from the Water Quality category. The methodology used to adjust for missing category data mirrors the approach taken in the Risk Assessment for public water systems. The Risk Assessment redistributes the weights/score of

a missing risk category to the other categories when an entire category is excluded from the assessment, as illustrated in Figure B4.

Figure B4: How the Aggregated Risk Assessment Adjusts for a Missing Risk Indicator Category



AGGREGATED RISK ASSESSMENT THRESHOLDS

The final combined risk score per PLSS section is determined by multiplying the normalized category score by the category weight, adding the weighted scores for all three categories, and dividing by the number of categories with data. The final risk score is binned into three groups: “At-Risk,” “Potentially At-Risk,” and “Not At-Risk.” These numeric cutoffs mean that any area with a high score in two or more categories is always “At-Risk” and any area with a high score in either the water quality or water shortage categories is always “Potentially At-Risk” or “At-Risk.”

Table B4: Aggregated Risk Assessment Thresholds

Risk Level	Score
At-Risk	≥ 1
Potentially At-Risk	1 < n ≥ 0.5
Not At-Risk	< 0.5

RISK CATEGORY & INDICATOR DETAILS

WATER QUALITY RISK (AQUIFER RISK MAP)

A complete description of the 2023 Aquifer Risk Map methodology is available online.[27] The Aquifer Risk Map uses previously collected water quality results from various datasets, including the Division of Drinking Water, the US Geological Survey-Groundwater Ambient Monitoring and Assessment programs' Priority Basin and Domestic Well Projects, the USGS-National Water Information System dataset, the Department of Water Resources, local groundwater monitoring projects, the Irrigated Lands Regulatory Program, and monitoring/clean-up sites. These water quality results are depth-filtered to only focus on data from groundwater depths accessed by domestic wells and state small water systems. Data from all chemical constituents with a Maximum Contaminant Level (MCL) are assessed, and several additional chemical constituents including hexavalent chromium, copper, lead, and N-Nitrosodimethylamine (NDMA) are included in the analysis as well (refer to Table B1 for chemical constituent codes and comparison concentrations). Water quality results were converted to an MCL Index[28] to allow comparison between chemical constituents. The 20-year average concentration and highest recent (within 5 years) results are calculated for each square mile (PLSS) section where data is available. The average and highest recent results are compared to the MCL to determine the risk status of the square mile section. The R script used to download, process, and filter the water quality data is available on GitHub.[29]

Table B5: Chemical Constituent Codes and Maximum Contaminant Values for Aquifer Risk Map Chemical Constituents

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
24D	2,4-Dichlorophenoxyacetic acid (2,4 D)	µg/L	70	MCL
AL	Aluminum	µg/L	1000	MCL
ALACL	Alachlor	µg/L	2	MCL
ALPHA	Gross Alpha radioactivity	pCi/L	15	MCL
AS	Arsenic	µg/L	10	MCL
ATRAZINE	Atrazine	µg/L	1	MCL
BA	Barium	mg/L	1	MCL
BDCME	Bromodichloromethane (THM)	µg/L	80	MCL

[27] Methodology for 2023 Aquifer Risk Map
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=a00ee2ed17464141900131c46e126c45
[28] The MCL index consists of the finding divided by the MCL, with a special consideration for non-detect results with a reporting limit above the MCL.
[29] Methodology script (GitHub)
https://github.com/EmilyHoulihan/Aquifer_Risk_Map

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
BE	Beryllium	µg/L	4	MCL
BETA	Gross beta	pCi/L	50	MCL
BHCGAMMA	Lindane (Gamma-BHC)	µg/L	0.2	MCL
BIS2EHP	Di(2-ethylhexyl) phthalate (DEHP)	µg/L	4	MCL
BRO3	Bromate	µg/L	10	MCL
BTZ	Bentazon	µg/L	18	MCL
BZ	Benzene	µg/L	1	MCL
BZAP	Benzo(a)pyrene	µg/L	0.2	MCL
BZME	Toluene	µg/L	150	MCL
CD	Cadmium	µg/L	5	MCL
CHLORDANE	Chlordane	µg/L	0.1	MCL
CHLORITE	Chlorite	mg/L	1	MCL
CLBZ	Chlorobenzene	µg/L	70	MCL
CN	Cyanide (CN)	µg/L	150	MCL
CR	Chromium	µg/L	50	MCL
CR6	Chromium, Hexavalent (Cr6)	µg/L	10	Temporary comparison level*
CRBFN	Carbofuran	µg/L	18	MCL
CTCL	Carbon Tetrachloride	µg/L	0.5	MCL
CU	Copper	mg/L	1.3	Action Level
DALAPON	Dalapon	µg/L	200	MCL
DBCME	Dibromochloromethane (THM)	µg/L	80	MCL
DBCP	1,2-Dibromo-3-chloropropane (DBCP)	µg/L	0.2	MCL
DCA11	1,1-Dichloroethane (1,1 DCA)	µg/L	5	MCL
DCA12	1,2 Dichloroethane (1,2 DCA)	µg/L	0.5	MCL
DCBZ12	1,2 Dichlorobenzene (1,2-DCB)	µg/L	600	MCL
DCBZ14	1,4-Dichlorobenzene (p-DCB)	µg/L	5	MCL

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
DCE11	1,1 Dichloroethylene (1,1 DCE)	µg/L	6	MCL
DCE12C	cis-1,2 Dichloroethylene	µg/L	6	MCL
DCE12T	trans-1,2, Dichloroethylene	µg/L	10	MCL
DCMA	Dichloromethane (Methylene Chloride)	µg/L	5	MCL
DCP13	1,3 Dichloropropene	µg/L	0.5	MCL
DCPA12	1,2 Dichloropropane (1,2 DCP)	µg/L	5	MCL
DINOSEB	Dinoseb	µg/L	7	MCL
DIQUAT	Diquat	µg/L	20	MCL
DOA	Di(2-ethylhexyl) adipate	mg/L	0.4	MCL
EBZ	Ethylbenzene	µg/L	300	MCL
EDB	1,2 Dibromoethane (EDB)	µg/L	0.05	MCL
ENDOTHAL	Endothall	µg/L	100	MCL
ENDRIN	Endrin	µg/L	2	MCL
F	Fluoride	mg/L	2	MCL
FC11	Trichlorofluoromethane (Freon 11)	µg/L	150	MCL
FC113	1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	mg/L	1.2	MCL
GLYP	Glyphosate (Round-up)	µg/L	700	MCL
H-3	Tritium	pCi/L	20000	MCL
HCCP	Hexachlorocyclopentadiene	µg/L	50	MCL
HCLBZ	Hexachlorobenzene (HCB)	µg/L	1	MCL
HEPTACHLOR	Heptachlor	µg/L	0.01	MCL
HEPT-EPOX	Heptachlor Epoxide	µg/L	0.01	MCL
HG	Mercury	µg/L	2	MCL
MOLINATE	Molinate	µg/L	20	MCL
MTBE	MTBE (Methyl-tert-butyl ether)	µg/L	13	MCL
MTXYCL	Methoxychlor	µg/L	30	MCL
NI	Nickel	µg/L	100	MCL
NNSM	N-Nitrosodimethylamine (NDMA)	µg/L	0.01	NL

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
NO2	Nitrite as N	mg/L	1	MCL
NO3N	Nitrate as N	mg/L	10	MCL
OXAMYL	Oxamyl	µg/L	50	MCL
PB	Lead	µg/L	15	Action Level
PCA	1,1,2,2 Tetrachloroethane (PCA)	µg/L	1	MCL
PCATE	Perchlorate	µg/L	6	MCL
PCB1016	Polychlorinated Biphenyls (PCBs)	µg/L	0.5	MCL
PCE	Tetrachloroethene (PCE)	µg/L	5	MCL
PCP	Pentachlorophenol (PCP)	µg/L	1	MCL
PICLORAM	Picloram	mg/L	0.5	MCL
RA-226/RA-228	Radium 226 and Radium 228	pCi/L	5	MCL
SB	Antimony	µg/L	6	MCL
SE	Selenium	µg/L	50	MCL
SILVEX	2,4,5-TP (Silvex)	µg/L	50	MCL
SIMAZINE	Simazine	µg/L	4	MCL
SR-90	Strontium 90	pCi/L	8	MCL
STY	Styrene	µg/L	100	MCL
TBME	Bromoform (THM)	µg/L	80	MCL
TCA111	1,1,1-Trichloroethane	µg/L	200	MCL
TCA112	1,1,2-Trichloroethane	µg/L	5	MCL
TCB124	1,2,4- Trichlorobenzene (1,2,4 TCB)	µg/L	5	MCL
TCDD2378**	2,3,7,8-Tetrachlorodibenzodioxin (Dioxin)	µg/L	3.00E-05	MCL
TCE	Trichloroethene (TCE)	µg/L	5	MCL
TCLME	Chloroform (THM)	µg/L	80	MCL
TCPR123	1,2,3-Trichloropropane (1,2,3 TCP)	µg/L	0.005	MCL
THIOBENCARB	Thiobencarb	µg/L	70	MCL
THM	Total Trihalomethanes	µg/L	80	MCL
TL	Thallium	µg/L	2	MCL

Chemical Abbreviation (Web Tool)	Chemical Name	Units	Comparison Concentration Value	Comparison Concentration Type
TOXAP	Toxaphene	µg/L	3	MCL
U	Uranium	pCi/L	20	MCL
VC	Vinyl Chloride	µg/L	0.5	MCL
XYLENES	Xylenes (total)	µg/L	1750	MCL

*Since there is currently no MCL for Hexavalent Chromium (CrVI), a temporary comparison value was used to remain consistent with the risk assessment for public water systems.
**No data for 2,3,7,8-Tetrachlorodibenzodioxin (Dioxin) was available for this analysis, because there are no samples from wells that met our depth and time criteria.

DEPTH FILTER

Most available groundwater quality data is sourced from public (municipal) supply wells. This is a result of California's requirement for monitoring and reporting of groundwater from wells that are part of a public water system that supplies water to 15 or more service connections. In contrast, domestic wells (any system that serves less than 5 connections) and state small water systems (5 – 14 connections) are not regulated by the state and therefore lack comprehensive data.

For many regions, municipal supply wells access a deeper portion of the groundwater resource when compared with domestic wells. This deeper groundwater is typically less affected by contaminants introduced at the ground surface than shallower groundwater. As a result, use of data from municipal wells would likely result in a systematically low bias for an estimate of the shallower groundwater typically accessed by domestic wells.

Accordingly, staff developed a method to filter data that more likely represents shallower groundwater accessed by domestic wells, as summarized below.

Since well depth varies throughout the state, a domestic depth zone was defined numerically for each groundwater unit[30] based on Total Completed Depth statistics from the Online System of Well Completion Reports (OSWCR) database. Based on well depth data in the OSCWR database, a well depth interval per groundwater unit was determined for wells classified as domestic and for wells classified as public (Figure B5). These well depth statistics were then compared to assess whether domestic and public well depth intervals overlap, which indicates that they access the same groundwater source. For groundwater units where the depth interval for public and domestic wells overlapped (or the public interval was shallower) water quality

[30] This project uses Groundwater Units as areas of analysis. Groundwater Units consist of groundwater basins as defined by DWR Bulletin 118 (https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Bulletin-118/Files/B118-Interim-Update-2016.pdf), and the connecting upland areas associated with each of these basins as delineated by the USGS (https://www.sciencedirect.com/science/article/pii/S2214581814000305?via%3Dihub). Use of Groundwater Units results in coverage of the entire state. Averaging of well depths and groundwater quality within a Groundwater Unit was considered reasonable based on the assumed relative consistency of hydrogeologic conditions within each Unit.

data from public wells was included in the analysis. For groundwater units where the depth interval for public wells was deeper than the depth interval for domestic wells, water quality data from public wells was screened out of the analysis. For details on the maximum domestic well depth and the comparison of public and domestic wells for each groundwater unit, see Attachment B1.[31]

Figure B5 illustrates the numeric depth filter which is based on the average of section maximum/minimum well depths per Groundwater Unit. Wells with a known depth that fall within the “domestic well depth interval” are included in the analysis. Wells with a known depth that fall outside the “domestic well depth interval” are screened out of the analysis. For wells without a known depth - if the “public bottom” depth of a Groundwater Unit is shallower or within 10% of the “domestic bottom” depth, then wells classified as public are included in the analysis. If the “public bottom” depth of a Groundwater Unit is more than 10% deeper than the “domestic bottom” depth, then wells classified as public are screened out of the analysis.

[31] Attachment B1 lists the depth filter output for each groundwater unit in California. The table shows the ID, name, maximum domestic depth (in feet) and whether that groundwater unit has domestic and public wells at similar depths. The numeric value in the third column indicates the domestic depth maximum cutoff – only wells with shallower depths are used to estimate domestic/state small water quality. A “no” in the final column indicates that domestic and public wells are accessing different groundwater depths, and public wells are not used to estimate domestic/state small water quality when well depth is unknown. A “yes” in the final column indicates that domestic and public wells are accessing similar groundwater depths, and public wells are used to estimated domestic/state small water quality when well depth is unknown.
Attachment B1: Groundwater Depth by Unit
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023gwdepthbyunit.xlsx

Figure B5: Numeric Depth Filter

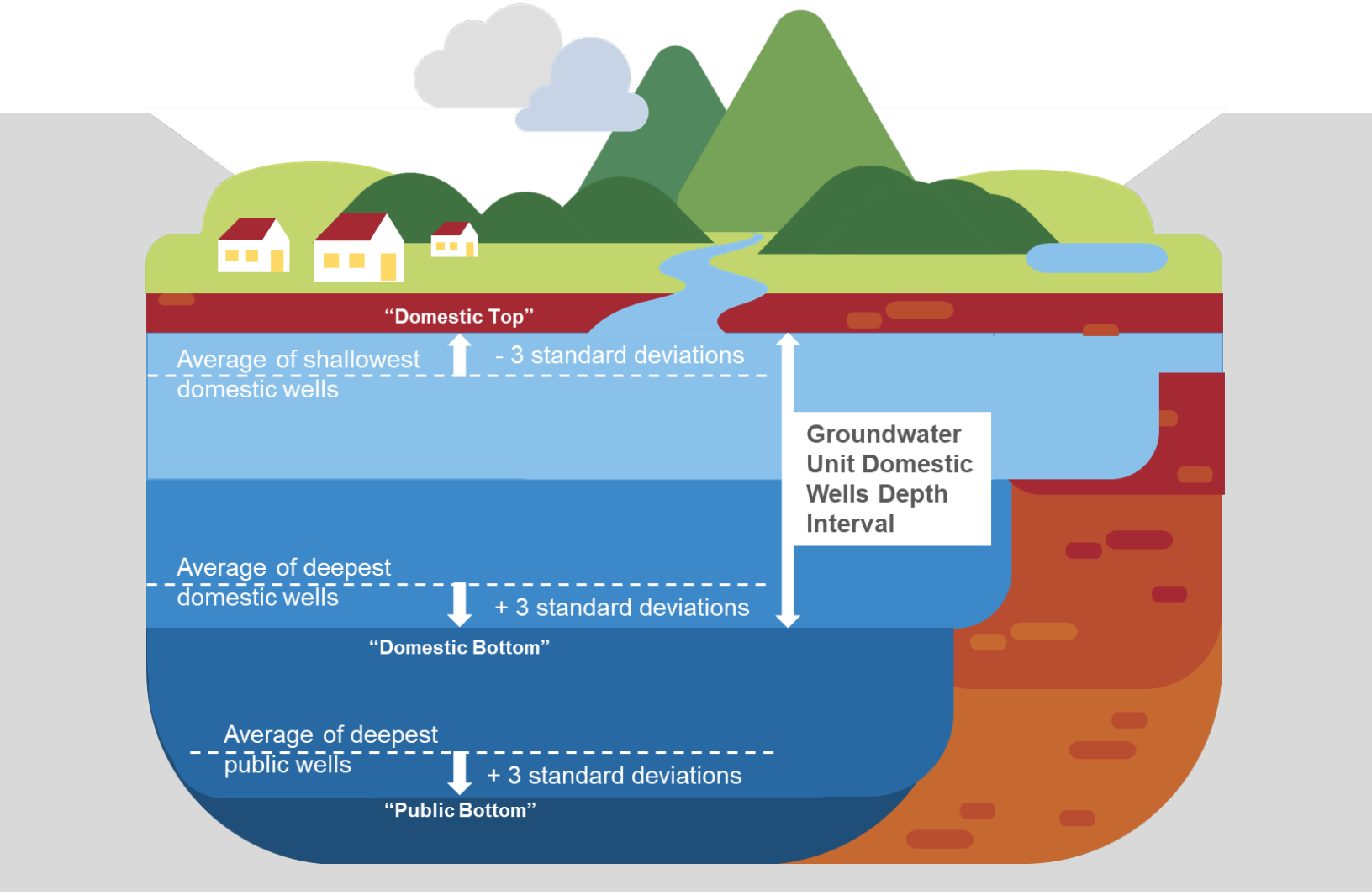
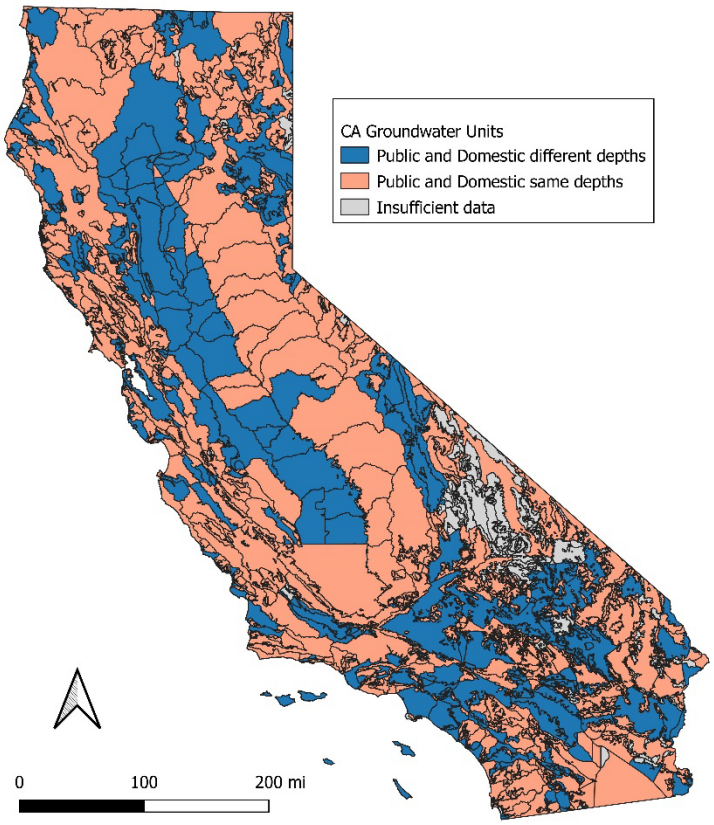


Figure B6 illustrates the depth filter by well type (for wells with unknown depth) in California. This map shows basins where domestic wells and public wells may be accessing similar groundwater depths (pink) and basins where domestic wells and public wells are accessing different groundwater depths (blue). For the basins shown in pink, public wells were used as a proxy for domestic depth water quality.

Figure B6: Depth by Well Type



Most wells with water quality data do not have well construction data (indicating the depth of well or screen interval). Wells with depth data were filtered based on their numeric well construction; wells without numeric construction data were filtered by well type.

Wells with Known Numeric Depths

Staff used OSWCR Total Completed Depth section summary statistics to determine a "Domestic Bottom" and "Domestic Top" depth for each Groundwater Unit. The domestic well depth zone was defined as the range between "Domestic Bottom" depth[32] and "Domestic Top" depth[33]. For Group 1 wells, if the given depth of the well fell between the "Domestic Top" depth and the "Domestic Bottom" depth, water quality data from that well was included in the analysis.

[32] Domestic Bottom = average of section maximum domestic well depths (from OSWCR) plus 3 standard deviations of section maximum well depths for each groundwater unit.
[33] Domestic Top = average of section minimum domestic well depths (from OSWCR) minus 3 standard deviations of section minimum well depths for groundwater unit.

Wells with Unknown Numeric Depths

Staff used OSWCR well depth information to compare "Domestic Bottom" depth (defined above) to "Public Bottom" depth[34] (defined below). If the "Public Bottom" depth for a given Groundwater Unit was shallower than the "Domestic Bottom" depth, or within 10% of "Domestic Bottom" depth (shallower or deeper), then it was considered reasonable to include data from public wells into the analysis for that Groundwater Unit. If the "Public Bottom" depth for a given Groundwater Unit was more than 10% deeper than the "Domestic Bottom" depth, water quality data from public wells was screened out of the analysis for that Groundwater Unit.

DE-CLUSTERING

Available water quality results were spatially and temporally de-clustered to square mile sections to account for differences in data sampling density within each section over space and time. This was conducted to prevent certain areas with a high density of wells and frequent sampling to achieve a disproportionate weighting to the overall risk characterization of an area. To expand the coverage of the water quality risk map, averaged, de-clustered data from sections that contain a well(s) that provide water quality data are projected onto neighboring sections that do not include a well providing water quality data.

Water quality data is assessed using two metrics - the long-term (20 year) average and all recent results (within 5 years). The temporal and spatial de-clustering methodology for each metric is outlined below.

Long-Term Average

- Water quality results from each well for each chemical constituent are averaged per year (for the past 20 years).
- The results are averaged per well.
- The results are averaged for each square mile section.

Recent Results

- All recent (within the past 5 years) results in a section are categorized as "under" (less than 80 percent of MCL), "close" (80 percent – 100 percent of MCL), or "over" (greater than MCL) for each constituent.
- The count of recent results in each category (under, close, over) are summarized per square mile section.

The average and recent result count from adjacent sections is used to calculate results for neighboring square mile sections that do not contain a well with water quality data. If neighboring sections have multiple adjacent source sections with water quality data, the adjacent results are averaged.

[34] Public Bottom = average of section maximum public well depths (from OSWCR) plus 3 standard deviations of section maximum well depths for groundwater units.

NORMALIZING WATER QUALITY RISK DATA

In summary, the Aquifer Risk Map uses available raw source groundwater quality data to estimate the water quality risk to state small water systems and domestic wells. For the combined Risk Assessment for state small water systems and domestic wells, the 2023 Aquifer Risk Map data is normalized into four risk bins summarized in Table B6.

Table B6: Normalizing Aquifer Risk Map Results

Aquifer Risk Map Result	Normalized Risk Score	Risk Level
No nearby water quality data available for any contaminants.	N/A	Unknown Risk
20-year average and all recent results for all measured contaminants are below 80% of the MCL.	0	Low Risk
20-year average or highest recent result for one or more contaminants is between 80% - 100% of the MCL.	0.25	Medium Risk
20-year average or highest recent result for one or more contaminants is above the MCL.	1	High Risk

Since the water quality risk estimates are limited to areas within ~2 miles of a well with water quality data, much of the state is assigned the “unknown risk”. However, the majority of state small water systems and domestic well locations do have water quality data available nearby (90% of state small water systems and 80% of known domestic wells).

2023 WATER QUALITY RISK RESULTS

Table B7: 2023 Water Quality Risk Results

Water Quality Risk	High Risk	Medium Risk	Low Risk	Unknown Risk
State Small Water Systems	699 (54%)	78 (6%)	387 (30%)	133 (10%)
Domestic Wells	99,814 (34%)	15,869 (5%)	117,028 (40%)	58,690 (20%)

WATER SHORTAGE RISK (DWR WATER SHORTAGE VULNERABILITY TOOL)

The water shortage risk scores are from the DWR’s Water Shortage Vulnerability Tool for state small water systems and domestic wells. The complete methodology for this analysis is

available online.[35] In summary, the DWR assessment utilizes a suite of risk factors to assess water shortage risk for at the public land survey system (PLSS) square mile sections, including exposure to hazard, climate change, physical vulnerability, socioeconomic vulnerability, and record of outages.

To improve the Water Shortage Vulnerability Map, 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 B8.[36]

Table B8: Major Revisions Made to DWR's Water Shortage Vulnerability Assessment for State Small Water Systems & Domestic Wells

Revision Description	2021 Version	2022 Version
Terminology Change: Risk changed to vulnerability	Referred to aggregated score as “drought risk”	Refers to aggregated scores as “water shortage vulnerability”
Present physical vulnerability and social vulnerability separately	Physical vulnerability and social vulnerability were aggregated as a sing score	Aggregate scores of physical and social vulnerability are represented as separate indices
Spatial units, increase resolution	All indicators applied to Census Block Groups for spatial analysis	All indicators of physical vulnerability presented and combined at one square mile grid for whole state (PLSS)
Vulnerability Scores (physical)	Applied weighting by component	Apply weights by indicator and by basin location
Re-created tool	Tableau with minimal access to data besides aggregate score	ArcGIS Web App Tool, improved access to all individual maps and customizable user interface designed to support county planning

For the combined Risk Assessment for state small water systems and domestic wells, the DWR water shortage risk scores were normalized into four risk bins summarized in Table B9.

[35] Water Shortage Vulnerability Scoring and Tool | DWR
https://water.ca.gov/Programs/Water-Use-And-Efficiency/SB-552/SB-552-Tool
[36] Technical Methods for the Drought and Water Shortage Vulnerability Assessment Update 2023: California’s Domestic Wells and State Small Water Systems
https://data.cnra.ca.gov/dataset/water-shortage-vulnerability-technical-methods/resource/fe040d6a-ed1b-4f0f-9ad9-50aada68ba03?inner_span=True

Table B9: Normalizing DWR Water Shortage Vulnerability Results

DWR Drought Assessment Result	Normalized Risk Score	Risk Level
No drought and water shortage risk scores are available for this area.	N/A	Unknown Risk
Below top 40% of areas with a state small water systems and/or domestic well.	0	Low Risk
Top 40% of areas with a state small water systems and/or domestic well.	0.25	Medium Risk
Top 20% of areas with a state small water systems and/or domestic well.	1	High Risk

2023 WATER SHORTAGE RISK RESULTS

Table B10: Water Shortage Risk Results

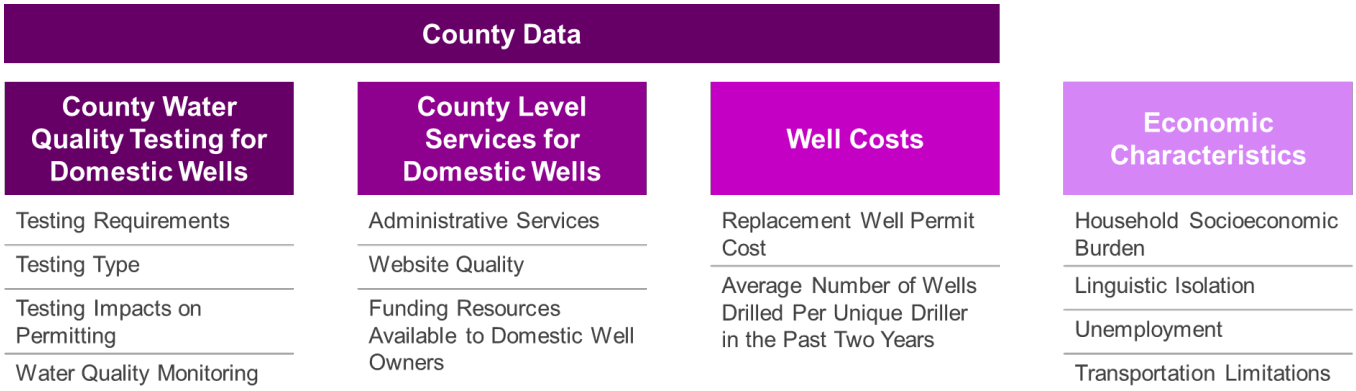
Water Shortage Risk	High Risk	Medium Risk	Low Risk	Unknown Risk
State Small Water Systems	261 (20%)	183 (14%)	853 (66%)	0 (0%)
Domestic Wells	101,393 (35%)	69,245 (24%)	120,763 (41%)	0 (0%)

SOCIOECONOMIC RISK

Historically, the Needs Assessment has not included affordability indicators in the Risk Assessment for state small water systems and domestic well communities. Based on stakeholder feedback, the State Water Board and OEHHA explored potential affordability and broader socioeconomic indicators in 2021-22, applicable to state small water systems and domestic wells, for inclusion in the Needs Assessment.

Thirteen indicators were identified to develop a new Socioeconomic Risk map for the 2023 Risk Assessment for state small water systems and domestic wells. The suite includes seven county level measures capturing water quality testing practices and administrative services or resources available to domestic well owners. Well costs are captured through two indicators measured at the county level. Finally, four socioeconomic indicators were developed at the Census Tract and Block Group level using demographic information included in the 2019 and 2021 5-Year American Communities Survey.

Figure B7: Socioeconomic Risk Indicators



County Data Collection Effort

During the Fall and Winter of 2022, OEHHA and the State Water Board reviewed county-specific information about domestic wells for all 58 California counties to develop the dataset needed for the county-based risk indicators.[37] This effort included:

1. Evaluation of publicly available information related to domestic wells on each county's website, including attachments and links.
2. Review of domestic well ordinances, fee schedules, and drought assistance programs.
3. In cases where information was unavailable online, counties were contacted via phone.

These indicators are used in the Risk Assessment to capture risk associated with resource availability and County managerial capacity to support communities served by state small water systems and domestic wells.

How the Socioeconomic Risk Category is Calculated

To calculate the Socioeconomic Risk Category results, indicator scores for the thirteen Socioeconomic Risk indicators were multiplied by their weight at the geographic scale associated with each indicator (county, census tract, or census block group). As the geographic scales vary across the indicators, the risk scores were spatially associated with square mile sections. At the section scale, individual risk scores were summed and then divided by the number of indicators with data (max of thirteen).

COUNTY WATER QUALITY TESTING FOR DOMESTIC WELLS

State and federal law do not require water quality testing for domestic wells, neither before nor during operation. However, many California counties have water quality testing requirements for domestic wells. These requirements and programs were evaluated to assess risk for communities served by domestic wells. Counties with fewer domestic well water quality requirements/programs receive a higher score for each risk indicator, illustrating that well owners may be at greater risk when there are fewer regulatory requirements or programs

[37] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

designed to ensure domestic well owners are informed of potential water quality concerns. Four indicators were considered for this category: Water Quality Testing Requirements, Testing Type Required, Test Impacts/Corrective Actions, and County Sampling/Monitoring programs. Each of these indicators are described below.

Water Quality Testing Requirements for Domestic Wells

This indicator reflects whether a County requires any level of water quality testing for new domestic wells during the permitting process. It has three thresholds: Testing required, testing recommended but not required, and testing neither recommended nor required.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- County outreach and public information review conducted in 2022. This dataset is published on the State Water Board's website.[38]

Threshold Determination

Testing Required (Threshold 0): Counties were classified as having testing required when some level of water quality testing is mandated when drilling a new well. Often, testing requirements are specified in a county ordinance, but they may also be highlighted on a website or other documents. In some counties, water quality tests are only required when a well is drilled in addition to a building or plumbing permit issuance. For example, a test would be required if the well is drilled in tandem with the construction of a new primary or accessory dwelling unit, but not necessarily if it is drilled in isolation. For this analysis, these counties were not classified as having "required testing," because testing would not be mandatory for replacement wells.[39] This threshold is associated with the lowest level of risk.

Testing is Recommended but not Required (Threshold 1): Counties that advise well owners to test their wells, but do not mandate a water quality test as a part of the permitting process are included in this threshold. For example, Fresno County recommends and supports testing but notes that "private wells are not required to meet any water quality standards."[40] This threshold is considered medium risk.

No testing required or recommended (Threshold 2): Some counties neither require nor recommend water quality testing. These counties may have ordinances that give permission for staff to request samples, but testing is not explicitly recommended or

[38] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx
[39] This was observed in Butte County.
[40] Fresno County Well Permitting Program
https://www.co.fresno.ca.us/departments/public-health/environmental-health/water-surveillance-program/water-well-permitting-program

required in the ordinance or other supporting documents. These counties were classified as “no testing recommended or required.” Additionally, counties where testing was only recommended through a generic well owner’s guide were included in this category. These counties were classified as having “No testing required," indicating the highest risk level.

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 internal deliberations and stakeholder feedback, the minimum weight of 3 was suggested for the “Water Quality Testing Requirements for Domestic Wells” risk indicator. Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 3. Table B11 summarizes the thresholds, score, and weights for “Water Quality Testing Requirements for Domestic Wells.”

Table B11: “Water Quality Testing Requirements for Domestic Wells” Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location	N/A	N/A	*Missing*	Unknown
0	Required water quality testing	0	N/A	0	None
1	Recommended testing, but not required	0.5	3	1.5	Medium
2	No testing required or recommended	1	3	3	High

Water Quality Testing Type Required for Domestic Wells

The purpose of this risk indicator is to assess the extent to which water quality testing is performed or recommended. It captures which contaminants counties either require or recommend be tested for (e.g., coliform, nitrate, arsenic).

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- County outreach and public information review conducted in 2022. This dataset is published on the State Water Board’s website.[41]

[41] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

Threshold Determination

Bacteria + Other (Threshold 0): This threshold applies to counties that recommend/require testing for bacteria and at least one non-bacteria test.

The number of contaminants tested varies widely by county; some counties require an extensive panel for all chemicals listed in Title 22,[42] while others may only require one or two non-bacteria tests. For example, Santa Clara County requires that wells are tested for bacteria and all Title 22 inorganics, while Yolo County only mandates bacteria and nitrate. Some counties did not list the specific chemicals that should be considered, instead indicating that "chemical and bacteriological" tests are necessary.[43] All these counties have been classified in this lowest threshold based on available information.

Bacteria Only (Threshold 1): Some counties only require or recommend bacteriological testing and do not recommend other contaminants should be tested for.

This indicator was based on county water quality testing requirements for new domestic wells. If the county "recommends" testing of additional contaminates they were still assigned this threshold since water quality testing of additional contaminants is recommended and not required. There are currently six counties that currently require bacteriological testing as a part of the permitting process but encourage additional testing too. These counties were categorized as "bacteria only" to reflect the permitting requirements. This threshold is associated with a medium level of risk.

Not applicable, no testing required, or tests are unspecified (Threshold 2): Counties that neither recommend nor require testing were categorized as "Not Applicable." Additionally, counties that may recommend/require testing but provided no additional information about the necessary tests were placed in this threshold. For example, Sacramento County only states that "appropriate analyses should be made based upon the intended uses of the water."[44] Because there was no specific information about the nature of the testing, Sacramento County was classified as "Not Applicable." This threshold is associated with the highest level of risk for this indicator.

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 internal deliberations and stakeholder feedback, the minimum weight of 1 was suggested for the "Water Quality Testing Type Required for Domestic Wells." Therefore, the minimum risk score for this indicator is 0 and the

[42] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Lawbook.html
[43] Merced County.
[44] Sacramento County Municipal Code 6.28.030.8.b

maximum risk score is 1. Table B12 summarizes the thresholds, score, and weights for "Water Quality Testing Type Required for Domestic Wells."

Table B12: "Water Quality Testing Type Required for Domestic Wells" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location	N/A	N/A	*Missing*	Unknown
0	Bacterial + Other	0	N/A	0	None
1	Bacterial Only	0.5	1	0.5	Medium
2	Not applicable, no testing required, or tests are unspecified	1	1	1	High

Water Quality Test Results Impacts on Permitting for Domestic Wells

While several counties require water quality testing as part of the domestic well permitting process, not all counties require corrective actions if the water quality does not meet health standards. This risk indicator captures whether corrective actions are required if water quality does not meet health standards.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- County outreach and public information review conducted in 2022. This dataset is published on the State Water Board's website.[45]

Threshold Determination

Corrective Actions Required (Threshold 0): This threshold applies to counties that require corrective actions, such as re-chlorination or installation of treatment systems, in the event of a failed water quality test. Counties in this threshold also typically require resampling of the well to verify that the water is safe to drink after corrective actions are taken. This threshold represents the lowest risk for this indicator.

Unknown (Threshold 1): Some counties do not specify if a failed water quality test would require corrective actions or if the tests are for owner information only. Therefore, these counties are considered low risk.

Testing is for Owner Information Only (Threshold 2): Some counties do not require any corrective actions in the event of a failed water quality test. Water quality testing is solely meant to inform domestic well owners about their drinking water safety. All

[45] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

counties that recommend, but do not require, water quality testing were included in this threshold and are considered medium risk.

Not Applicable (Threshold 3). Counties that do not require or recommend testing were classified in this threshold. This is the highest risk for this indicator.

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 internal deliberations and stakeholder feedback, the minimum weight of 2 was suggested for the "Water Quality Test Results Impacts on Permitting for Domestic Wells." Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 2. Table B13 summarizes the thresholds, score, and weights for "Water Quality Test Results Impacts on Permitting for Domestic Wells."

Table B13: "Water Quality Test Results Impacts on Permitting for Domestic Wells" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Yes, failure requires corrective actions.	0	N/A	0	None
1	Unknown, it's unclear if the failed test will result in corrective actions prior to permit finalization.	0.25	2	0.5	Low
2	No, testing is for owner information only.	0.5	2	1	Medium
3	Not applicable, no testing required.	1	2	2	High

Does the County Have a Water Quality Monitoring Program?

Many counties have programs to conduct voluntary domestic well water quality sampling and monitoring by county staff or through third-party partnerships. These programs not only help inform domestic well owners of their water quality, they also create a valuable dataset that could be used by counties and other stakeholders to make more informed decisions for future

well permitting and groundwater management. This risk indicator captures whether a county has a program to sample domestic well water quality for contamination.

Calculation Methodology
Required Risk Indicator Data Points & Sources:

- County outreach and public information review conducted in 2022. This dataset is published on the State Water Board's website.[46]

Threshold Determination

County Run or Funded Program (Threshold 0): Counties that have a program or staff that will sample or test domestic wells fall in this threshold. These programs may vary in scope, with some counties taking samples for every new well, while other counties may only conduct the sampling upon request. This is considered the lowest risk threshold for this indicator.

Program Operated Through Non-County Providers (Threshold 1): Some counties partner with third party organizations (e.g., Self-Help Enterprises, Central Coast Testing Program) to offer well-sampling services. These counties are considered in this threshold.

Additionally, counties that assist in facilitating testing or transporting samples, but do not directly conduct sampling or testing, are included in this threshold. For example, Mendocino County has a sample drop-off point, and the county facilitates the transport of sample bottles to the regional laboratory. This allows residents to sample the water themselves, then deliver these samples to the regional laboratory easily and affordably.

This threshold represents medium risk for this indicator. Counties that only publish lists of local water quality testing laboratories or companies were not considered in this threshold.

No Program (Threshold 2): Counties that do not have a water quality testing program or partnerships with external organizations are considered in this threshold. These counties may reference local laboratories or sampling services on their website. This is considered the highest risk for this indicator.

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 internal deliberations and stakeholder feedback, the minimum weight of 2 was suggested for the "Does the County Have a Water Quality Monitoring Program?" Therefore, the minimum risk score for this indicator is 0 and the

[46] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

maximum risk score is 2. Table B14 summarizes the thresholds, score, and weights for “Does the County Have a Water Quality Monitoring Program?”

Table B14: “Does the County Have a Water Quality Monitoring Program?” Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Yes, county either operates of funds a program.	0	N/A	0	None
1	Yes, program is operated through a non-county provider.	0.5	2	2	Medium
2	No program either operated by the county or non-county provider.	1	2	2	High

COUNTY LEVEL SERVICES

Aside from water quality, another important aspect of risk to domestic well users is the availability of administrative resources to domestic well users when a well runs dry or becomes contaminated. County staff, resource information, and funding programs are all services needed to support state small water systems and domestic wells when preparing for or responding to challenges.

County Administrative Services

This risk indicator reflects whether counties have specific programs or advertised administrative capacity to assist domestic well owners. The scope of these services varies widely between counties, so a broad interpretation of these services was used during the evaluation of this indicator.

Examples of administrative services include:

- Advertised staff assistance or consultation for dry wells
- Advertised staff assistance for interpreting water quality reports/tests
- Water delivery for owners of dry wells
- Water storage installation for owners of dry wells
- Custom web maps used to expedite well drilling applications
- Water refilling stations
- Training and equipment loans for well level monitoring

Water quality sampling was not considered an administrative service, as this is captured in separate risk indicators.

Calculation Methodology
Required Risk Indicator Data Points & Sources:

- County outreach and public information review conducted in 2022. This dataset is published on the State Water Board's website.[47]

Threshold Determination

County Provided Admin Services (Threshold 0). This threshold indicates that county staff are directly involved with providing at least one administrative service as listed above. Counties in this threshold may also partner with external agencies to provide other services but provide at least one service in-house. This is the lowest risk threshold for this indicator.

External agency/group admin services (Threshold 1). Counties in this threshold do not provide any of the administrative services listed above, instead they link or partner with external agencies with assistance programs for well owners. For example, many counties in the San Joaquin Valley partner with Self-Help Enterprises, which has numerous programs available for well-owners, including well consultation and water storage installation. This threshold is considered medium risk.

No admin services provided or linked (Threshold 2). Counties in this threshold do not provide or advertise any administrative services for domestic well owners. This threshold is considered high 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. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on internal deliberations and stakeholder feedback, the minimum weight of 2 was suggested for the "County Administrative Services." Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 2. Table B15 summarizes the thresholds, score, and weights for "County Administrative Services."

Table B15: "County Administrative Services" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Administrative services are provided by the county.	0	N/A	0	None
1	Services provided by a non-county provider.	0.5	2	2	Medium

[47] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
2	No administrative services provided or referenced on county website.	1	2	2	High

County Website Quality

This risk indicator is intended to capture the general quality of information available, and ease of access, for well owners and drillers on the county's website.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- County outreach and public information review conducted in 2022. This dataset is published on the State Water Board's website.[48]

Threshold Determination

Substantial information about quality, resources, and services (Threshold 0). Counties in this threshold typically had extensive information about the well-permitting process, county programs, advice for maintaining a well etc. on their websites. Most counties in the state (38) were in this threshold, which represents the lowest risk.

Some information about quality, resources, or services (Threshold 1). Counties in this threshold had some information pertinent to well owners on their websites. However, the information is limited in scope, may be outdated, and/or would likely leave a well owner or driller with remaining questions. 10 counties were in this threshold, which represents medium risk.

Little or no information about quality, resources, or services (Threshold 2). Counties with no or very limited information on their websites were placed in this threshold. These counties may not have a webpage dedicated to domestic well owners or have minimal relevant information. This threshold represents the highest 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. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on internal deliberations and stakeholder feedback, the minimum weight of 1 was suggested for the "County Website Quality."

[48] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 1. Table B16 summarizes the thresholds, score, and weights for "County Website Quality."

Table B16: "County Website Quality" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Substantial information about water quality, available resources, and/or services provided.	0	N/A	0	None
1	Some information about water quality, available resources, and/or services provided.	0.5	1	0.5	Medium
2	Little or no information about water quality, available resources, and/or services provided.	1	1	1	High

County Funding Resources Available to Domestic Well Owners

The purpose of this risk indicator is to assess available county financial resources available to domestic well owners experiencing water quality and/or quantity challenges. Most public-financial resources are provided or administered by state or federal agencies; however, a limited number of counties have their own funding and/or assistance programs for domestic well owners.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- County outreach and public information review conducted in 2022. This dataset is published on the State Water Board's website.[49]

Threshold Determination

Funding resources are provided by the county (Threshold 0). This threshold includes counties with their own funding programs. These counties may also provide links to external resources. Only four counties had their own dedicated funding programs. This threshold represents the lowest risk. Examples include:

- Funding for installation of temporary water tanks, water hauling, piping and electrical improvements (Yolo County)

[49] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

- Housing rehabilitation funds may be used for dry wells (Fresno County)
- Funding for well deepening and/or pump repairs (Shasta County)
- Zero interest loans for well repairs (Humboldt County)

External funding resources are provided (Threshold 1). This threshold includes counties that provide links to other sources of funding administered by other public agencies. This threshold is considered medium risk.

Examples of external funding sources include:

- U.S. Department of Agriculture Loans
- Rural Community Assistance Corporation
- Community Development Block Grant Funds
- State Water Quality Control Board

No funding linked or provided (Threshold 2). This threshold includes counties that did not provide any information about available funding programs on their website. This is considered the highest risk threshold.

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 internal deliberations and stakeholder feedback, the minimum weight of 1 was suggested for the "County Funding Resources Available to Domestic Well Owners." Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 1. Table B17 summarizes the thresholds, score, and weights for "County Funding Resources Available to Domestic Well Owners."

Table B17: "County Funding Resources Available to Domestic Well Owners" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	County funding resources available.	0	N/A	0	None
1	County provides information on funding available from non-county sources.	0.5	1	0.5	Medium
2	No funding resources available or information provided.	1	1	1	High

WELL COSTS CATEGORY

Maintaining, deepening, and/or replacing wells can be a cost burden for those who are dependent on them. This category of risk indicators attempts to assess the relative cost risk associated with dependency on state small water systems and domestic wells. The State Water Board and OEHHA suggest additional data collection to enhance this category of risk indicators over time. This is especially critical with rising costs and inflation.

Replacement Well Permit Cost

This risk indicator measures the cost to obtain permits for a replacement well in each county. This indicator does not include the cost of drilling the well, which varies by factors such as the drilling company, necessary well depth, and local basin conditions. Most counties increase fees at the beginning of the fiscal year (July 1); thus, the indicator is representative of the 2021-2022 fiscal year.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- County outreach and public information review conducted in 2022. This dataset is published on the State Water Board's website.[50]
- Information on domestic well permits and associated fees were collected by calling county well permitting agencies and speaking on the phone with environmental health specialists, department directors, and permit fee specialists in late 2021 and early 2022. The county representative was asked the cost of permitting if a homeowner wanted to build a replacement well, deepen an existing well, or build a second well. The first scenario, building a replacement well, was identified as the most common solution for when an existing well goes dry and is used here for this indicator of replacement well permit cost.

Threshold Determination

Percentiles were calculated for each county, where the county with the highest replacement well permit costs received a percentile of 100. The thresholds for this indicator were set in the same manner as other risk indicators in the Risk Assessment for public water systems where comparative ranking across the state occurs (see DWR Drought and Water Shortage Risk), where the top 20% of counties or counties above the 80th percentile, where assigned the highest threshold 2. Counties in the middle 60th to 80th percentile were assigned a medium threshold 1, and counties in the bottom 40th (percentiles below 60) were assigned a threshold of 0 (no 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. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on internal deliberations and stakeholder feedback, the minimum weight of 2 was suggested for the "Replacement Well Permit Cost."

[50] County Risk Indicator Analysis
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2023prelimcountydata.xlsx

Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 2. Table B18 summarizes the thresholds, score, and weights for "Replacement Well Permit Cost."

Table B18: "Replacement Well Permit Cost" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Percentile less than 60.	0	N/A	0	None
1	60 to less than the 80 percentile.	0.5	2	2	Medium
2	Percentile 80 to 100 (top 20% of counties).	1	2	2	High

Average Number of Wells Drilled Per Unique Driller in the Past Two Years

The purpose of this risk indicator is to approximate the cost associated with wait-time and increased demand for well drillers. A higher number of wells drilled per active well driller in a county may also be associated with areas experiencing high demand and increased costs associated with drilling a well.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- OWSCR (Online System of Well Completion Reports).[51]
- The data was filtered by well type (domestic, public, and other) and the unique driller ID number. Other well types include industrial, irrigation, and monitoring. Data on the number of active unique drillers in each county between 2020-2022 and the number of domestic wells drilled between 2020-2022 in each county were identified. This indicator was calculated by dividing the number of domestic wells drilled by the number of active unique drillers per county. This ensures that counties with lower demand will not receive lower scores simply because they have fewer active drillers.

Threshold Determination

Percentiles were calculated for each county, where the county with the highest average number of domestic wells per driller (Nevada County with an average new domestic well per driller of 80) received a percentile of 100 and the county with the lowest average number of domestic wells per driller (Orange County with an average domestic well per driller of 1) received the lowest percentile. The thresholds for this indicator were set in the same manner as other risk indicators in the Risk Assessment for public water systems where comparative ranking across the state occurs (see DWR Drought and Water Shortage Risk), where the top

[51] OWSCR Well Completion Report Well
data.ca.gov/dataset/well-completion-reports

20% of counties or counties above the 80th percentile, where assigned the highest threshold 2. Counties in the middle 60th to 80th percentile were assigned a medium threshold 1, and counties in the bottom 40th (percentiles below 60) were assigned a threshold of 0 (no 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. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on internal deliberations and stakeholder feedback, the minimum weight of 2 was suggested for the "Average Number of Wells Drilled Per Unique Driller in the Past Two Years." Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 2. Table B19 summarizes the thresholds, score, and weights for "Average Number of Wells Drilled Per Unique Driller in the Past Two Years."

Table B19: "Average Number of Wells Drilled Per Unique Driller in the Past Two Years" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Percentile less than 60.	0	N/A	0	None
1	60 to less than the 80 percentile.	0.5	2	2	Medium
2	Percentile 80 to 100 (top 20% of counties).	1	2	2	High

Table B20: Well Cost Category Indicator Data

County	Replacement Well Permit Cost	Number of Domestic Wells Drilled	Unique Drillers	Average Domestic Wells per Driller
Alameda	$794	24	5	4.80
Alpine	$512	11	1	11.00
Amador	$450	106	5	21.20
Butte	$593	253	14	18.07
Calaveras	$935	117	8	14.63
Colusa	$532	29	4	7.25
Contra Costa	$1,383	72	10	7.20
Del Norte	$150	41	2	20.50
El Dorado	$771	344	5	68.80
Fresno	$1,287	946	27	35.04
Glenn	$575	145	9	16.11
Humboldt	$522	95	5	19.00

County	Replacement Well Permit Cost	Number of Domestic Wells Drilled	Unique Drillers	Average Domestic Wells per Driller
Imperial	$3,776	N/A	N/A	N/A
Inyo	$512	8	4	2.00
Kern	$2,320	205	22	9.32
Kings	$550	174	13	13.38
Lake	$422	41	9	4.56
Lassen	$339	28	5	5.60
Los Angeles	$3,209	71	13	5.46
Madera	$1,065	520	21	24.76
Marin	$2,846	22	6	3.67
Mariposa	$248	190	5	38.00
Mendocino	$772	303	12	25.25
Merced	$894	268	13	20.62
Modoc	$90	8	3	2.67
Mono	$648	24	2	12.00
Monterey	$4,344	61	11	5.55
Napa	$546	131	10	13.10
Nevada	$1,086	480	6	80.00
Orange	$738	3	3	1.00
Placer	$1,450	371	10	37.10
Plumas	$514	87	7	12.43
Riverside	$719	437	12	36.42
Sacramento	$1,086	99	14	7.07
San Benito	$1,348	57	9	6.33
San Bernardino	$906	576	21	27.43
San Diego	$970	68	8	8.50
San Francisco	N/A	N/A	N/A	N/A
San Joaquin	$966	269	12	22.42
San Luis Obispo	$1,196	299	11	27.18
San Mateo	$5,939	9	2	4.50
Santa Barbara	$1,482	23	10	2.30
Santa Clara	$3,034	90	7	12.86

County	Replacement Well Permit Cost	Number of Domestic Wells Drilled	Unique Drillers	Average Domestic Wells per Driller
Santa Cruz	$2,441	96	6	16.00
Shasta	$650	264	8	33.00
Sierra	$747	11	3	3.67
Siskiyou	$545	205	8	25.63
Solano	$184	34	11	3.09
Sonoma	$987	647	10	64.70
Stanislaus	$615	312	10	31.20
Sutter	$1,062	27	8	3.38
Tehama	$241	267	11	24.27
Trinity	$240	175	4	43.75
Tulare	$447	508	33	15.39
Tuolumne	$1,298	107	3	35.67
Ventura	$1,535	15	6	2.50
Yolo	$1,322	47	11	4.27
Yuba	$857	184	7	26.29

SOCIOECONOMIC BURDEN CATEGORY

Four indicators representing socioeconomic burden were included in this risk layer to estimate additional factors that affect a state small water system and domestic well community's ability to afford and acquire water. OEHHA and the State Water Board evaluated existing Census measures of socioeconomic vulnerability to identify relevant indicators. The new affordability indicator for public water systems called 'Household Socioeconomic Burden', which is a combination of poverty and housing-burdened low-income households, is proposed here with the same reasons outlined in the November 2022 white paper.[52] OEHHA and the State Water Board also evaluated other measures of socioeconomic vulnerability including the 14 measures included in the Center for Disease Control's Social Vulnerability Index[53] as well as the five socioeconomic factors included in CalEnviroScreen.[54] Linguistic isolation, unemployment, and transportation limitations (households without a vehicle) are also proposed as indicators here as they may reflect the ability to pay for water at a neighborhood level.

Household Socioeconomic Burden

The purpose of this risk indicator is to identify communities that have both high levels of poverty and high housing costs for low-income households. These communities may be

[52] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/docs/2022/affordability-whitepaper-workshop3-nov2022.pdf
[53] https://www.atsdr.cdc.gov/placeandhealth/svi/index.html
[54] https://oehha.ca.gov/calenviroscreen/population-indicators

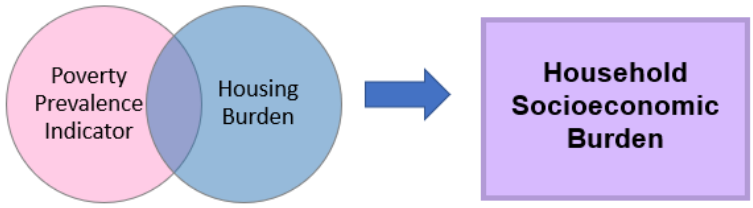
struggling to pay for access to safe drinking water and may have a difficult time shouldering future drinking water costs when their limited disposable income is constrained by high housing costs. This indicator is a composite indicator of two data points: Poverty Prevalence and Housing Burden.

- **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 A1: 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),[55] 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),[56] a dataset containing cost burdens for households by HUD-adjusted median family income

[55] American Community Survey
https://data.census.gov/cedsci/
[56] HUD CHAS Data
https://www.huduser.gov/portal/datasets/cp.html

(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.

Each PLSS section was associated with a PPI and Housing Burden score based on the block group or tract that the centroid of the PLSS section fell within.

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

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.[57] When this approximation could not be used, the formula[58] 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.

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

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.[59] When this approximation could not be used, the formula[60] 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.

Component Thresholds

Poverty Prevalence (PPI): For PPI, various thresholds have been explored by other organizations and researchers including the use of 30%[61] or multiple categories such as less than 10%, 10% to 30%, 30% to 50%, and greater than 50%.[62] 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[63,64,65,66]. In the Raucher et al. report entitled 'Developing a New Framework for Household Affordability and Financial Capability

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[59] American Community Survey Office, 2013, equation 4
https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2011.pdf
[60] American Community Survey Office, 2013, equation 3
https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2011.pdf
[61] Lauren Patterson (2021): Water Affordability
https://internetofwater.org/wp-content/uploads/2021/12/Blog010_WaterAffordability_Patterson.pdf
[62] David Mitchell, and Elizabeth Stryjewski (2020): Technical Memorandum on Water/Sewer Service Affordability Analysis
https://www.cityofsantacruz.com/home/showpublisheddocument/83950/637553072866376248
[63] 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
[64] American Water Works Association: Measuring Water Affordability and the Financial Capability of Utilities
https://awwa.onlinelibrary.wiley.com/doi/full/10.1002/aws2.1260
[65] 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
[66] Duke University, Nicholas Institute: Exploring the Affordability of Water Services within and across Utilities
https://nicholasinstitute.duke.edu/water-affordability/affordability/Affordability_Preprint.pdf

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 A1: 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.[67] Additionally, a recently published Master's Thesis about housing challenges in California identified census tracts in the top quartile of the state as being the "most impacted."[68] 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.[69] 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.

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[67] 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

[68] 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

[69] 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/

Table A2: 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.[70] 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 B8 shows how much each calculated score represents a degree of PPI and Housing Burden within the matrix.

Equation B1: Calculating Household Socioeconomic Burden Score

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

Figure B8: 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

[70] 2022 Needs Assessment. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2022needsassessment.pdf

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 B21.

Table B21: 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 B22 summarizes the thresholds, score, and weights for Household Socioeconomic Burden.

Table B22: "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 area PLSS.*

Linguistic Isolation

Linguistic isolation measures limited English-speaking where no one over the age of 14 speaks English at least "very well," as defined by the U.S. Census. Linguistically isolated households may face barriers to obtaining technical and financial assistance for their wells or state small water systems.

Calculation Methodology
Required Risk Indicator Data Points & Sources:

- American Community Survey, 2017-2021.
- This number of households classified as limited English-speaking was downloaded by block groups for the state of California. Percentiles were calculated at the block group scale.
- To summarize by PLSS sections, the centroid of each PLSS section was associated with the percentile and threshold of the census block group it fell into.

Threshold Determination
The thresholds for this indicator were set in the same manner as other risk indicators in the Risk Assessment for public water systems where comparative ranking across the state occurs (see DWR Drought and Water Shortage Risk). The top 20% of census block groups (above the 80th percentile), were assigned the highest threshold 2. Block groups in the middle 60th to 80th percentile were assigned a medium threshold 1, and block groups in the bottom 40th (percentiles below 60) were assigned a threshold of 0 (no 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. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on internal deliberations and stakeholder feedback, the minimum weight of 1 was suggested for the "Linguistic Isolation" 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 B23 summarizes the thresholds, score, and weights for "Linguistic Isolation."

Table B23: "Linguistic Isolation" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Percentile less than 60.	0	N/A	0	None
1	60 to less than the 80th percentile.	0.5	1	0.5	Medium
2	Percentile 80 to 100 (top 20% of block groups).	1	1	1	High

Unemployment

Unemployment measures the percentage of the population over the age of 16 that is unemployed and eligible for the labor force. Communities with higher levels of unemployment may face difficulties paying for well repairs, replacements, or alternatives.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- American Community Survey, 2017-2021.
- This number of unemployed individuals was downloaded by block groups for the state of California. Percentiles were calculated at the block group scale.
- To summarize by PLSS sections, the centroid of each PLSS section was associated with the percentile and threshold of the census block group it fell into.

Threshold Determination

The thresholds for this indicator were set in the same manner as other risk indicators in the Risk Assessment for public water systems where comparative ranking across the state occurs (see DWR Drought and Water Shortage Risk). The top 20% of census block groups (above the 80th percentile), were assigned the highest threshold 2. Block groups in the middle 60th to 80th percentile were assigned a medium threshold 1, and block groups in the bottom 40th (percentiles below 60) were assigned a threshold of 0 (no 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. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on internal deliberations and stakeholder feedback, the minimum weight of 1 was suggested for the “Unemployment.” Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 1. Table B24 summarizes the thresholds, score, and weights for “Unemployment.”

Table B24: “Unemployment” Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Percentile less than 60.	0	N/A	0	None
1	60 to less than the 80th percentile.	0.5	1	0.5	Medium
2	Percentile 80 to 100 (top 20% of block groups).	1	1	1	High

Transportation Limitations

Transportation limitations are measured by the percent of households without a vehicle. Communities with domestic wells and state small water systems typically have lower

walkability and public transportation access, so vehicles are important for accessing employment, education, recreation, and healthcare. Households without vehicles may have limited mobility, impacting their ability to get water from alternative sources in the event that their state small water system or domestic well is experiencing problems.

Calculation Methodology

Required Risk Indicator Data Points & Sources:

- American Community Survey, 2017-2021.
- This number of unemployed individuals was downloaded by block groups for the state of California. Percentiles were calculated at the block group scale.
- To summarize by PLSS sections, the centroid of each PLSS section was associated with the percentile and threshold of the census block group it fell into.

Threshold Determination

The thresholds for this indicator were set in the same manner as other risk indicators in the Risk Assessment for public water systems where comparative ranking across the state occurs (see DWR Drought and Water Shortage Risk). The top 20% of census block groups (above the 80th percentile), were assigned the highest threshold 2. Block groups in the middle 60th to 80th percentile were assigned a medium threshold 1, and block groups in the bottom 40th (percentiles below 60) were assigned a threshold of 0 (no 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. Risk indicator weights between 1 and 3 are also applied to individual risk indicators. Based on internal deliberations and stakeholder feedback, the minimum weight of 1 was suggested for the "Transportation Limitations." Therefore, the minimum risk score for this indicator is 0 and the maximum risk score is 1. Table B25 summarizes the thresholds, score, and weights for "Transportation Limitations."

Table B25: "Transportation Limitations" Thresholds, Weights, & Scores

Threshold Number	Threshold	Score	Weight	Max Risk Score	Risk Level
N/A	Data missing for location.	N/A	N/A	*Missing*	Unknown
0	Percentile less than 60.	0	N/A	0	None
1	60 to less than the 80th percentile.	0.5	1	0.5	Medium
2	Percentile 80 to 100 (top 20% of block groups).	1	1	1	High

Table B26: Socioeconomic Risk Results

Socioeconomic Risk	High Risk	Medium Risk	Low Risk	Unknown Risk
State Small Water Systems	198 (16%)	269 (22%)	830 (63%)	0 (0%)
Domestic Wells	71,156 (24%)	53,734 (18%)	166,511 (57%)	0 (0%)

To calculate the Socioeconomic Risk results shown in Table B26, first the risk scores for the thirteen individual Socioeconomic Risk indicators with various underlying spatial scales (county, census tract, or census block group) were associated with square mile sections. Per section, an overall Socioeconomic Risk score was calculated by averaging the thirteen risk scores. Grouped results in Table B26 for areas with a domestic well or state small water system was calculated by grouping the section level Socioeconomic Risk Component score by their 2023 Needs Assessment Combined Risk category and calculating averages or counts for each risk bin. For square mile sections that overlapped more than one census tract/block group, the data from the maximum overlapping tract/block group was used. For the domestic well analysis, only square miles sections with at least one domestic well record were used to calculate the averages. For the state small water system analysis, only square mile sections with at least one state small water system location were used to calculate the averages. The number of domestic well records or state small water systems was not used to weight the socioeconomic data, meaning that this analysis is just of *areas* with domestic wells or state small water systems, not a socioeconomic analysis for these systems specifically. This methodology also means that socioeconomic data was area-weighted, because final numbers were calculated by assigning data to square mile sections and then calculating averages. Also, note that several socioeconomic data points used in this analysis (poverty, MHI, and limited English-speaking households or linguistic isolation) were also used as risk factors in the Water Shortage Vulnerability Tool, which was used to calculate the combined risk score.