METHODOLOGY FOR A STATEWIDE DRINKING WATER CONTAMINANT INDICATOR

CALENVIROSCREEN VERSION 2.0

OFFICE OF ENVIRONMENTAL HEALTH
HAZARD ASSESSMENT

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Acknowledgements:

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I. INTRODUCTION

Californians receive their drinking water from a wide variety of sources and distribution systems. Drinking water quality varies with location, water source, treatment method, and the ability of the water provider to remove contaminants before distribution. Because water is universally consumed, drinking water contamination has the potential for widespread effects on health. This has been demonstrated through episodes of water supply contamination by chemical leaks and releases.

The lack of a drinking water indicator as an exposure component of pollution burden was identified as a limitation in previous versions of CalEnviroScreen. The following document provides a detailed account of the methodology used to describe contaminants in delivered drinking water across the state at the census tract scale. By these methods, the Office of Environmental Health Hazard Assessment (OEHHA) developed a drinking water indicator as an exposure component of pollution burden, and used the indicator in the calculation of overall CalEnviroScreen scores in Version 2.0.

This drinking water contaminant indicator is a tool that compares census tracts across California based on the areas' reported drinking water contaminant concentration data. This analysis takes into account information on whether multiple contaminants are present, the measured level of contaminants in water, and whether the water system has received violations in the past. This indicator is not a measure of a water service provider's current compliance with regulations and the indicator does not indicate whether water is safe to drink. A water system can comply with all state regulations and its associated tract(s) might still show a relatively high score in CalEnviroScreen for this indicator depending on how the factors cited above compare with those of other census tracts in California.

As census tracts can encompass multiple drinking water systems, the drinking water contaminant score generated by this method for any given census tract may not reflect the concentration of contaminants in water that an *individual* resident of that census tract is drinking. Residents who are interested in the quality of their drinking water are encouraged to review the most recent consumer confidence report published by their water provider. These are updated annually and are usually available on the website of the water provider or by request.

Our goal is to assign drinking water scores to areas of California at the census tract scale that represent water that people are drinking. We were able to accomplish this using the following broad steps:

I. Drinking water system boundaries were identified based upon established boundaries or, where necessary, boundaries were approximated.
II. Drinking water contaminant concentration and violation data were associated with each water system for a select group of contaminants and violations.
III. The average concentration of each contaminant and violations by system was population-weighted to the census tract scale.
IV. Drinking water contaminant scores were assigned to each census tract by summing the percentile scores for the tract of all contaminants and violations.

II. ESTABLISHING DRINKING WATER SYSTEM SERVICE BOUNDARIES

The development of the drinking water indicator required identifying the areas of the state that are served by different drinking water systems. Information on the area served by a water system is available for many of the public water systems in the state (serving more than 90 percent of the population). In other places, we needed to approximate the areas served by individual water systems. We applied different methodologies for systems that have service boundary information reported to the California Department of Public Health (CDPH) compared to those for which we have less information available (service boundaries not reported to CDPH). For areas without reported water systems, we created boundaries based on township divisions from the Public Land Survey System.[1]. In this analysis we only used boundaries for systems that serve residents year round, specifically community[2] or state small water systems.[3] Figure 1 depicts our method for identifying or allocating water system boundaries based on the amount of information available for different areas of the state.

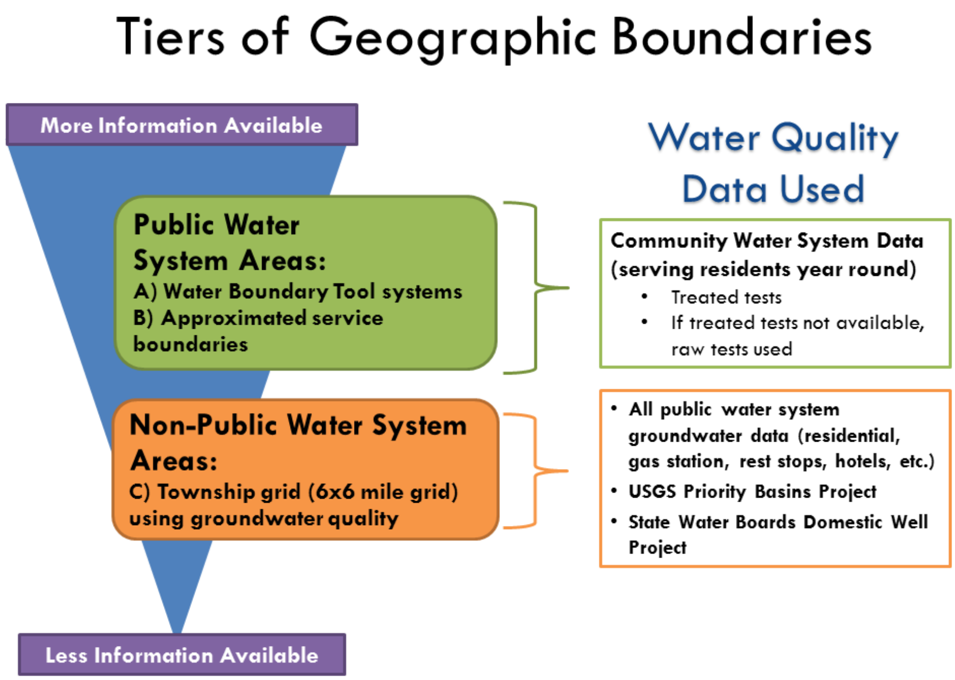

Figure 1. Development of geographic boundaries for drinking water based on currently accessible information.

The word "source" or "sample source" in this document is in the context of the Permits, Inspection, Compliance, Monitoring and Enforcement Database (PICME)[4], which indicates a location where a

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[1] Public Land Survey System (PLSS). http://nationalatlas.gov/articles/boundaries/a_plss.html

[2] A "community water system" refers to a public water system that serves at least 15 service connections used by yearlong residents or regularly serves at least 25 yearlong residents of the area served by the system.

[3] A "state small water system" refers to a system that serves 5-14 service connections, less than 25 people, and less than 60 days of the year.

[4] Permitting, Inspections, Compliance, Monitoring and Enforcement (PICME) database, California Department of Public Health.

water-quality sample was obtained, rather than a water source. For example, a source might be a spigot on a line in a treatment plant, or it could be a grab sample location in a stream, or a well-head tap.

In the context of this analysis, we used the following PICME definitions, which categorize the sources sampled in water systems:

Treated sources:	Sources that represent water after treatment.
Untreated sources:	Sources of water that will not be treated prior to delivery.
Raw sources:	Sources of water that will be subsequently treated. (Any water system with raw sources should have treated sources, too.)

A. Reported Water System Boundaries

Water system operators upload water system service boundaries to the CDPH website on a voluntary basis along with the population served by the system. Water system boundaries are publicly available on the California Department of Public Health's Geographic Reporting Tool, also known as the Water Boundary Tool.[5] Approximately 1,500 water systems serving as much as 91 percent of California's population have uploaded boundary information to the Water Boundary Tool. An example of an uploaded water system on the Water Boundary Tool is shown in Figure 2.

The boundaries dataset was downloaded from the Water Boundary Tool on June 12, 2014. We only selected community or state small water systems and for the purpose of assigning boundaries to areas, we primarily used retail water system boundaries that are currently active. If an area was not covered by a retail system boundary, but had a wholesale system boundary, then the wholesale system boundary was used to characterize that area. A wholesale system[6] is a public water system that treats water for the purpose of delivering some or all of the water to another public water system, a retail system. We were able to extract this information, along with population served information, from California's Safe Drinking Water Information System (SDWIS) database.[7]

[5] Drinking Water Systems Geographic Reporting Tool, California Environmental Health Tracking Program, California Department of Public Health (CDPH). http://www.ehib.org/page.jsp?page_key=61

[6] Health & Safety Code http://www.cdph.ca.gov/certlic/drinkingwater/pages/lawbook.aspx

[7] Safe Drinking Water Information System, U.S. Environmental Protection Agency http://water.epa.gov/scitech/datait/databases/drink/sdwisfed/index.cfm

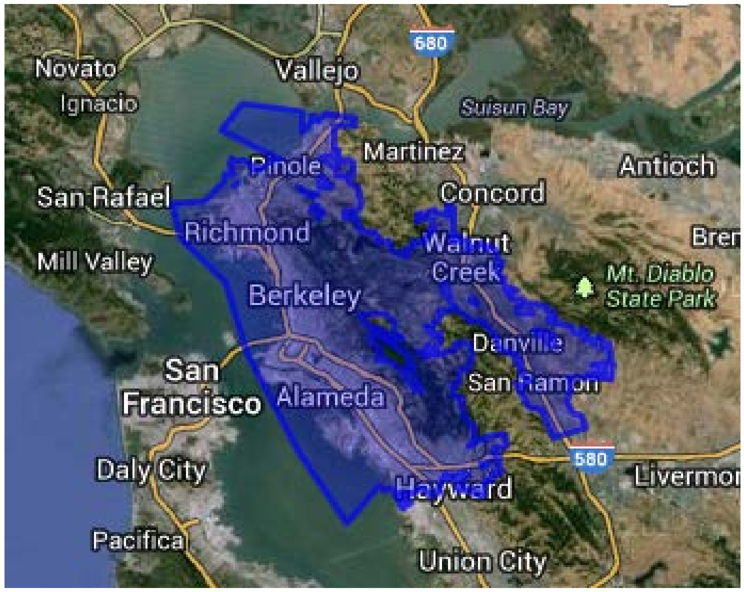

Figure 2. Example of a water system uploaded to the Water Boundary Tool. This system is the East Bay Municipal Utility District (Water System No. CA0110005).

Populated census blocks were linked to the water system boundary that they fell within. If a system partially overlapped a census block, then the census block was divided accordingly. The number of people was assigned to each portion by area weighting.

Assumptions:

- Boundaries uploaded to CDPH are accurate.
- All persons living within the boundary are served by that water system.
- Service areas have been constant over the nine-year time period evaluated (2005 to 2013).
- Areas within wholesaler system boundaries not also included in a retail system are appropriately characterized with the wholesale water contaminant data.

Data gaps and limitations:

- Approximately one-half of public water system boundaries have been uploaded to this database, possibly because the Water Boundary Tool is relatively new, having been compiled for the first time in 2011, and there are no requirements to submit boundaries. (As stated above, the systems with uploaded boundaries serve more than 90 percent of California's population.)
- Some small water systems for which no boundary data are available are likely to be within the boundaries of other, larger systems (e.g., many small systems in local primacy agency (LPA) counties[8] and unregulated systems).
- The dataset is known to have missing, incomplete, and incorrect service area boundary shapes resulting from human error in the manual service area delineation process and non-participation by water system operators.

[8] CDPH, under the provisions of Section 116330 of the California Health and Safety Code, has delegated primacy to 31 local primacy agencies (LPAs) for the regulation of public water systems serving fewer than 200 service connections [http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Smallwatersystems.aspx].

- The Water Boundary Tool dataset includes spatial anomalies such as overlapping service areas of different systems, multiple service areas for a single system, and other boundary area errors.
  - Using ArcGIS software, these problems were resolved in the least invasive manner available. Geometry issues were resolved by running the "Repair Geometry" tool. The function of the ArcMap Repair Geometry tool is described in the ArcGIS documentation.[9] To resolve the problem of multiple boundaries for the same system, the multiple boundaries were merged into a single system. This results in the largest and most inclusive boundary for each system. Overlapping regions of different systems were assigned to the system with the smallest area under the assumption that smaller systems are more likely to report correct boundaries, where a larger system may not necessarily remove small areas not served by the system.
- Service providers may report a population representing a combination of community and transient water systems generally resulting in an overestimation of people served.
- Local primacy agencies (LPAs) sometimes do not upload water service boundaries for small water systems in their jurisdiction.

B. Approximated Water System Service Areas

Approximately 1,250 small water systems serving 565,000 people (about 1.5 percent of California's population) did not provide their boundaries to the Water Boundary Tool at the time of download. We approximated system boundaries based on population served by a system from California's SDWIS database and estimates of where that system is most likely located. The approximate location for these systems was determined through 1) developing a geographic centroid where treated source locations were available from the PICME database, 2) conducting online research to determine the location of the system or by 3) using the U.S. Census Bureau's Census Designated Places as a guide for unincorporated place boundaries. The source locations from the PICME database are confidential and precise coordinates are not available to the public.

The boundaries for these systems were created using an ArcGIS model. Since there is no publicly available information that tells us exactly where people live within a census block, a randomly-distributed population within each block was generated. The ArcGIS model creates a boundary around these randomly placed "people" nearest to the system location. The model captures only an area representing the total number of people that are served by the water system. Areas already covered by reported systems (above) were not captured. The outline of the captured area was then used as the system's approximated boundary.

Assumptions:

- Service areas for water systems without reported boundaries, but with reported source locations, are near those treated sources.
- The model used in this methodology captures people and areas that are being served by the system.

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[9] http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//00170000003v000000

- Source locations are accurate.
- Estimates of the population served by a water system are accurate.

Data Gaps and Limitations:

- The population assigned to a water system by this methodology may not truly reside close to the system.
- Human error could be introduced by manually researching probable system locations.
- Approximately 200 to 300 public water systems do not have data on the locations of their sources from the PICME database.
- Captured areas may not be accurate. Areas relatively far from the sources may be captured, especially if reported system boundaries are nearby (displacement).
- Source locations may change over time.

C. Other Areas

In the absence of available data indicating otherwise, we assume that the remaining populated areas, totaling 2.1 million, receive water from private wells or are served by a small system not reported to the state's databases. To evaluate these areas in the drinking water indicator, we divided the state using the six square-mile township grid to create polygons referred to as "townships." The townships were downloaded from the Public Land Survey System.[10] Each township serves as an approximated boundary for summarizing localized water quality. Figure 3 illustrates the township grid used to create these township boundaries. Of the 2.1 million people estimated not to received water from a public water system (1.6 million people), local groundwater sampling data are available within the six square mile township grid. The groundwater quality data sources used here are described in further detail in Section III.B. (Average Chemical Concentrations for Other Areas, p. 13). The remaining 0.5 million people remain unassigned to any water quality data.

[10] Public Land Survey System (PLSS). http://nationalatlas.gov/articles/boundaries/a_plss.html.

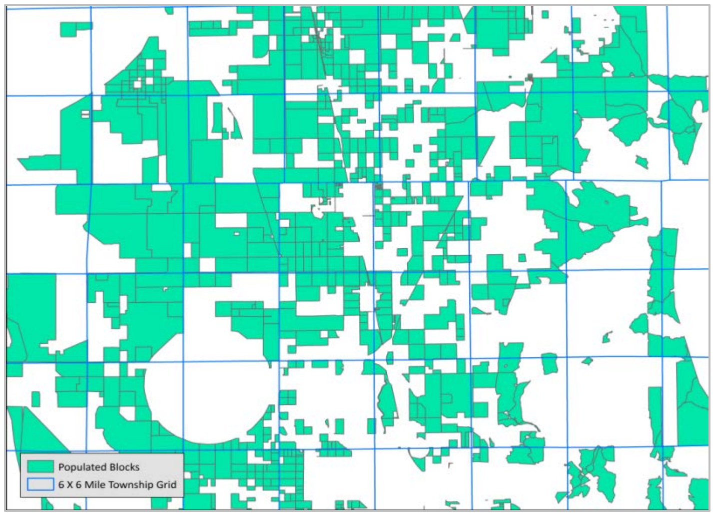

Figure 3. Detail of six square mile township grid. The green populated census blocks are the remaining populated areas after removing blocks allocated to reported and approximated systems.

Assumptions:

- People are drinking groundwater (from wells) in areas outside of reported and approximated water system service areas where there are nearby groundwater data (within the township).
- Groundwater sampling points within the township area accurately represents the quality of drinking water available in that area.

Data Gaps and Limitations:

- Township areas in which groundwater data are used to approximate drinking water quality may be served by small water systems not included in state databases.

D. Summary

Figure 4 shows an example of a populated area and the assignment of different areas based on the Water Boundary Tool, approximated boundaries, township "systems", or areas that cannot be assigned because of the absence of nearby data on water quality. The methodology accounts for 37.2 million, or about 98.7 percent of people living in California. We estimate the number of Californian's who do not receive water from a public water system and rely on groundwater to be 2.1 million people. We were able to assign water quality to 1.6 million of these people.

The numbers for the population-served by public water systems, reported by water providers, may be an overestimate in some cases because non-residential populations (such as workers who reside elsewhere) may be included. This may also result in an underestimate of unassigned residents. The distribution of California population between the various types of water system boundaries developed here is depicted in Figure 5. At this time, we do not have sufficient information to assign water quality to areas that fall outside of public water systems and townships without groundwater quality data. However, this methodology does account for about 98.7 percent of Californians.

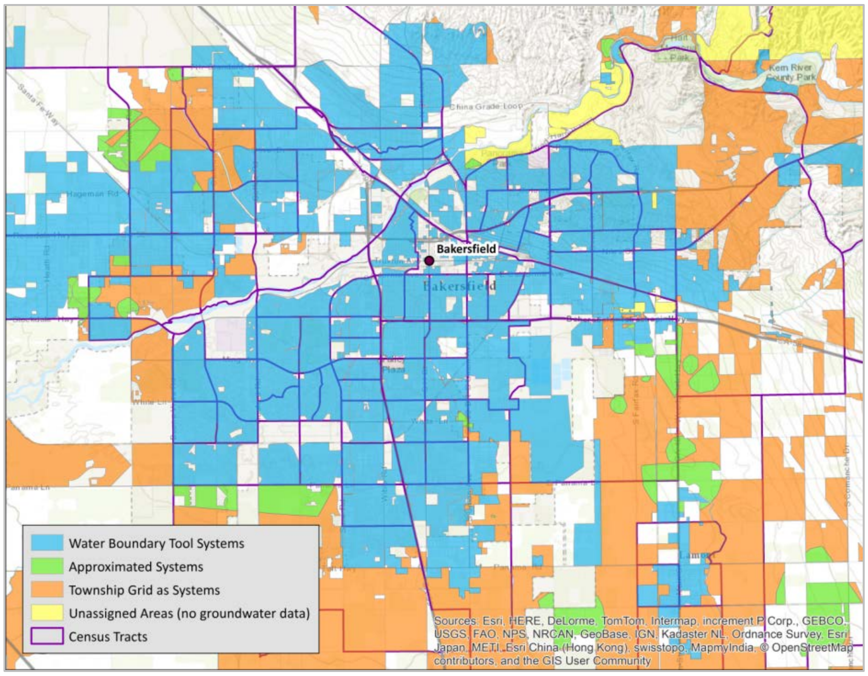

Figure 4. Geographic boundaries for water systems and groundwater assigned areas overlaid with census tracts.

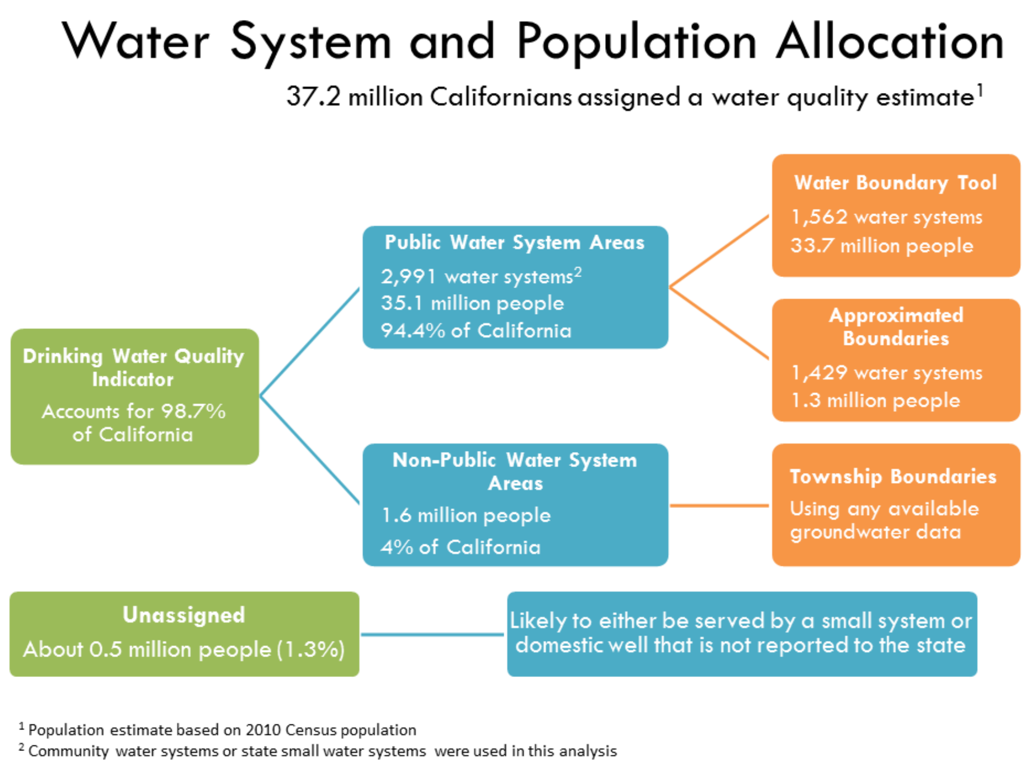

Figure 5. Allocation of population to each boundary identification system.

III. CALCULATING DRINKING WATER CONTAMINANT CONCENTRATIONS

We selected a subset of contaminants tested in drinking water across California for the analysis (Table 1). The contaminants were selected based on frequency of tests, detections, and toxicity concerns. Averages for these chemical concentrations were calculated for each public water system area or township (groundwater).

Contaminants and Violations	Detection Limit for Reporting
Arsenic	2.0 µg/l
Cadmium	1.0 µg/l
Dibromochloropropane (DBCP)	0.01 µg/l
Hexavalent Chromium	1.0 µg/l
Lead	5.0 µg/l
Nitrate (NO_3)	2.0 mg/l
Perchlorate	4.0 µg/l
Total Trihalomethanes (THM)	--
Trichloroethylene (TCE)	0.5 µg/l
Uranium (pCi/L)	1.0 pCi/l

Table 1. Select contaminants used in the analysis and the detection limit for purposes of reporting as required by the California Department of Public Health.

We incorporated information on the relationship between the mean and median system contaminant concentrations and the contaminant PHG or MCL values in selecting which contaminants to include in the indicator. California's drinking-water law requires OEHHA to develop PHGs for all regulated drinking water contaminants. A PHG is the level of a contaminant in drinking water that does not pose a health risk. PHGs are goals that California's water systems should strive to achieve if it is feasible to do so, but water systems are not required to reduce contaminants to the PHG level. Public water systems are required to comply with Maximum Contaminant Levels (MCLs), which are regulatory standards established by CDPH and that, by law, must be as close to the PHG as is economically and technically feasible. As long as contaminant levels comply with the MCLs, drinking water is considered acceptable for public consumption, even if the levels of some contaminants exceed the PHGs.

A. Average Chemical Concentrations for Areas Served by Public Water Systems

Monitoring data for chemicals is available from CDPH's Water Quality Monitoring (WQM) database.[11] We downloaded reported results for water source testing locations within currently active drinking water systems. We used data from 2005-2013, which includes the most recent compliance period as well as the entire nine-year compliance cycle. The goal was to identify

[11] Water Quality Monitoring. http://www.cdph.ca.gov/certlic/drinkingwater/pages/EDTlibrary.aspx.

water quality data that are most representative of water that is delivered to residents in the service area. Therefore, we primarily evaluated samples from delivered water sources using the variable from the PICME database describing the source type, e.g., "active treated." Delivered water could include sources sampled post-treatment or sampled from "untreated" sources. Water from untreated sources is delivered without ever being treated. For the remaining systems that had no treated or untreated source classifications, we relied on sources classified as raw. Raw sources only accounted for about three percent of systems in this analysis.

From the PICME databases, we are able to determine which sources are connected to a wholesale water supply and are therefore part of water systems that rely either in part or completely on purchased water to distribute to their consumers. For large water systems serving more than 100,000 people that rely both on local sources of water and water purchased from wholesalers, the fraction of water that was purchased was identified from publicly available information (e.g., water quality reports). If no information was found on fraction purchased, it was assumed that the water came in equal parts from the local supply and any wholesalers identified. In other words, we assumed that 50 percent of water supplied is purchased water and the other 50 percent is from local sources of water. Retailers that purchase water from the large Metropolitan Water District (MWD) wholesale provider in Southern California were each researched individually as to the fraction of water they purchase and which specific MWD treatment plant they draw from. This information was incorporated. For all other systems relying on purchased water and serving fewer than 100,000 people, we assumed that the water came in equal parts from the local system and listed wholesalers.

Chemical concentrations from testing are reported by sample source locations for water systems. For the purpose of this analysis, concentrations listed at or below the reported detection limit for that contaminant were treated as concentrations of zero.

To calculate average concentrations of contaminants from individual sources, we first calculated time-weighted averages for each contaminant by calendar year. We then took the mean of the yearly time-weighted averages to derive a source concentration. If no test for a contaminant was reported in a given year, that year did not contribute to the multi-year average. If only a single test was reported for a contaminant in a given year, that concentration was used to represent the entire year. Subsequently, all source concentrations within a water system were averaged to calculate one concentration value for each chemical in each system. When no treated or untreated samples are available for a specific contaminant, raw samples were used. For systems with wholesaler water purchases, the average was adjusted based on the known or default fractions of the water that the wholesaler supplies that system.

An example of this calculation is below:

Step 1: System Monitoring Data

System ID	Source ID	Sample Date**	Time Interval	Chemical	Finding
23456K1	23456K1-001	1/1/2010	105	Chemical A	0.0*
23456K1	23456K1-001	4/15/2010	260	Chemical A	5.0
23456K1	23456K1-001	1/1/2011	365	Chemical A	2.0
23456K1	23456K1-001	1/1/2011	365	Chemical B	6.7
23456K1	23456K1-002	1/1/2013	140	Chemical B	0.0*
23456K1	23456K1-002	5/20/2013	225	Chemical B	1.0

*Findings below the detection limit were given a value of zero.

Step 2: Calculation of Yearly Time-Weighted Average

System ID	Source ID	Chemical	Year	Calculation*	Result
23456K1	23456K1-001	Chemical A	2010	[(0.0 × 105) + (5.0 × 260)] ÷ 365	3.56
23456K1	23456K1-001	Chemical A	2011	(2.0 × 365) ÷ 365	2.00
23456K1	23456K1-001	Chemical B	2011	(6.7 × 365) ÷ 365	6.70
23456K1	23456K1-002	Chemical B	2013	[(0.0 × 140)+ (1.0 × 225)] ÷ 365	0.62

*Calculation for Time-Weighted Average = [∑ (Finding × Time Interval)] ÷ (Total Time Interval).

Step 3: Calculation of Average By Source

System ID	Source ID	Chemical	Result
23456K1	23456K1-001	Chemical A	(3.56 + 2.00) ÷ 2 = 2.78*
23456K1	23456K1-001	Chemical B	6.70
23456K1	23456K1-002	Chemical B	0.62

*System has multiple yearly averages for Chemical A.

Step 4: Calculation of Average by System

System ID	Chemical	Result
23456K1	Chemical A	2.78
23456K1	Chemical B	(6.70 + 0.62) ÷ 2 = 3.66*

*System has multiple source averages for Chemical B.

Step 5: Concentrations by System		
System ID	**Chemical A**	**Chemical B**
23456K1	2.78	3.66
23456K2	5.00	NA*

*Raw data is used, if available, as described in text.

Step 6: Concentrations by System + Raw Data		
System ID	**Chemical A**	**Chemical B**
23456K1	2.78	3.66
23456K2	5.00	4.00*

*Raw data is included here

At this point, the average concentrations would be adjusted for systems with wholesaler water purchases based on the fractions of water supplied by the wholesaler.

Assumptions:

- Available test data are adequate to represent contaminants in delivered water.
- Water quality is divided equally between a system's use of purchased water from wholesalers and the system's local source. For some systems serving more than 100,000 people, more specific information was available and used to assign the relative proportions of wholesaler versus local delivered water.
- Contaminant concentrations represent the concentration of the water source on the day the measurement was taken until the next measurement.
- Each source within a drinking water system contributes equally to the overall water quality for that system. This may lead to overestimates of contaminant concentrations, especially if sources are mixed unequally to reduce contaminant concentrations.
- Drinking water quality is homogeneous within a water system.
- Non-detect results are treated as a zero concentration for contaminants, because test protocols may vary for different water systems. Assuming a minimum concentration for non-detects with high frequency could lead to an accumulation of high concentration when the true concentration is unknown.
- When incorporating purchased water contaminant concentrations to local water systems, weighted averages were used, with each water supplier contributing its relative fraction of the water supply for each contaminant. This assumes purchased and local water contaminants combine in their relative assigned proportions. Contaminants with no data for either local or purchased water were eliminated from the calculation thereby leaving the relative fraction of the reported result to yield the entire concentration for the system.

- When no treated or untreated source locations within a system are available, the availability of a raw source suggests either an untreated source or a treated source is present but not reported.

Data gaps and limitations:

- Use of raw water quality data may overestimate contaminant concentrations.
- Treated water quality data may be available but not reported to CDPH, especially for water systems regulated by LPA counties, state small water systems, and local small water systems.
- Sources may be misclassified as treated, untreated, or raw water.
- Reported water quality data may be an average of multiple sources within a system.
- In combining purchased and local water contaminant concentrations, results containing a combination of reported data and no available data can either over- or underestimate the final contaminant concentration. This depends on the fraction of the delivered water without available data and the concentration of the contaminant in that fraction.
- The availability of raw samples in the absence of treated or untreated samples suggests the possibility of misclassification of the water source. This could be due to errors in data entry.

B. Average Chemical Concentrations for Other Areas

People were assumed to drink groundwater if they did not live in areas within a public water system boundary, but fell within a six-by-six mile township boundary that had at least one known groundwater source with contaminant data. Residents of each township (described earlier) were assigned water based on available groundwater testing data from three databases.

Groundwater quality data for areas outside public water system boundaries were from raw or untreated community or non-community water systems were obtained through (1) the WQM dataset in the same manner as for the known water system boundary data, (2) from US Geological Survey Priority Basins[12] well-water quality data produced between 2004 and 2012, and (3) from GAMA Domestic Wells Survey data[13] produced between 2002 and 2011. These last two datasets are publically available on the Geotracker GAMA website maintained by the State Water Resources Control Board (SWRCB). All well locations from the three databases are confidential and precise coordinates are not available to the public.

Groundwater quality data were assigned to townships based on the associated confidential latitude/longitude coordinates of the sampling locations. We first averaged the selected contaminant concentrations for each well location by year. Then, each yearly concentration mean was averaged to create a concentration value for each sample well location. Lastly, each source concentration in the township was averaged to yield one value for each contaminant. Figure 6

[12] USGS Priority Basins. http://www.waterboards.ca.gov/water_issues/programs/gama/priority_basin_projects.shtml

[13] GAMA Domestic Well Project. http://www.waterboards.ca.gov/water_issues/programs/gama/domestic_well.shtml.

illustrates groundwater sample sources within townships. Each township grid receives the groundwater quality from the samples that are located within it.

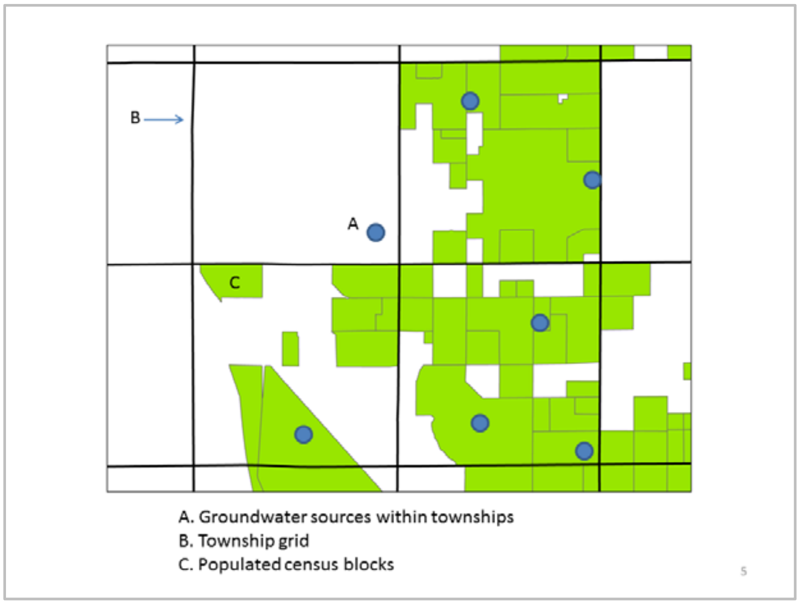

Figure 6. Groundwater sample sources within townships. Note: The sample points in the figure are randomly drawn and do not represent actual locations of sample wells.

Assumptions:

- People that are not served by public water systems who are living near groundwater sources drink from groundwater wells.
- Groundwater quality is representative of delivered water quality for people in these areas.

Data gaps and limitations:

- Small water systems that are not in the CDPH water quality database may be present in an area where groundwater is assumed to be consumed. Delivered water quality from these systems may differ from groundwater.

IV. INCORPORATING VIOLATIONS INTO THE DRINKING WATER CONTAMINANT SCORE

Information on the systems that received violations for exceeding Maximum Contaminant Levels (MCLs) for chemical contaminants or for Total Coliform Rule (TCR) is available from CDPH's Annual Compliance Reports to the US Environmental Protection Agency. For the purpose of incorporating into the drinking water contaminant index, a violations index was created for both MCL and TCR violations.

The number of MCL violations and the number of TCR violations were summed by system for the five most recent years of available data, 2008-2012. If systems had no reported violations then they received a value of zero. The MCL and TCR violations were then treated as an additional two components of the evaluated contaminants. The number of violations in a system was allocated to census tracts as described for chemical contaminants. That is, the number of violations was essentially treated as a chemical concentration. These water system values were then re-allocated from the water system-scale to census tract-scale as described below for chemical contaminants.

V. RE-ALLOCATING WATER SYSTEM BOUNDARIES TO CENSUS TRACTS

Average contaminant concentrations were calculated for each system or township. Census blocks were assigned the contaminant concentrations associated with the system or township they fell within. The concentrations for each census block were aggregated up to the census tract level using population weighting.

A census tract may have multiple water systems that contribute to its overall average contaminant concentration. For example, two blocks in one tract may receive water from different water systems. The tracts overall contaminant concentration is calculated as the population-weighted average of all the systems represented in that tract.

Percentile scores for each contaminant were calculated for each census tract based on the contaminant's relative concentration compared to concentrations of census tracts statewide. The overall drinking water indicator score for CalEnviroScreen is a sum of the contaminant percentiles. An example of how a tract score is calculated is shown below.

A. Example of Allocating Scores to Tracts from System Contaminant Data

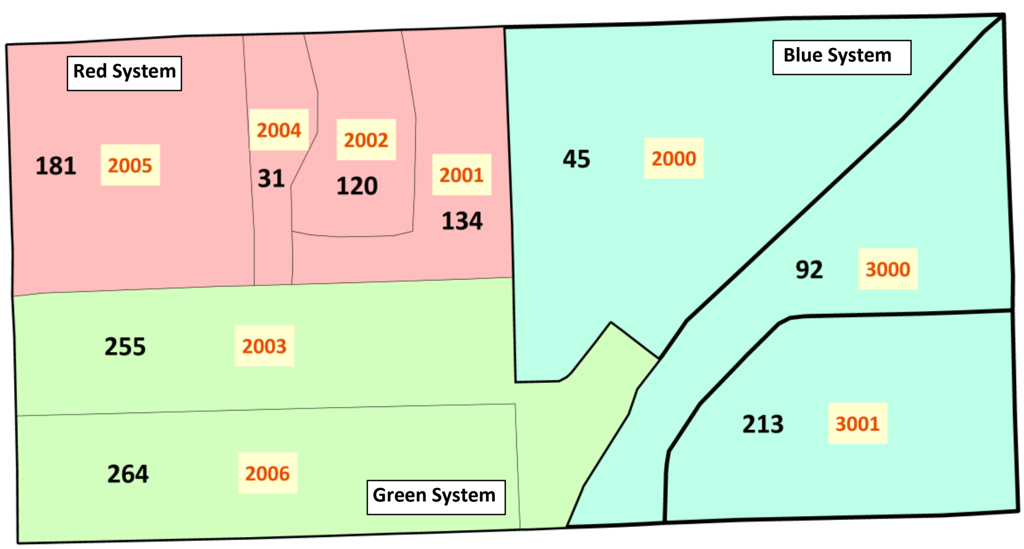

Figure 7. Hypothetical census tract to illustrate the contribution of multiple drinking water sources/systems to a single tract.

The example census tract in Figure 7 was generated for demonstrating this methodology and is not an actual California census tract. Inside the tract are census blocks, each labeled in red with a four digit number (ex. 2005). The numbers in black (e.g., 181) represent the population of the block. Each color represents a different water system. Contaminants concentrations represent system averages. Therefore, if multiple census blocks are entirely within a water system boundary, they all are assigned the same contaminant concentration.

System ID	Lead Average	THM Average	Nitrate Average
Red System	0.02	3.00	0.003
Green System	9.00	4.00	0.010
Blue System	2.50	5.00	1.000

Tract ID	Block ID	Block Pop	System ID	Lead	THM	Nitrate
601000001	2001	134	Red System	0.02	3.0	0.003
601000001	2002	120	Red System	0.02	3.0	0.003
601000001	2004	31	Red System	0.02	3.0	0.003
601000001	2005	181	Red System	0.02	3.0	0.003
601000001	2003	255	Green System	9.00	4.0	0.010
601000001	2006	264	Green System	9.00	4.0	0.010
601000001	2000	45	Blue System	2.50	4.0	0.010
601000001	3000	92	Blue System	2.50	5.0	1.000
601000001	3001	213	Blue System	2.50	5.0	1.000

Example of Calculating the Tract Average for Lead

Population Weighted Average

$= \sum (\text{Contaminant Values} \times \text{Population}) \div \sum (\text{Population})$

$= [(0.02 \times 134) + (0.02 \times 120) + (0.02 \times 31) + (0.02 \times 181) + (9.0 \times 255) + (9.0 \times 264) + (2.5 \times 45) + (2.5 \times 92) + (2.5 \times 213)] \div [134 + 120 + 31 + 181 + 255 + 264 + 45 + 92 + 213]$

$= 5555.32 \div 1335.00$

$= 4.16$

	Lead	THM	Nitrate
∑(Cont × Pop)	5555.32	5179	312.038
∑ Pop	1335	1335	1335
Pop Weighted Average	**4.16**	**3.88**	**0.23**

After ranking and assigning percentiles to all the tract population weighted averages for each contaminant separately, the percentiles were summed across to create the score for this census tract.

Tract ID	Lead	Lead Percentile	THM	THM Percentile	Nitrate	Nitrate Percentile	Tract Score
601000001	4.16	80.0	3.88	30.5	0.23	10.3	**120.8**

This example tract's drinking water contaminant score is 120.8.

VI. DRINKING WATER CONTAMINANT INDEX

In order to achieve a statewide comparison of drinking water contamination, we calculated a cumulative contaminant percentile score for each census tract. This index is comprised of the sum of the census tract-scale percentile values for the individual chemical contaminants plus the percentile values for both MCL violations and TCR violations. These percentile sums were then ordered across all the census tracts in the state to produce an overall drinking water contaminant index percentile. This drinking water contaminant percentile is then incorporated with the percentiles for the other indicators in CalEnviroScreen 2.0.

Key Points and Assumptions:

- Detectable concentrations of contaminants contribute to the drinking water contaminant index even when all concentrations are below their respective MCLs.
- A tract with multiple low contaminant percentiles may get a similar score as a tract with one or two high contaminant percentiles. The index is not designed to highlight areas with a single high contaminant, but rather assess the accumulation of multiple contaminants in an area.

Data gaps and limitations:

- Missing data for any contaminant does not contribute to the drinking water score. Therefore, missing data for any single contaminant could result in an underestimate to the overall score.
- Toxicological interactions between contaminants are not well understood. As such, the multi-contaminant index described here is not an expression of health risk or a measure of the safety of the drinking water in any particular area.

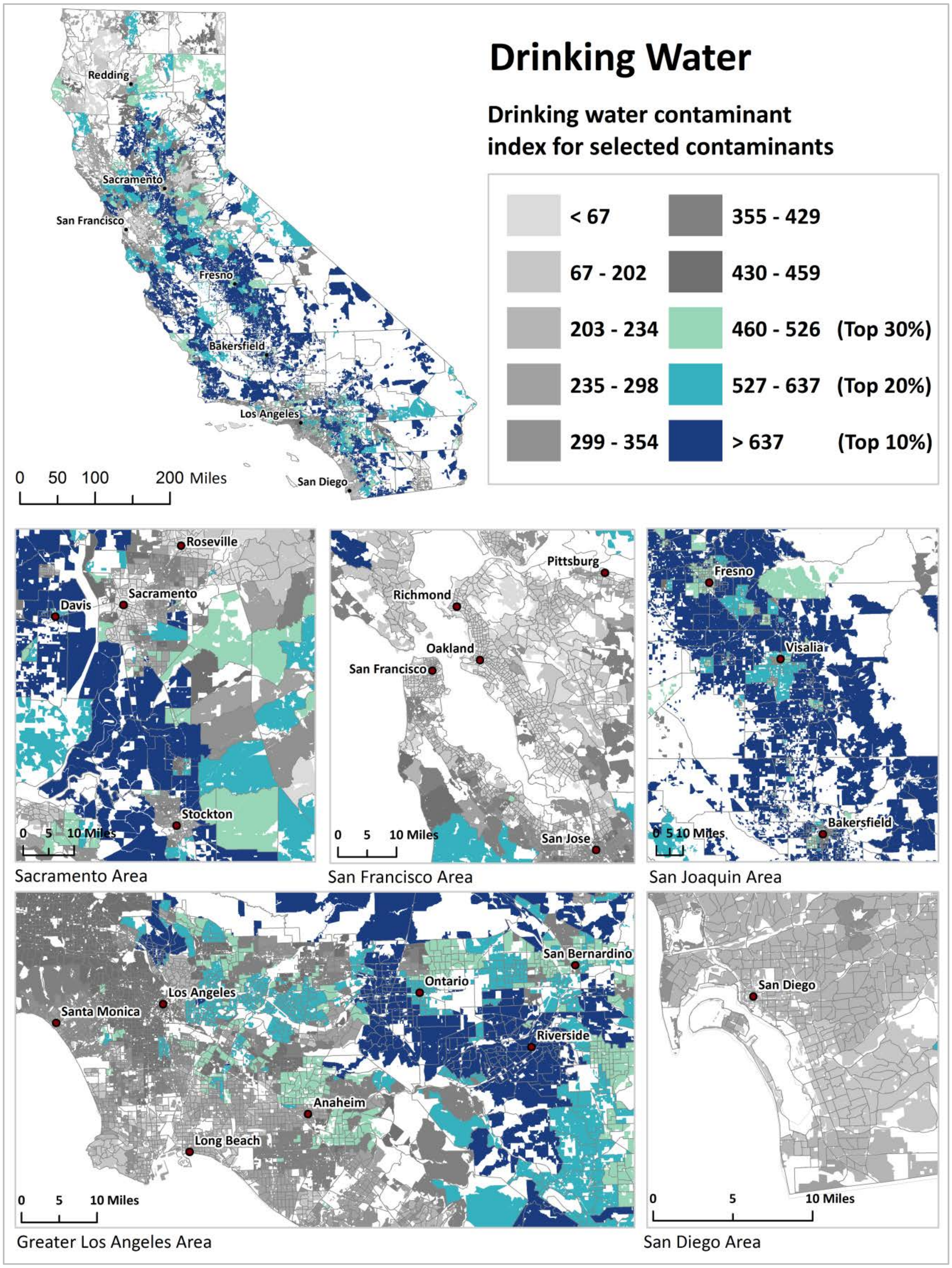

Figure 8. Statewide map of proposed drinking water quality indicator results.