

Water System Boundaries Version 2.0

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File name: CWS_v2_082123_Full.shp; CWS_v2_082123_Downloadable.shp*

Spatial Reference

Geographic Coordinate System	NAD 1983	Projected Coordinate System	NAD 1983 (Teale) Albers (Meters)
WKID	4269	Projection	3310
Authority	EPSG	Authority	EPSG
Angular Unit	Degree (0.0174532925199433)	Linear Unit	Meters (1.0)
Prime Meridian	Greenwich (0.0)	False Easting	0.00
Datum	D North American 1983	False Northing	-4000000.0
Spheroid	GRS 1980	Central Meridian	-120.0
Semimajor Axis	6378137.0	Standard Parallel 1	34.0
Semiminor Axis	6356752.314140356	Standard Parallel 2	40.5
Inverse Flattening	298.257222101	Latitude of Origin	0.0

Description

This file contains spatial geography for 4,035 water systems in California; 2,917 boundaries maintained by the California State Water Resources Control Board (Water Board) and processed by Cal EPA Office of Environmental Health Hazard Assessment for CalEnviroScreen 4.0 (CES4.0)¹, and 1,271 boundaries from the Monterey County Department of Public Health². Statewide boundaries originating from the Water Board include community water systems (CWS)--systems with 15 or more service connections or serving 25 or more people at least 6-months out of the year, and State Small Water Systems (SSWS)--5-14 service connections. Limited statewide boundaries were available for SSWS (less than 10% of estimated SSWS have polygon boundaries). We integrated regional water system boundaries provided by Monterey County, a dataset unique to Monterey County that includes State Small Water Systems (SSWS)--5-14 service connections; Local Small Water Systems (LSWS) --2-4 service connections; Transient non-community (TNC) and Non-transient non-community (NTNC) (i.e. parks and schools, respectively) and boundaries for public water systems that are monitored by Monterey County, the Local Primacy Agency (LPA). Boundaries were cleaned and integrated into a single layer. Statewide, we estimate that 37.6 million people are served by a water system included in this dataset. Appendix A provides a breakdown of water systems by type. NTNC and TNC systems were excluded in the statewide dataset but retained in Monterey county.

Water quality estimates for arsenic, nitrate, hexavalent chromium (Cr[VI]) and 123-trichloropropane (123-TCP) originate from two sources. Water systems in CES4.0 received a water quality estimate representing the 9-year system average for water delivered to the customer. Water systems from the

Monterey County Department of Public Health received annual maximum measured water quality for each year from 2015-2020, and the overall maximum measured concentration from 2015-2020.

Each water system includes demographic data from the US Census Bureau's American Community Survey 2017-2021 5-year estimates for race/ethnicity, median household income, and disadvantaged community status (DAC)^{3,4}. Demographic data was originally downloaded at the block group level and aggregated to water systems using areal apportionment.

Methods

Cleaning State and local Small water system boundaries and LPA boundaries

1. Identified duplicate systems with the same system ID. Several systems were in the dataset twice because they are monitored by local primacy agency (LPA) and county small water system (SWS) program. In the case of duplicates, we retained boundaries from SWS under recommendation from the Community Water Center (CWC) based on local knowledge.
2. Identified overlapping geography by intersecting systems monitored by LPA and SWS. Overlapping geography was assigned to the smaller system (typically the SWS).
3. Manually cleaned boundaries for Visalia to match [CalWater](#)⁵ service area map, available online.
4. Manually cleaned boundaries for Porterville water system at request of CWC (Porterville consolidated the Central Mutual Water Co. several years ago but the updated boundary was not reflected in CES4.0).
5. Manually removed slivers (i.e. small polygons created by merging geography from different polygons) from CA4810001 (Elmira system in Vacaville, CA).

Combining SWS and Public water system (PWS) boundaries and removing slivers

1. Removed overlaps in PWS boundaries (assigned overlaps to smaller systems).
2. Removed overlaps between Monterey county system boundaries and Statewide PWS (assigned overlaps to smaller systems)
3. Combined Monterey and Statewide systems into a single shapefile.
4. Identified slivers (small polygons) created in step 4; New slivers of 5 meters or less were merged with the water system sharing the longest border.
5. Manually fixed boundary for Maywood systems 1, 2, 3 based on the [Luskin](#)⁶ Water Systems Governance Map.

Assigning Water Quality

1. Assigned time weighted 9-year estimates for delivered water quality for nitrate as N, arsenic, hexavalent chromium, and 123-TCP. Data was processed and shared by OEHHA and originally developed for CES4.0.
 - 2,930 joined by system ID
 - 2,812 received water quality data for one or more contaminant
 - 115 (3.92%) were missing water quality data
 - 13% received a concentration of "0", indicating that all measurement were below the detection limit

2. Assigned 1-year maximum measured water quality for nitrate as N, arsenic, and chromium[VI]. Data was shared by Monterey County and processed by Ananya Subramanian and Clare Pace. Most systems in this dataset were sampled once every year or once every two years.
 - 1,271 systems joined by system ID
 - 956 received water quality data for at least one contaminant for at least one year.
 - One system (CA2700802) received water quality data for nitrate from both CES4.0 and Monterey County:
 - o CES4.0: 9-year avg Nitrate = 6.55
 - o Monterey County: Max Nitrate 2015-2020: NA; 6.5; 6.8, 6.8; 6.5; 6.5

Assigning population estimates to water systems

1. First, assigned population by areal apportionment using [Depsky, 2020](#) population grid⁷.
2. If resulting population was considered implausible (less than 25 people for CWS (n=1,542); less than 8 people for SSWS; and less than 2 people for local small water system (LSWS), then we used the following steps to estimate the population:
 - a. Used the Safe Drinking Water Information System (SDWIS)⁸ population estimate if the SDWIS population was greater than or equal to the above cutoff.
 - b. If the population estimate from SDWIS was below the cutoff, we multiplied the number of service connections reported in SDWIS by 3 to get a new population (n=655)
 - c. Manually checked all remaining systems with low population. All were plausible: remaining systems with low population were categorized as ‘non-community’ type systems “NTNC” or “TNC.” These include 14 systems have 0 pop; 152 have a population under 25).
3. Adjusted for potential well users
 - a. Summed domestic wells in overlapping water system/DWA areas⁹
 - b. We explored a matrix of options for calculating the number of people served by each well across the state. Factors that we considered were the number of wells that are active/in use (i.e. activity weight), the number of wells that may be missing from the OSWCR dataset (i.e. completeness weight), and the number of people in each household (i.e. population weight).
 - c. Subtracted potential (low, moderate, high) estimated well populations in PWS areas from respective water system and evaluated for plausibility (i.e. determined how many “adjusted” water system populations would be below population limits established in step 2.
 - d. Based on our results and consultation with our technical advisory committee, we assigned a weight of 1 person to each domestic well. Under these conditions only 14 systems received implausible population estimates.
 - e. For the 14 systems flagged in step 3d –we make a final adjustment: We assumed that the corresponding wells are not active and we did not adjust the final population estimates by shifting these people from water system population to DWA population. This impacted 558 people statewide.
 - f. In all, we shifted a total of 58,898 people from water system areas and added them to their respective domestic well areas (DWAs).

Assigning water system demographics

1. Calculated areal weights
 - a. Calculated the area in km² of California block group (BG) geography
 - i. Created a feature layer, setting use ratio policy for the area field
 - b. Calculated the area in km² for the water system boundaries
 - c. Performed spatial intersect between the water systems layer (rank 1) and the block group feature layer (rank 2)
 - d. Calculated areal weights by dividing the intersected block group area by the total area of the water system
2. Assigned block group level 2021 American Community Survey (ACS) of the US Census 5-year data to water system boundaries
 - a. Joined ACS data to the intersected water system/BG layer by GEOID
 - b. Multiplied race/ethnicity proportions by the areal weights
 - c. Multiplied median household income (MHI) by the areal weights
3. Assigned missing MHI data to water systems
 - a. Selected the 2,325 block group sections missing MHI data
 - i. Assigned the missing block group sections MHI data at the census tract level
 - b. Selected the 430 block group sections still missing MHI data
 - i. Assigned the missing block group sections MHI data at the county subdivision level
 - ii. *Note:* Because county subdivisions do *not* share a GEOID with block groups, county subdivision data was spatially joined to the intersected water system/BG layer by centroid
 - c. Repeated step 2c.
4. Summed demographic data by water system
 - a. Dissolved the intersected water system/BG layer by system ID
 - b. Calculated the sum of race/ethnicity proportions and MHI per water system
 - c. Identified and created new binary variables for disadvantaged community (DAC) and severely disadvantaged community (SDAC) communities (1=yes, 0=no)
 - i. A DAC has MHI of less than 80% of California’s overall MHI. A SDAC has an average MHI of less than 60% of California’s overall MHI. In 2021, the statewide MHI was \$84,097. The calculated DAC threshold is \$67,278 and the calculated SDAC threshold is \$50,458. Census geographies with MHIs below \$67,278 are labeled DACs and MHIs below \$50,458 are labeled SDACs.

Attribute Table

	Field Heading	Field Description	Source
	FID	Field ID	ESRI generated
	Shape	Polygon ZM	ESRI generated

Water System Information	Sys_ID	Water system ID	CalEnviroscreen 4.0 (CES) ¹ /Monterey County dataset ²
	Name	Water System name	CES/Monterey County
	TYPE	<p>COMMUNITY</p> <ul style="list-style-type: none"> 15 or more service connections or serving 25 or more residential customers at least 60 days of the year <p>NTNC</p> <ul style="list-style-type: none"> Non-Transient non-community (i.e. school or business) <p>TNC</p> <ul style="list-style-type: none"> transient non-community (i.e. park or motel) <p>STATE SMALL WS</p> <ul style="list-style-type: none"> 5-14 service connections <p>LOCAL SMALL WS</p> <ul style="list-style-type: none"> 2-4 service connections serving households <p>OTHER</p>	CES/Monterey County
	REG_TYPE	<p>Regulatory type</p> <p>PUBLIC = public water system</p> <p>SSWS = small water system (regulated by county)</p> <p>LSWS = local small water system (no federal requirements to monitor)</p> <p>NP = Non-public</p>	CES/Monterey County
Geog	<p>Geography source</p> <p>OEHHA (statewide):</p> <ul style="list-style-type: none"> OEHHA = boundary developed/modified by Cal EPA OEHHA for CES 4.0 LADWP boundary = shared by LA Department of Water Projects, used in CES 4.0 WBT = boundary from water boundary tool , used in CES 4.0 	CES/Monterey County/WESS	

		<ul style="list-style-type: none"> ● WESS = from WBT, modified by WESS ● LADWP - WESS = shared by LA DWP, modified by WESS <p>EJCW (Monterey county only)</p> <ul style="list-style-type: none"> ● EJCW - shared by Monterey county ● EJCW - LPA shared by Monterey County, originating from a subset of Monterey systems monitored by local primacy agency 	
	In_CES4	YES – boundary included in CalEnviroscreen 4.0 NO – not included	WESS
	In_EJCW	YES – boundary included in Monterey county tool developed by Environmental Justice Coalition for Water (EJCW) NO-not included	WESS
	primary_wa	Primary water source: Groundwater, Purchased Groundwater, Surface Water, Purchased Surface Water	SWRCB/WESS
	Dwell_CWS	Count of domestic wells within the water system boundary	WESS
Water Quality*	WQ_CES4	Yes No	WESS
	As_ugL_9y	Average arsenic (ug/L) shared by OEHHA, CES4.0 2011-2019 (MCL = 10 µg/L) -999 = no data	CES
	N_mgL_9y	Average nitrate as N (mg/L) 2011-2019, shared by OEHHA, CES4.0 (MCL = 10 mg/L) -999 = no data	CES
	CR_ugL_9y	Average hexavalent chromium shared by OEHHA, CES4.0 Former MCL = 10 µg/L -999 = no data	CES

TCP_ugL9y	Average 1,2,3-trichloropropane (TCP) (ug/L) shared by OEHHA, CES4.0 2011-2019 (MCL = .005 µg/L) -999 = no data	CES
WQ_EJCW	Yes/No – indicates whether water quality data is available from Monterey county dataset	Monterey County
N_15_max	Maximum nitrate (mg/L) 2015	Monterey County
N_16_max	Maximum nitrate (mg/L) 2016	Monterey County
N_17_max	Maximum nitrate (mg/L) 2017	Monterey County
N_18_max	Maximum nitrate (mg/L) 2018	Monterey County
N_19_max	Maximum nitrate (mg/L) 2019	Monterey County
N_20_max	Maximum nitrate (mg/L) 2020	Monterey County
NMax15_20	Maximum measured nitrate (mg/L) 2015-2020	Monterey County
As_15_max	Maximum arsenic (µg/L) 2015	Monterey County
As_16_max	Maximum arsenic (µg/L) 2016	Monterey County
As_17_max	Maximum arsenic (µg/L) 2017	Monterey County
As_18_max	Maximum arsenic (µg/L) 2018	Monterey County
As_19_max	Maximum arsenic (µg/L) 2019	Monterey County
As_20_max	Maximum arsenic (µg/L) 2019	Monterey County

	AsMax15_20	Maximum measured arsenic ($\mu\text{g/L}$) 2015-2020	Monterey County
	Cr6_16_max	Maximum Cr[VI] ($\mu\text{g/L}$) 2016	Monterey County
	Cr6_17_max	Maximum Cr[VI] ($\mu\text{g/L}$) 2017	Monterey County
	Cr6Max16_17	Maximum Cr[VI] ($\mu\text{g/l}$) 2016-2017 these are the only years we currently have data	Monterey County
Population	Final_pop	Estimated population of water system	WESS
Demographics	prp_nl_wht	Proportion of the population served that identifies as Non-Latinx White	ACS/WESS
	prp_latinx	Proportion of the population served that identifies as Latinx	ACS/WESS
	prp_nl_blk	Proportion of the population served that identifies as Non-Latinx Black	ACS/WESS
	prp_nl_asn	Proportion of the population served that identifies as Non-Latinx Asian	ACS/WESS
	prp_nl_pac	Proportion of the population served that identifies as Non-Latinx Pacific Islander	ACS/WESS
	prp_nl_nat	Proportion of the population served that identifies as Non-Latinx Native American	ACS/WESS
	prp_nl_oth	Proportion of the population served that identifies as Non-Latinx Other	ACS/WESS
	prp_nl_mix	Proportion of the population served that identifies as Non-Latinx Mixed/Multiple	ACS/WESS
	mhi	Median household income of the community served by a water system	ACS/WESS
	disadv	Disadvantaged community status of the community served by a water system 1 = yes; 0 = no	ACS/WESS
	sev_disadv	Severely disadvantaged community status of the community served by a water system	ACS/WESS

		1 = yes 0 = no	
	Shape_Length	Length in meters	ESRI generated
	Shape_Area	Area in square meters	ESRI generated

*Water quality data is not currently available in the downloadable water systems shapefile but can be accessed as follows:

The drinking water contaminant data is available for download from OEHHA for public and state small water systems

<https://oehha.ca.gov/calenviroscreen/indicator/drinking-water-contaminants>

Water quality data for public and state small water systems in Monterey, CA.

<https://www.co.monterey.ca.us/government/departments-a-h/health/environmental-health/drinking-water-protection>

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References

1. Community water system boundaries, CalEnviroScreen 4.0. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, 2021, 207. Available from <https://oehha.ca.gov/media/downloads/calenviroscreen/report/calenviroscreen40reportf2021.pdf>. Accessed September 2022.
2. State small water system boundaries (2022), Monterey County, CA. Available from <https://www.co.monterey.ca.us/government/departments-a-h/health/environmental-health/drinking-water-protection/state-and-local> Accessed September 15, 2022.
3. U.S. Census Bureau. B03002: HISPANIC OR LATINO ORIGIN ... - Census Bureau Table. 2017-2021 American Community Survey 5-Year Estimates. Available from <https://data.census.gov/table?q=B03002>
4. U.S. Census Bureau. B19013: MEDIAN HOUSEHOLD INCOME IN ... - Census Bureau Table. 2017-2021 American Community Survey 5-Year Estimates. Available from <https://data.census.gov/table?q=B19013>
5. CalWater service area boundaries. Available from https://www.calwater.com/docs/rates/rates_tariffs/vis/Service_Area_Map/20200822-Visalia_SA_M.pdf. Accessed August 12, 2022.
6. Los Angeles County Water Governance Mapping Tool. Available from <https://innovation.luskin.ucla.edu/los-angeles-county-water-governance-mapping-tool/>. Accessed October 15, 2022.
7. Depsky, N., L. Cushing, & R. Morello-Frosch. (2022). *High-resolution gridded estimates of population and sociodemographics from the 2020 census in California*. PLOS ONE. Available from <https://doi.org/10.1371/journal.pone.0270746>.

8. Water system search database, California Water Board. Available from <https://sdwis.waterboards.ca.gov/PDWW/JSP/SearchDispatch?number=&name=&county=&WaterSystemType=All&WaterSystemStatus=A&SourceWaterType=All&action=Search+For+Water+Systems>. Accessed August 18, 2023.
9. Rempel, J.* , C. Pace* , L. Cushing, R. Morello-Frosch. (2023). Domestic Well Areas Version 2.0. Drinking Water Tool metadata, prepared by the Water Equity Science Shop, UC Berkeley.
*Designates shared co-first authorship.