

Figure 33 Sacramento River Hydrologic Region

Basins and Subbasins of the Sacramento River Hydrologic Region

Basin/subbasins	Basin name	Basin/subbasins	Basin name
5-1	Goose Lake Valley	5-30	Lower Lake Valley
5-1.01	Lower Goose Lake Valley	5-31	Long Valley
5-1.02	Fandango Valley	5-35	Mccloud Area
5-2	Alturas Area	5-36	Round Valley
5-2.01	South Fork Pitt River	5-37	Toad Well Area
5-2.02	Warm Springs Valley	5-38	Pondosa Town Area
5-3	Jess Valley	5-40	Hot Springs Valley
5-4	Big Valley	5-41	Egg Lake Valley
5-5	Fall River Valley	5-43	Rock Prairie Valley
5-6	Redding Area	5-44	Long Valley
5-6.01	Bowman	5-45	Cayton Valley
5-6.02	Rosewood	5-46	Lake Britton Area
5-6.03	Anderson	5-47	Goose Valley
5-6.04	Enterprise	5-48	Burney Creek Valley
5-6.05	Millville	5-49	Dry Burney Creek Valley
5-6.06	South Battle Creek	5-50	North Fork Battle Creek
5-7	Lake Almanor Valley	5-51	Butte Creek Valley
5-8	Mountain Meadows Valley	5-52	Gray Valley
5-9	Indian Valley	5-53	Dixie Valley
5-10	American Valley	5-54	Ash Valley
5-11	Mohawk Valley	5-56	Yellow Creek Valley
5-12	Sierra Valley	5-57	Last Chance Creek Valley
5-12.01	Sierra Valley	5-58	Clover Valley
5-12.02	Chilcoot	5-59	Grizzly Valley
5-13	Upper Lake Valley	5-60	Humbug Valley
5-14	Scotts Valley	5-61	Chrome Town Area
5-15	Big Valley	5-62	Elk Creek Area
5-16	High Valley	5-63	Stonyford Town Area
5-17	Burns Valley	5-64	Bear Valley
5-18	Coyote Valley	5-65	Little Indian Valley
5-19	Collayomi Valley	5-66	Clear Lake Cache Formation
5-20	Berryessa Valley	5-68	Pope Valley
5-21	Sacramento Valley	5-86	Joseph Creek
5-21.50	Red Bluff	5-87	Middle Fork Feather River
5-21.51	Corning	5-88	Stony Gorge Reservoir
5-21.52	Colusa	5-89	Squaw Flat
5-21.53	Bend	5-90	Funks Creek
5-21.54	Antelope	5-91	Antelope Creek
5-21.55	Dye Creek	5-92	Blanchard Valley
5-21.56	Los Molinos	5-93	North Fork Cache Creek
5-21.57	Vina	5-94	Middle Creek
5-21.58	West Butte	5-95	Meadow Valley
5-21.59	East Butte		
5-21.60	North Yuba		
5-21.61	South Yuba		
5-21.62	Sutter		
5-21.64	North American		
5-21.65	South American		
5-21.66	Solano		
5-21.67	Yolo		
5-21.68	Capay Valley		

Description of the Region

The Sacramento River HR covers approximately 17.4 million acres (27,200 square miles). The region includes all or large portions of Modoc, Siskiyou, Lassen, Shasta, Tehama, Glenn, Plumas, Butte, Colusa, Sutter, Yuba, Sierra, Nevada, Placer, Sacramento, El Dorado, Yolo, Solano, Lake, and Napa counties (Figure 33). Small areas of Alpine and Amador counties are also within the region. Geographically, the region extends south from the Modoc Plateau and Cascade Range at the Oregon border, to the Sacramento-San Joaquin Delta. The Sacramento Valley, which forms the core of the region, is bounded to the east by the crest of the Sierra Nevada and southern Cascades and to the west by the crest of the Coast Range and Klamath Mountains. Other significant features include Mount Shasta and Lassen Peak in the southern Cascades, Sutter Buttes in the south central portion of the valley, and the Sacramento River, which is the longest river system in the State of California with major tributaries the Pit, Feather, Yuba, Bear and American rivers. The region corresponds approximately to the northern half of RWQCB 5. The Sacramento metropolitan area and surrounding communities form the major population center of the region. With the exception of Redding, cities and towns to the north, while steadily increasing in size, are more rural than urban in nature, being based in major agricultural areas. The 1995 population of the entire region was 2.372 million.

The climate in the northern, high desert plateau area of the region is characterized by cold snowy winters with only moderate precipitation and hot dry summers. This area depends on adequate snowpack to provide runoff for summer supply. Annual precipitation ranges from 10 to 20 inches. Other mountainous areas in the northern and eastern portions of the region have cold wet winters with large amounts of snow, which typically provide abundant runoff for summer supplies. Annual precipitation ranges from 40 to more than 80 inches. Summers are generally mild in these areas. The Coast Range and southern Klamath Mountains receive copious amounts of precipitation, but most of the runoff flows to the coast in the North Coastal drainage. Sacramento Valley comprises the remainder of the region. At a much lower elevation than the rest of the region, the valley has mild winters with moderate precipitation. Annual precipitation varies from about 35 inches in Redding to about 18 inches in Sacramento. Summers in the valley are hot and dry.

Most of the mountainous portions of the region are heavily forested and sparsely populated. Three major national forests (Mendocino, Trinity, and Shasta) make up the majority of lands in the Coast Range, southern Klamath Mountains, and the southern Cascades; these forests and the region's rivers and lakes provide abundant recreational opportunities. In the few mountain valleys with arable land, alfalfa, grain and pasture are the predominant crops. In the foothill areas of the region, particularly adjacent to urban centers, suburban to rural housing development is occurring along major highway corridors. This development is leading to urban sprawl and is replacing the former agricultural production on those lands. In the Sacramento Valley, agriculture is the largest industry. Truck, field, orchard, and rice crops are grown on approximately 2.1 million acres. Rice represents about 23 percent of the total irrigated acreage.

The Sacramento River HR is the main water supply for much of California's urban and agricultural areas. Annual runoff in the HR averages about 22.4 maf, which is nearly one-third of the State's total natural runoff. Major water supplies in the region are provided through surface storage reservoirs. The two largest surface water projects in the region are USBR's Shasta Lake (Central Valley Project) on the upper Sacramento River and Lake Oroville (DWR's State Water Project) on the Feather River. In all, there are more than 40 major surface water reservoirs in the region. Municipal, industrial, and agricultural supplies to the region are about 8 maf, with groundwater providing about 2.5 maf of that total. Much of the remainder of the runoff goes to dedicated natural flows, which support various environmental requirements, including in-stream fishery flows and flushing flows in the Delta.

Groundwater Development

Groundwater provides about 31 percent of the water supply for urban and agricultural uses in the region, and has been developed in both the alluvial basins and the hard rock uplands and mountains. There are 88 basins/subbasins delineated in the region. These basins underlie 5.053 million acres (7,900 square miles), about 29 percent of the entire region. The reliability of the groundwater supply varies greatly. The Sacramento Valley is recognized as one of the foremost groundwater basins in the State, and wells developed in the sediments of the valley provide excellent supply to irrigation, municipal, and domestic uses. Many of the mountain valleys of the region also provide significant groundwater supplies to multiple uses.

Geologically, the Sacramento Valley is a large trough filled with sediments having variable permeabilities; as a result, wells developed in areas with coarser aquifer materials will produce larger amounts of water than wells developed in fine aquifer materials. In general, well yields are good and range from one-hundred to several thousand gallons per minute. Because surface water supplies have been so abundant in the valley, groundwater development for agriculture primarily supplement the surface supply. With the changing environmental laws and requirements, this balance is shifting to a greater reliance on groundwater, and conjunctive use of both supplies is occurring to a greater extent throughout the valley, particularly in drought years. Groundwater provides all or a portion of municipal supply in many valley towns and cities. Redding, Anderson, Chico, Marysville, Sacramento, Olivehurst, Wheatland, Willows, and Williams rely to differing degrees on groundwater. Red Bluff, Corning, Woodland, Davis, and Dixon are completely dependent on groundwater. Domestic use of groundwater varies, but in general, rural unincorporated areas rely completely on groundwater.

In the mountain valleys and basins with arable land, groundwater has been developed to supplement surface water supplies. Most of the rivers and streams of the area have adjudicated water rights that go back to the early 1900s, and diversion of surface water has historically supported agriculture. Droughts and increased competition for supply have led to significant development of groundwater for irrigation. In some basins, the fractured volcanic rock underlying the alluvial fill is the major aquifer for the area. In the rural mountain areas of the region, domestic supplies come almost entirely from groundwater. Although a few mountain communities are supplied in part by surface water, most rely on groundwater. These groundwater supplies are generally quite reliable in areas that have sufficient aquifer storage or where surface water replenishes supply throughout the year. In areas that depend on sustained runoff, water levels can be significantly depleted in drought years and many old, shallow wells can be dewatered. During 2001, an extreme drought year on the Modoc Plateau, many well owners experienced problems with water supply.

Groundwater development in the fractured rocks of the foothills of the southern Cascades and Sierra Nevada is fraught with uncertainty. Groundwater supplies from fractured rock sources are highly variable in terms of water quantity and water quality and are an uncertain source for large-scale residential development. Originally, foothill development relied on water supply from springs and river diversions with flumes and ditches for conveyance that date back to gold mining era operations. Current development is primarily based on individual private wells, and as pressures for larger scale development increase, questions about the reliability of supply need to be addressed. Many existing foothill communities have considerable experience with dry or drought year shortages. In Butte County residents in Cohasset, Forest Ranch, and Magalia have had to rely on water brought up the ridges in tanker trucks. The suggested answer has been the development of regional water supply projects. Unfortunately, the area's development pattern of small, geographically dispersed population centers does not lend itself to the kind of financial base necessary to support such projects.

Groundwater Quality

Groundwater quality in the Sacramento River HR is generally excellent. However, there are areas with local groundwater problems. Natural water quality impairments occur at the north end of the Sacramento Valley in the Redding subbasin, and along the margins of the valley and around the Sutter Buttes, where Cretaceous-age marine sedimentary rocks containing brackish to saline water are near the surface. Water from the older underlying sediments mixes with the fresh water in the younger alluvial aquifer and degrades the quality. Wells constructed in these areas typically have high TDS. Other local natural impairments are moderate levels of hydrogen sulfide in groundwater in the volcanic and geothermal areas in the western portion of the region. In the Sierra foothills, there is potential for encountering uranium and radon-bearing rock or sulfide mineral deposits containing heavy metals. Human-induced impairments are generally associated with individual septic system development in shallow unconfined portions of aquifers or in fractured hard rock areas where insufficient soil depths are available to properly leach effluent before it reaches the local groundwater supply.

Water Quality in Public Supply Wells

From 1994 through 2000, 1,356 public supply water wells were sampled in 51 of the 88 basins and subbasins in the Sacramento River HR. Samples analyzed indicate that 1,282 wells, or 95 percent, met the state primary MCLs for drinking water. Seventy-four wells, or 5 percent, have constituents that exceed one or more MCL. Figure 34 shows the percentages of each contaminant group that exceeded MCLs in the 74 wells.

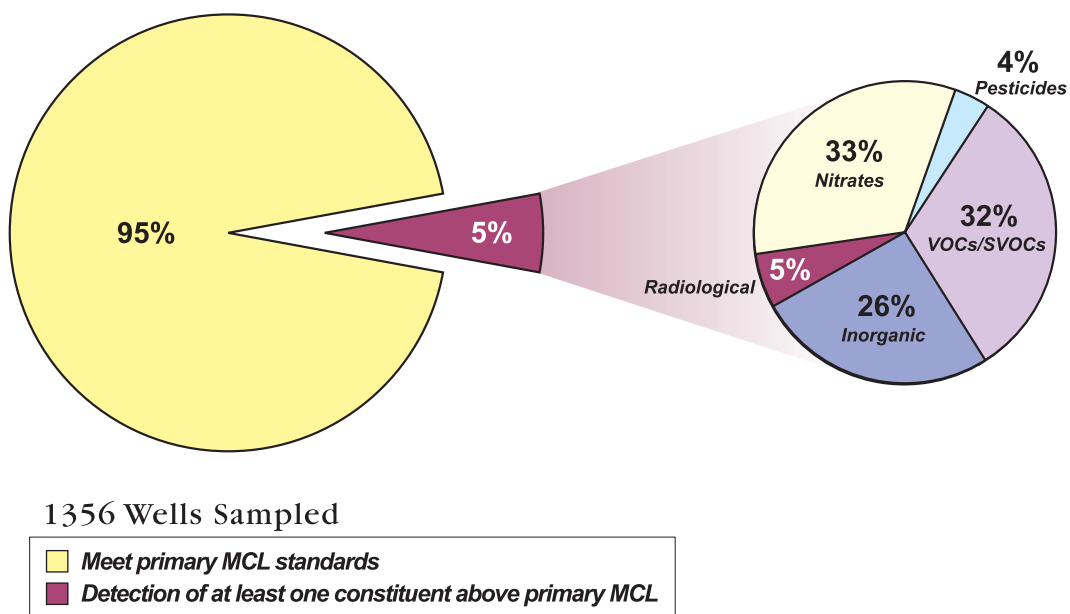


Figure 34 MCL exceedances in public supply wells in the Sacramento River Hydrologic Region

Table 25 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 25 Most frequently occurring contaminants by contaminant group in the Sacramento River Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics – Primary	Cadmium – 4	Chromium (Total) – 3	3 tied at 2
Inorganics – Secondary	Manganese – 221	Iron – 166	Specific Conductance – 3
Radiological	Gross Alpha – 4		
Nitrates	Nitrate (as NO ₃) – 22	Nitrate + Nitrite – 5	Nitrate Nitrogen (NO ₃ -N) – 2
Pesticides	Di(2-Ethylhexyl)phthalate – 4		
VOCs/SVOCs	PCE – 11	TCE – 7	Benzene – 4

PCE = Tetrachloroethylene
TCE = Trichloroethylene
VOC = Volatile Organic Compounds
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

Some modifications from the groundwater basins presented in Bulletin 118-80 are incorporated in this report. These are listed in Table 26.

Table 26 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Sacramento River Hydrologic Region

Basin name	New number	Old number
Fandango Valley	5-1.02	5-39
Bucher Swamp Valley	deleted	5-42
Modoc Plateau Recent Volcanic Areas	deleted	5-32
Modoc Plateau Pleistocene Volcanic Areas	deleted	5-33
Mount Shasta Area	deleted	5-34
Sacramento Valley Eastside Tuscan Formation Highlands	deleted	5-55
Clear Lake Pleistocene Volcanics	deleted	5-67

No additional basins were assigned to the Sacramento River HR in this revision. However, four basins have been divided into subbasins. Goose Lake Valley Groundwater Basin (5-1) has been subdivided into two subbasins, Fandango Valley (5-39) was modified to be a subbasin of Goose Lake Valley. Redding Area Groundwater Basin has been subdivided into six subbasins, Sierra Valley Groundwater Basin has been subdivided into two subbasins, and the Sacramento Valley Groundwater Basin has been subdivided into 18 subbasins.

There are several deletions of groundwater basins from Bulletin 118-80. Bucher Swamp Valley Basin (5-42) was deleted due to a thin veneer of alluvium over rock. Modoc Plateau Recent Volcanic Areas (5-32), Modoc Plateau Pleistocene Volcanic Areas (5-33), Mount Shasta Area (5-34), Sacramento Valley Eastside Tuscan Formation Highlands (5-55), and Clear Lake Pleistocene Volcanics (5-67) are volcanic aquifers and were not assigned basin numbers in this bulletin. These are considered to be groundwater source areas as discussed in Chapter 6.

Table 27 Sacramento River Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-1	GOOSE LAKE VALLEY									
5-1.01	LOWER GOOSE LAKE	36,000	B	-	400	9	9	-	183	68 - 528
5-1.02	FANDANGO VALLEY	18,500	B	2,000	-	3	-	-	-	-
5-2	ALTURAS AREA									
5-2.01	SOUTH FORK PITT RIVER	114,000	B	5,000	1,075	9	-	8	-	-
5-2.02	WARM SPRINGS VALLEY	68,000	B	400	314	3	-	11	-	-
5-3	JESS VALLEY	6,700	B	-	3,000	-	-	-	-	-
5-4	BIG VALLEY	92,000	B	4,000	880	19	9	10	260	141 - 633
5-5	FALL RIVER VALLEY	54,800	B	1,500	266	16	7	3	174	115 - 232
5-6	REDDING AREA									
5-6.01	BOWMAN	85,330	B	2,000	589	8	2	13	-	70 - 247
5-6.02	ROSEWOOD	45,320	B	-	-	4	-	-	-	118 - 218
5-6.03	ANDERSON	98,500	B	1,800	46	11	10	69	194	109-320
5-6.04	ENTERPRISE	60,900	B	700	266	11	3	43	-	160 - 210
5-6.05	MILLVILLE	67,900	B	500	254	6	5	4	140	-
5-6.06	SOUTH BATTLE CREEK	32,300	B	-	-	0	0	0	360	-
5-7	LAKE ALMANOR VALLEY	7,150	B	-	-	10	4	4	105	53 - 260
5-8	MOUNTAIN MEADOWS VALLEY	8,150	B	-	-	-	-	-	-	-
5-9	INDIAN VALLEY	29,400	B	-	-	-	4	9	-	-
5-10	AMERICAN VALLEY	6,800	B	40	40	-	4	11	-	-
5-11	MOHAWK VALLEY	19,000	B	-	500	1	2	15	248	210 - 285
5-12	SIERRA VALLEY									
5-12.01	SIERRA VALLEY	117,700	B	1,500	640	34	15	9	312	110 - 1,620
5-12.02	CHILCOOT	7,550	B	-	-	15	-	8	-	-
5-13	UPPER LAKE VALLEY	7,260	B	900	302	12	3	6	-	-
5-14	SCOTTS VALLEY	7,320	B	1,200	171	9	1	9	158	140 - 175
5-15	BIG VALLEY	24,210	B	1,470	475	49	11	7	535	270 - 790
5-16	HIGH VALLEY	2,360	B	100	37	5	2	-	598	480 - 745
5-17	BURNS VALLEY	2,900	B	-	30	1	5	-	335	280 - 455
5-18	COYOTE VALLEY	6,530	B	800	446	6	3	3	288	175 - 390
5-19	COLLAYOMI VALLEY	6,500	B	1,000	121	10	4	3	202	150 - 255
5-20	BERRYESSA VALLEY	1,400	C	-	-	0	-	0	-	-
5-21	SACRAMENTO VALLEY									
5-21.50	RED BLUFF	266,750	B	1,200	363	30	10	56	207	120 - 500
5-21.51	CORNING	205,640	B	3,500	977	29	7	30	286	130 - 490
5-21.52	COLUSA	918,380	B	5,600	984	98	30	134	391	120 - 1,220
5-21.53	BEND	20,770	B	-	275	0	3	9	-	334-360
5-21.54	ANTELOPE	18,710	B	800	575	4	5	22	296	-
5-21.55	DYE CREEK	27,730	B	3,300	890	8	1	3	240	159 - 396
5-21.56	LOS MOLINOS	33,170	B	1,000	500	3	3	9	217	-
5-21.57	VINA	125,640	B	3,850	1,212	23	5	69	285	48 - 543
5-21.58	WEST BUTTE	181,600	B	4,000	1,833	32	8	36	293	130 - 676

Table 27 Sacramento River Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring				TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range	
5-21.59	EAST BUTTE	265,390	B	4,500	1,019	43	4	44	235	122 - 570	
5-21.60	NORTH YUBA	100,400	C	4,000	-	21	-	32	-	-	
5-21.61	SOUTH YUBA	107,000	C	4,000	1,650	56	-	6	-	-	
5-21.62	SUTTER	234,000	C	-	-	34	-	115	-	-	
5-21.64	NORTH AMERICAN	351,000	A	-	800	121	-	339	300	150 - 1,000	
5-21.65	SOUTH AMERICAN	248,000	C	-	-	105	-	247	221	24-581	
5-21.66	SOLANO	425,000	C	-	-	123	23	136	427	150 - 880	
5-21.67	YOLO	226,000	B	4,000+	1,000	127	20	185	880	480 - 2,060	
5-21.68	CAPAY VALLEY	25,000	C	-	-	11	-	3	-	-	
5-30	LOWER LAKE VALLEY	2,400	B	100	37	-	3	5	568	290 - 1,230	
5-31	LONG VALLEY	2,600	B	100	63	-	-	-	-	-	
5-35	MCCLLOUD AREA	21,320	B	-	380	-	-	1	-	-	
5-36	ROUND VALLEY	7,270	B	2,000	800	2	-	-	-	148 - 633	
5-37	TOAD WELL AREA	3,360	B	-	-	-	-	-	-	-	
5-38	PONDOSA TOWN AREA	2,080	B	-	-	-	-	-	-	-	
5-40	HOT SPRINGS VALLEY	2,400	B	-	-	-	-	-	-	-	
5-41	EGG LAKE VALLEY	4,100	B	-	20	-	-	-	-	-	
5-43	ROCK PRAIRIE VALLEY	5,740	B	-	-	-	-	-	-	-	
5-44	LONG VALLEY	1,090	B	-	-	-	-	-	-	-	
5-45	CAYTON VALLEY	1,300	B	-	400	-	-	-	-	-	
5-46	LAKE BRITTON AREA	14,060	B	-	-	-	-	2	-	-	
5-47	GOOSE VALLEY	4,210	B	-	-	-	-	-	-	-	
5-48	BURNEY CREEK VALLEY	2,350	B	-	-	-	-	2	-	-	
5-49	DRY BURNEY CREEK VALLEY	3,070	B	-	-	-	-	-	-	-	
5-50	NORTH FORK BATTLE CREEK VALLEY	12,760	B	-	-	-	-	3	-	-	
5-51	BUTTE CREEK VALLEY	3,230	B	-	-	-	-	-	-	-	
5-52	GRAYS VALLEY	5,440	B	-	-	-	-	-	-	-	
5-53	DIXIE VALLEY	4,870	B	-	-	-	-	-	-	-	
5-54	ASH VALLEY	6,010	B	3,000	2,200	-	-	-	-	-	
5-56	YELLOW CREEK VALLEY	2,310	B	-	-	-	-	-	-	-	
5-57	LAST CHANCE CREEK VALLEY	4,660	B	-	-	-	-	-	-	-	
5-58	CLOVER VALLEY	16,780	B	-	-	-	-	-	-	-	
5-59	GRIZZLY VALLEY	13,400	B	-	-	-	-	1	-	-	
5-60	HUMBUG VALLEY	9,980	B	-	-	-	-	8	-	-	
5-61	CHROME TOWN AREA	1,410	B	-	-	-	-	-	-	-	
5-62	ELK CREEK AREA	1,440	B	-	-	-	-	-	-	-	
5-63	STONYFORD TOWN AREA	6,440	B	-	-	-	-	-	-	-	
5-64	BEAR VALLEY	9,100	B	-	-	-	-	-	-	-	
5-65	LITTLE INDIAN VALLEY	1,270	B	-	-	-	-	-	-	-	
5-66	CLEAR LAKE CACHE FORMATION	30,000	B	245	52	-	-	4	-	-	
5-68	POPE VALLEY	7,180	C	-	-	-	-	1	-	-	
5-86	JOSEPH CREEK	4,450	B	-	-	-	-	-	-	-	

Table 27 Sacramento River Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-87	MIDDLE FORK FEATHER RIVER	4,340	B	-	-	-	-	2	-	-
5-88	STONY GORGE RESERVOIR	1,070	B	-	-	-	-	-	-	-
5-89	SQUAW FLAT	1,300	C	-	-	-	-	-	-	-
5-90	FUNKS CREEK	3,000	C	-	-	-	-	-	-	-
5-91	ANTELOPE CREEK	2,040	B	-	-	-	-	-	-	-
5-92	BLANCHARD VALLEY	2,200	B	-	-	-	-	-	-	-
5-93	NORTH FORK CACHE CREEK	3,470	C	-	-	-	-	-	-	-
5-94	MIDDLE CREEK	700	B	-	75	-	-	1	-	-
5-95	MEADOW VALLEY	5,730	B	-	-	-	-	1	-	-

gpm - gallons per minute

mg/L - milligram per liter

TDS -total dissolved solids

Sacramento Valley Groundwater Basin

Solano Subbasin

Groundwater Basin Number: 5-21.66

County: Solano, Sacramento, Yolo

Surface Area: 425,000 acres (664 square miles)

Basin Boundaries and Hydrologic Features

The Solano Subbasin lies in the southwestern portion of the Sacramento Basin and the northern portion of the Sacramento-San Joaquin Delta. The elevation varies from 120 feet in the northwest corner to sea level in the south. Subbasin boundaries are defined by; Putah Creek on the north, the Sacramento River on the East (from Sacramento to Walnut Grove), the North Mokelumne River on the southeast (from Walnut Grove to the San Joaquin River), and the San Joaquin River on the South (from the North Mokelumne River to the Sacramento River). The western subbasin border is defined by the hydrologic divide that separates lands draining to the San Francisco Bay from those draining to the Sacramento-San Joaquin River Delta. That divide is roughly delineated by the English Hills and the Montezuma Hills.

Primary waterways in and bordering the basin include the Sacramento, Mokelumne and San Joaquin Rivers, the Sacramento River Deep Water Ship Channel, and Putah Creek.

Annual precipitation averages in the basin range from approximately 23 inches in the western portion of the subbasin to 16 inches in the eastern portion of the basin.

Hydrogeologic Information

Water Bearing Formations

The primary water-bearing formations comprising the Solano subbasin are sedimentary continental deposits of Late Tertiary (Pliocene) to Quaternary (Recent) age. Fresh water-bearing units include younger alluvium, older alluvium, and the Tehama Formation (Thomasson and others 1960). The units pinch out near the Coast Range on the west and thicken to a section of nearly 3000 feet near the eastern margin of the basin. Saline water-bearing sedimentary units underlie the Tehama formation and are generally considered the saline water boundary (adapted from Thomasson and others, 1960).

Flood basin deposits occur along the eastern margin of the subbasin. These deposits consist primarily of silts and clays, and may be locally interbedded with stream channel deposits of the Sacramento River. In the delta, flood basin deposits contain a significant percentage of organic material (peat), and are sometimes mapped as peaty mud (Wagner and others 1987). Thickness of the unit ranges from 0 to 150 feet. The flood basin deposits have low permeability and generally yield low quantities of water to wells. Recent stream channel deposits consist of unconsolidated silt, fine- to medium-grained sand, gravel and in some cases cobbles deposited in and adjacent to active streams in the subbasin. They occur along the Sacramento, Mokelumne and San Joaquin Rivers, and the upper reaches of Putah Creek.

Thickness of the younger alluvium ranges from 0 to 40 feet, however with the exception of the Delta, they generally lie above the saturated zone.

Older alluvium consists of loose to moderately compacted silt, silty clay, sand, and gravel deposited in alluvial fans during the Pliocene and Pleistocene. Thickness of the unit ranges from 60 to 130 feet, about one-quarter of which is coarse sand and gravel generally found as lenses within finer sands, silts, and clays. Permeability of the older alluvium is highly variable. Wells penetrating sand and gravel lenses of the unit produce between 300 and 1000 gpm. Adjacent to the Sacramento River, wells completed in ancestral Sacramento River stream channel deposits yield up to 4000 gpm. Wells completed in the finer-grained portions of the older alluvium produce between 50 and 150 gpm.

The Tehama Formation is the thickest water-bearing unit underlying the Solano subbasin, ranging in thickness from 1500 to 2500 feet. Surface exposures of the Tehama Formation are limited mainly to the English Hills along the western margin of the basin. It consists of moderately compacted silt, clay, and silty fine sand enclosing lenses of sand and gravel, silt and gravel, and cemented conglomerate. Permeability of the Tehama Formation is variable, but generally less than the overlying younger units. Because of its relatively greater thickness, however, wells completed in the Tehama can yield up to several thousand gpm.

Underlying the Tehama Formation are brackish to saline water-bearing sedimentary units including the somewhat brackish sedimentary rocks of volcanic origin (Pliocene to Oligocene?) underlain by undifferentiated marine sedimentary rocks (Oligocene? to Paleocene). These units are typically of low permeability and contain connate water. The upper contact of these units generally coincides with the fresh/saline water boundary at depths as shallow as a few hundred feet near the Coast Range on the west to nearly 3000 feet near the eastern margin of the basin (Berkstresser and others 1973).

Groundwater Level Trends

Groundwater levels were measured at what we now consider to be natural, predevelopment levels in 1912 by the USGS. At that time the general direction of groundwater flow in this subbasin was from northwest to southeast. From 1912 to 1932, below-average precipitation resulted in lower groundwater levels throughout the basin. Due to above-average precipitation from 1932 and 1941 groundwater levels recovered slightly in spite of increased groundwater development. After 1941, groundwater levels continued to decline due to increasing agricultural and urban development, reaching their lowest historical levels in the late 1950s. A large pumping depression between Davis and Dixon was one of the more notable groundwater level depressions in the subbasin. Surface water deliveries from the Solano Project beginning in 1959 caused groundwater levels to rise slightly or slow their descent. Since this time, groundwater level trends within the Solano subbasin have been impacted by drought periods in the mid-1970s and late-1980s but have recovered quickly in the following "wet" years. (This discussion is taken largely from California Department of Water Resources, 1994.)

Groundwater Storage

Groundwater Storage Capacity. To date, there has been no groundwater storage calculation for the Solano subbasin as it is described by Bulletin 118. The USGS, however, has determined specific yield averages and groundwater storage calculations for some areas within and around the Solano subbasin (Thomasson and others 1960).

Groundwater in Storage. (see above)

Groundwater Budget (Type C)

Currently no groundwater budget has been calculated for the Solano Subbasin.

Groundwater Quality

Characterization. This discussion of groundwater quality is based on USGS Water Supply Investigation Report 84-4244 (Evenson, 1985) except where noted.

Groundwater within the Solano subbasin is considered to be of generally good quality, and useable for both domestic and agricultural purposes. Chemical water types within the basin are variable and classified generally as magnesium bicarbonate in the central and northern areas, sodium bicarbonate in the southern and eastern areas, and calcium magnesium or magnesium calcium bicarbonate around and west of Dixon. Total dissolved solids (TDS) range from between 250 and 500 ppm in the northwest and eastern portion of the basin and are found at levels higher than 500 ppm in the central and southern areas. (Evaluation of data from the Department of Health Services (Department of Health Services, 2000) shows the TDS minimum = 150 ppm, maximum = 880 ppm, average = 427 ppm). In general, most of the water within the subbasin is classified as hard to very hard (see below).

Chloride concentrations are found over 100 ppm in the southern areas, while sulfate concentration is greater than 50 ppm in the southern areas. The maximum contaminant level (MCL) for both chloride and sulfate is 600 ppm.) Boron concentrations are less than 0.75 ppm except in the southern and southeastern basin where concentrations average between 0.75 and 2.0 ppm (more than 1.0 ppm will affect sensitive tree crops).

Iron concentrations increase toward the eastern side of the subbasin, from less than 0.02 ppm to greater than 0.05 ppm (MCL = 0.3 ppm) along the Sacramento River, while manganese concentrations also increase from west to east with concentrations from .01 ppm to over 0.1 ppm (MCL = 0.050 ppm) found north of Rio Vista and east of the Solano-Yolo County line.

Impairments. Overall hardness (as CaCO₃) is generally greater than 180 ppm. Approximately one half of drinking water well samples taken between 1970 and 2000 analyzed for overall hardness measured above 200 ppm, but

rarely over 400 ppm (Department of Health Services 2000). High concentrations of bicarbonate which cause precipitation of Ca and Mg carbonates is found in the southern portion of the basin.

Arsenic concentrations are typically between 0.02 and 0.05 ppm, with the highest concentrations found along the southeastern margin of the basin. Although this is currently not considered problematic, there could be impacts if the MCL is lowered. The current MCL (as set by the EPA) for arsenic is 0.05 ppm. Also, manganese (a secondary constituent) is found at concentrations above the MCL of 0.05 ppm along the Sacramento River along the eastern portion of the subbasin.

Water Quality in Public Supply Wells

Constituent Group ¹	Number of wells sampled ²	Number of wells with a concentration above an MCL ³
Inorganics – Primary	71	1
Radiological	41	0
Nitrates	96	8
Pesticides	56	3
VOCs and SVOCs	57	1
Inorganics – Secondary	71	17

¹ A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).

² Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.

³ Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Characteristics

Well yields (gal/min)

Currently there is insufficient data to provide statistics on water well yields.

Total depths (ft) ¹

Domestic	Range: 38 to 1070 ft	Average: 239 ft
Municipal/Irrigation	Range: 62 to 2275 ft	Average: 510 ft

¹Based on DWR well completion report data from 2001.

Active Monitoring Data

Agency	Parameter	Number of wells / measurement frequency
DWR	Groundwater levels	35 semi-annually
Solano ID		7 monthly
USBR		2 monthly
DWR	Miscellaneous water quality	60 semi-annually
Department of Health Services and cooperators		12 monthly
	Title 22 water quality	23
		136

Basin Management

Groundwater management:	City of Vacaville adopted AB3030 plan in 2/95 Maine Prairie Water District adopted AB3030 plan in 1/97 Reclamation District #2068 adopted AB3030 plan in 1/97 Solano Irrigation District adopted AB3030 plan in 2/95
Water agencies	
Public	City of Dixon City of Rio Vista California Water Service City of Vacaville
Private	University of California, Davis Maine Prairie Water District Solano Irrigation District Solano County Water Agency North Delta Water Agency Reclamation District #501 Reclamation District #536 Reclamation District #1607 Reclamation District #1667 Reclamation District #2060 Reclamation District #2068 Reclamation District #2084 Reclamation District #2093 Reclamation District #2098 Reclamation District #2104 Reclamation District #2112

Cited References

- Berkstresser, C.F., Jr., 1973, Base of fresh ground-water -- approximately 3,000 micromhos - in the Sacramento Valley and Sacramento-San Joaquin Delta, California: U.S. Geological Survey Water-Resources Investigations 40-73, 1 map.
- California Department of Health Services, 2001. California Drinking Water Data: Drinking Water Program.
- California Department of Water Resources, 1994, Historical Ground Water Levels in Solano County, Central District Report, 386 p.
- Evenson, K.D., 1985, Chemical Quality of Ground Water in Yolo and Solano Counties, California. U.S. Geological Survey Water-Resource Investigations Report 84-4244.

- Solano Water Authority, 1995, Groundwater Conditions in Solano County: 1995 Annual Report.
- Thomasson, H.G., Jr., Olmsted F.H., and LeRoux E. F., 1960, Geology, water resources and usable ground-water storage capacity of part of Solano County, California: U.S. Geological Survey Water-Supply Paper 1464, 693 p.
- Wagner, D. L., Jennings, C. W., Bedrossian, T. L., and Bortugno, E. J., 1987, Geologic map of the Sacramento quadrangle: California Department of Conservation Division of Mines and Geology, 4 maps.

Additional References

- Bertoldi, G. L., 1974, Estimated permeabilities for soils in the Sacramento Valley, California: U.S. Geological Survey Water-Resources Investigations 51-73. 17p.
- Boyle Engineering Corporation, 1987, Solano Project Ground Water Model for Beneficial Impact Assessment.
- Bryan, Kirk, 1923, Geology and Ground-Water Resources of the Sacramento Valley, California. U.S. Geological Survey Water-Supply Paper 495, 285 p.
- California Department of Water Resources, 1955, Report the California State Legislature on Putah Creek Cone Investigation, 211 p.
- California Department of Water Resources, 1978, Evaluation of Ground Water Resources: Sacramento Valley. California Department of Water Resources Bulletin 118-6, 136 p.
- Helley, E.J., and Harwood, D.S., 1985, Geologic map of the late Cenozoic deposits of the Sacramento Valley and Northern Sierran foothills, California. U.S. Geological Survey Miscellaneous Field Studies Map MF-1790.
- Harwood, D.S., and Helley, E.J., 1987, Late Cenozoic tectonism of the Sacramento Valley, California: U.S. Geological Survey Professional Paper 1359.
- Murray, Burns, and Kienlen Engineers, 1996, Reclamation District No. 2068, Maine Prairie Water District, Groundwater Conditions.
- Olmstead, F.H., and Davis, G.H., 1961, Geologic features and ground-water storage capacity of the Sacramento Valley, California: U.S. Geological Survey Water-Supply Paper 1497, 241 p.
- Page, R.W., 1974, Base and thickness of the Post-Eocene Continental Deposits in the Sacramento Valley, California, U.S. Geological Survey Water-Resource Investigations Report 45-73. 16 p.
- Page, R.W., 1986, Geology of the fresh ground-water basin of the Central Valley. California, with texture maps and sections. U.S. Geological Survey Professional Paper 1401-C. 54 p.
- Summers Engineering, Inc., 1988, Solano Irrigation District, Groundwater Resources.
- West Yost and Associates, 1995, City of Vacaville AB 3030 Groundwater Management Plan.

Errata

Changes made to the basin description will be noted here.