

## Sacramento River Hydrologic Region

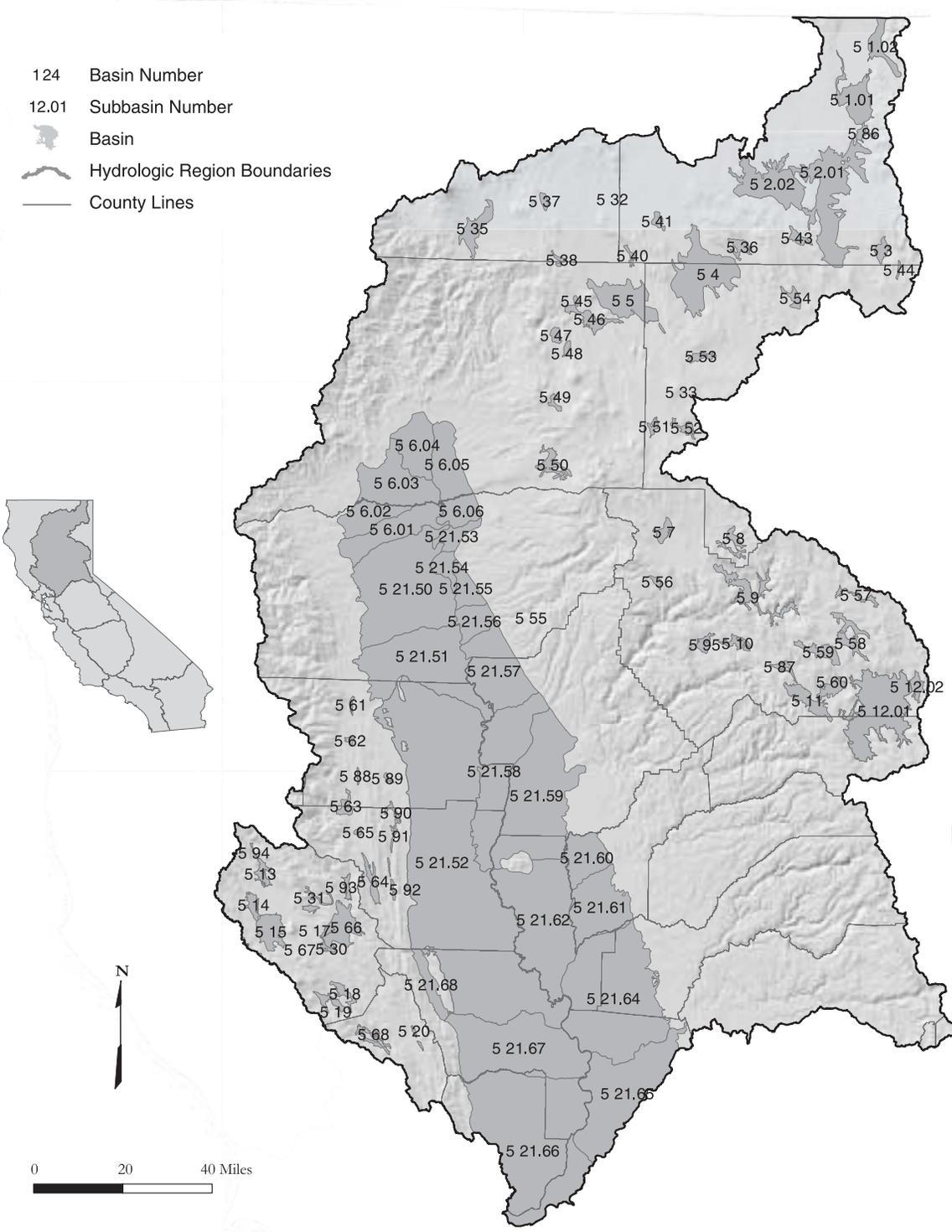


Figure 33 Sacramento River Hydrologic Region

## 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.

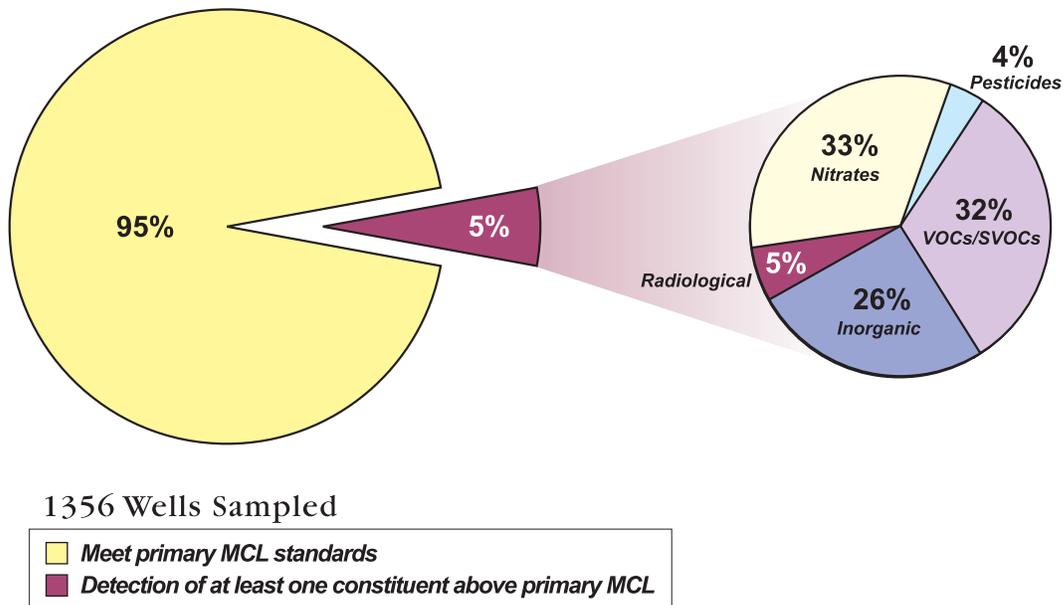


Figure 34 MCL exceedances in public supply wells in the Sacramento River Hydrologic Region

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 <sub>3</sub> ) – 22	Nitrate + Nitrite – 5	Nitrate Nitrogen (NO <sub>3</sub> -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

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## Sacramento Valley Groundwater Basin, Colusa Subbasin

- Groundwater Basin Number: 5-021.52
- County: Colusa, Glenn, Tehama, Yolo
- Surface Area: 918,380 acres (1,434 square miles)

### Basin Boundaries and Hydrology

The portion of the Sacramento Valley that comprises the Colusa Subbasin is bounded on the east by the Sacramento River, on the west by the Coast Range and foothills, on the south by Cache Creek, and on the north by Stony Creek. Annual precipitation ranges from 17- to 27-inches with higher precipitation occurring to the west.

### Hydrogeologic Information

#### *Water-Bearing Formations*

The Colusa Subbasin aquifer system is composed of continental deposits of late Tertiary to Quaternary age. Quaternary deposits include Holocene stream channel and basin deposits and Pleistocene Modesto and Riverbank formations. The Tertiary deposits consist of the Pliocene Tehama Formation and the Tuscan Formation. Except where noted, the following information is taken from USBR (1960).

**Holocene Stream Channel Deposits.** These deposits consist of unconsolidated gravel, sand, silt, and clay derived from the erosion, reworking, and deposition of adjacent Tehama Formation and Quaternary stream terrace deposits. The thickness varies from 1- to 80-feet (Helley and Harwood 1985). These deposits represent the upper part of the unconfined zone of the aquifer and are moderately-to-highly permeable; however, the thickness and areal extent of the deposits limit the water-bearing capability.

**Holocene Basin Deposits.** These deposits are the result of sediment-laden floodwaters that rose above natural levees of streams and rivers and spread across low-lying areas. They consist primarily of silts and clays and may be locally interbedded with stream channel deposits along the Sacramento River. Thickness of the unit ranges up to 150 feet. These deposits have low permeability and generally yield low quantities of water to wells. The quality of groundwater produced from basin deposits is often poor.

**Pleistocene Modesto and Riverbank Formations.** Terrace deposits include the Modesto Formation (deposited between 14,000 and 42,000 years ago) and the Riverbank Formation (deposited between 130,000 and 450,000 years ago). The Modesto deposits consist of moderately to highly permeable gravels, sands, and silts. Thickness of the formation ranges from less than 10 feet to nearly 200 feet across the valley floor (Helley and Harwood 1985). The Riverbank deposits are the older terrace deposits that occur at a higher topographic level and consist of poorly to highly pervious pebble and small cobble gravels interlensed with reddish clay, sand, and silt. Thickness of the formation ranges from less than 1 foot to over 200 feet depending on location. The formation yields moderate quantities of water to domestic and

shallow irrigation wells and also provides water to deeper irrigation wells that have multiple zones of perforation. Generally, the thickness of the formation limits the water-bearing capabilities.

**Pliocene Tehama Formation.** The Tehama Formation is the predominant water-bearing unit within the Colusa Subbasin and reaches a thickness of 2,000 feet (Olmsted and Davis 1961). The formation occurs at depths ranging from a few feet to several hundred feet from the surface. The formation consists of moderately compacted silt, clay, and fine silty sand enclosing lenses of sand and gravel; silt and gravel; and cemented conglomerate. Occasional deep sands and thin gravels constitute a poorly to moderately productive, deep, water-bearing zone.

**Pliocene Tuscan Formation.** The Tuscan Formation occurs in the northern portion of the subbasin at an approximate depth of 400 feet from the surface and may extend to the west to the Greenwood Anticline east of Interstate Highway 5 (DWR 2000). The formation is composed of a series of volcanic mudflows, tuff breccia, tuffaceous sandstone, and volcanic ash layers. The formation is described as four separate but lithologically similar units, A through D (with Unit A being the oldest), which in some areas are separated by layers of thin tuff or ash units (Helley and Harwood 1985).

Units A, B, and C are found within the subbasin. Unit A is the oldest water-bearing unit of the formation and is characterized by the presence of metamorphic clasts within interbedded lahars, volcanic conglomerate, volcanic sandstone, and siltstone. Unit B is composed of a fairly equal distribution of lahars, tuffaceous sandstone, and conglomerate. Unit C consists of massive mudflow or lahar deposits with some interbedded volcanic conglomerate and sandstone. In the subsurface, these low permeability lahars form thick, confining layers for groundwater contained in the more permeable sediments of Unit B.

#### **Subareas of the Colusa Subbasin**

**Stony Creek Fan.** The Stony Creek Fan occupies the northern extent of the subbasin and extends from Black Butte Reservoir to the City of Willows, northeast from the City of Willows to the Sacramento River, and north beyond the Tehama County line. The geologic units within the fan area include Holocene alluvial deposits, Pleistocene deposits of the Riverbank and Modesto formations, and Pliocene deposits of the Tehama and Tuscan formations.

Holocene alluvial deposits are observed along Stony Creek to the north and along the Sacramento River to the east. Modesto and Riverbank deposits extend to the east along Stony Creek and south and southeast within several ancestral stream channels (DWR 2000). Older alluviated floodplain and channel deposits reach a thickness of 150 feet at Stony Creek and 110 feet along the Sacramento River.

Thick clays of the upper Tehama Formation underlie the intermediate water-bearing zone of the Stony Creek plain at a depth of 300 feet, rising to a minimum depth of 40 feet on the axis of the Willows anticline. Wells

installed 4 miles east of Highway 99W intersect occasional Tehama Formation gravels between 225- and 625-foot depths.

Tuscan Units A, B, and C are believed to extend into the Colusa Subbasin north of the City of Willows. The sediments of the Tuscan Formation interfinger with the sediments of the Tehama Formation in the subsurface (Lydon 1969). The degree of hydraulic conductivity between the Tuscan Formation, the Tehama Formation, and the overlying Stony Creek fan deposits has not been established.

**Willows-to-Williams Plain.** Basin deposits overlie much of the flat alluvial plains in the area between Willows and Williams. Permeabilities of the near-surface soils are extremely low. Riverbank deposits are observed along the western subbasin boundary north of Maxwell. The interstream areas of the westside creeks contain little gravel and are underlain by a poorly pervious, occasionally alkaline, claypan soil. The Tehama Formation contains little gravel and is not an important water-bearing material in this region.

**Arbuckle and Dunnigan Plains.** Quaternary surface deposits of alluvium, Modesto and Riverbank formations, and basin deposits in the Arbuckle and Dunnigan plains occur east of Hungry Hollow and Dunnigan hills from Williams to Cache Creek. Basin deposits overlie older alluvial deposits. The region north of Arbuckle is alluviated to depths of 20- to 60-feet with moderately to highly permeable sands and gravels from Sand and Cortina creeks. This zone extends east of Highway 99W and, in the College City area, appears to be Sacramento River channel deposits. The area between Salt and Petroleum creeks is composed of poorly to moderately permeable gravels, clayey sands, and silts. Petroleum and Little Buckeye creeks have deposited a thin, moderately to highly permeable sandy gravel and sandy silts over older stream and terrace alluvium.

The area in the vicinity of Zamora is underlain by a homogeneous section of gravels, sands, and interbedded clays to minimum depths of 450 feet. Water producing members range from 25- to 35- percent of total material penetrated. Well production is high within gravel channels.

A poorly to highly productive water-bearing zone consisting of older alluvial deposits and Tehama deposits on the western and southwestern edges of the Arbuckle Plain ranges in depth from 100- to 300-feet. The zone thickens easterly to depths of 400- to 450-feet.

Tehama deposits coarsen in this area and are an important water-bearing unit. The upper 800- to 900-feet contains 10- to 13-percent fine pebble gravel with a well-sorted, fine to medium sand matrix. This portion of the Tehama Formation is highly pervious, loose, and well bedded. The gravel beds range from 5- to 20-feet in thickness and are well confined within a silt and clayey silt section.

**Cache Creek Floodplain.** Holocene stream channel deposits are observed along the entire extent of Cache Creek (DWR 2000). The Cache Creek area is alluviated with floodplain deposits which are exposed north of the town of Yolo and extend to Knights Landing. The relative proportion of sand and gravel for the depth interval of 20- to 100-feet is approximately 27 percent.

Between depths of 100- to 200-feet the proportion is reduced to 24 percent. The percentage of sand and gravel for deposits extending northward from Cache Creek averages 22 percent for the 20- to 200-foot interval. Farther east the proportion increases to 36 percent for the same depth interval (Olmsted and Davis 1961). Tehama deposits are penetrated in the depth interval of 100- to 200-feet.

### ***Groundwater Level Trends***

Review of hydrographs for long-term comparison of spring-spring groundwater levels indicates a slight decline in groundwater levels associated with the 1976-77 and 1987-94 droughts, followed by recovery to pre-drought conditions of the early 1970's and 1980's. Some wells increased in levels beyond the pre-drought conditions of the 1970's during the wet season of the early 1980's. Generally, groundwater level data show an average seasonal fluctuation of approximate 5-feet for normal and dry years. Overall there does not appear to be any increasing or decreasing trends in groundwater levels.

### ***Groundwater Storage***

The storage capacity of the subbasin was estimated based on estimates of specific yield for the Sacramento Valley as developed in DWR (1978). Estimates of specific yield, determined on a regional basis, were used to obtain a weighted specific yield conforming to the subbasin boundary. The estimated specific yield for the subbasin is 7.1 percent. The estimated storage capacity to a depth of 200 feet is approximately 13,025,887 acre-feet.

### ***Groundwater Budget (Type B)***

Estimates of groundwater extraction for the Colusa Subbasin are based on surveys conducted by the California Department of Water Resources during 1993, 1994, and 1999. Surveys included landuse and sources of water. Estimates of groundwater extraction for agricultural, municipal and industrial, and environmental wetland uses are 310,000, 14,000 and 22,000 acre-feet respectively. Deep percolation from applied water is estimated to be 64,000 acre-feet.

### ***Groundwater Quality***

**Characterization.** Calcium-magnesium bicarbonate and magnesium-calcium bicarbonate are the predominant groundwater types in the subbasin. Calcium bicarbonate waters occur locally from Orland to Artois and near Stony Creek. Mixed character waters for different regions of the subbasin occur as follows: sodium bicarbonate waters from Williams-Colusa south to Grimes; magnesium-sodium bicarbonate or sodium-magnesium bicarbonate waters near Williams-Arbuckle area and locally near Zamora; and magnesium bicarbonate waters locally near Dunnigan. Total dissolved solids (TDS) values range from 120- to 1,220-mg/L, averaging 391 mg/L (DWR unpublished data).

**Impairments.** High EC, TDS, adjusted sodium absorption ratio (ASAR), nitrate, and manganese impairments occur near Colusa. High TDS and boron occur near Knights Landing. High nitrates occur in Arbuckle, Knights

Landing, and Willows. Localized areas have high manganese, fluoride, magnesium, sodium, iron, ASAR, chloride, TDS, ammonia, and phosphorus.

### Water Quality in Public Supply Wells

Constituent Group <sup>1</sup>	Number of wells sampled <sup>2</sup>	Number of wells with a concentration above an MCL <sup>3</sup>
Inorganics – Primary	103	0
Radiological	57	0
Nitrates	109	2
Pesticides	64	0
VOCs and SVOCs	58	0
Inorganics – Secondary	103	18

<sup>1</sup> 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).

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

<sup>3</sup> 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)	
Municipal/Irrigation	Range 25 – 5,600	Average: 1,967 (109 Well Completion Reports)
	Total depths (ft)	
Domestic	Range: 11 to 870	Average: 155 (2,599 Well Completion Reports)
Municipal/Irrigation	Range 20 to 1340	Average: 368 (1,515 Well Completion Reports)

### Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
DWR	Groundwater levels	98 wells semi-annually
DWR	Miscellaneous water quality	30 wells biennially
Department of Health Services	Miscellaneous water quality	134

## Basin Management

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Groundwater management:	Tehama County adopted a groundwater management ordinance in 1994. Glenn County adopted a groundwater management ordinance in 2000. Colusa County adopted a groundwater management ordinance in 1998. Yolo County adopted a groundwater management ordinance in 1996. Reclamation District No. 787 adopted a groundwater management plan in Feb. 1997 and the plan was amended on November 16, 2005.
Water agencies	
Public	Knights Landing WUA, Orland Unit WUA, Cortina Creek FC&WCD, Colusa County FC&WCD, and <a href="#">Yolo County FC&amp;WCD</a> , Artois CSD, Butte City CSD, Hamilton City CSD, NE Willows CSD, Ord CSD, City of Colusa, City of Orland, City of Williams, 4-M WD, Chrome WD, Colusa County WD, Cortina WD, Davis WD, Dunnigan WD, Glenn Valley WD, Glide WD, Holthouse WD, Kanawha WD, La Grande WD, Orland-Artois WD, Princeton WD, Westside WD, and Yolo-Zamora WD, <a href="#">Glenn-Colusa ID</a> , Maxwell ID, Princeton-Cordora-Glenn ID, Provident ID, Maxwell ID, RD 108, RD 478, RD 730, RD 787, RD 1004, RD 2047, Arbuckle PUD, Maxwell PUD
Private	California Water Service Co., Colusa Drain Mutual Water Co., California Water Service Co., Roberts Ditch & Irr. Co. Inc, Willow Creek Mutual Water Co.

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## Errata

Updated groundwater management information and added hotlinks to applicable websites.  
(1/20/06)