Stockton East Water District

Calaveras River Habitat Conservation Plan

Appendix B

Calaveras River Environment

Calaveras River Environment

The following sections describe the general environmental setting of the Calaveras River Basin, including a basin overview, climate, topography/geology, hydrology/streams/ drainage, New Hogan Reservoir storage and operation, water temperature, nutrients, dissolved oxygen, sediment, and existing land use.

1.0 Basin Overview

The Calaveras River Basin extends for roughly 60 miles in a southwesterly direction from the Sierra Nevada Mountains to the Stockton metropolitan area (Figure B-1). The entire basin encompasses an area of approximately 590 square miles. The mountainous portion upstream from New Hogan Reservoir comprises roughly 360 square miles. The lower basin consists of approximately 230 square miles, including 100 square miles of foothill drainage between New Hogan Dam (RM 42) and Bellota (RM 24), and 120 square miles of valley floor downstream of Bellota (USAED 1981). Elevations in the Calaveras River Basin range from near sea level at the confluence with the San Joaquin River to 130 feet at Bellota, 500 feet at New Hogan Dam, and approximately 6,000 feet at the headwaters. Only about 5% of the basin is found above 4,000 feet in elevation (Tetra Tech 2001; USACE 2001).

The Calaveras River mainstem begins at the junction of the North Fork Calaveras River and the South Fork Calaveras River, a short distance upstream of the upper extent of New Hogan Reservoir, and is the basin's primary drainage channel from the headwaters to Bellota (RM 24), where the river splits into the Old Calaveras River channel and Mormon Slough/Stockton Diverting Canal (SDC).

The river was first impounded in 1930 when the Hogan Dam (76,000 acre-feet [AF] capacity) was constructed for flood control near Valley Springs, California, about 28 miles east of Stockton, California. Prior to 1949, there were no outlet controls in the dam and flows were not regulated in the lower river. In 1949, outlet controls were installed at the dam and the Stockton and East San Joaquin Water Conservation District (previous name of Stockton East Water District, SEWD), together with the City of Stockton, began operating the dam in a manner to conserve runoff for later release for irrigation purposes. Immediately downstream of the original dam, the U.S. Army Corps of Engineers (USACE) constructed New Hogan Dam from November 1960 to June 1964. The new dam increased the storage capacity of the reservoir to 317,000 AF at gross pool, with up to 165,000 AF of flood control storage space during the flood season and a minimum pool (inactive pool) of 15,000 AF for sediment storage, fish and wildlife, and general recreation (Tetra Tech 2001). The dam is a combination rock and earth-fill structure with a crest elevation of 725 feet above mean sea level (MSL), which is about 200 feet above the original streambed. The New Hogan Project is operated for flood control, municipal and industrial water supply, irrigation, and recreation purposes.

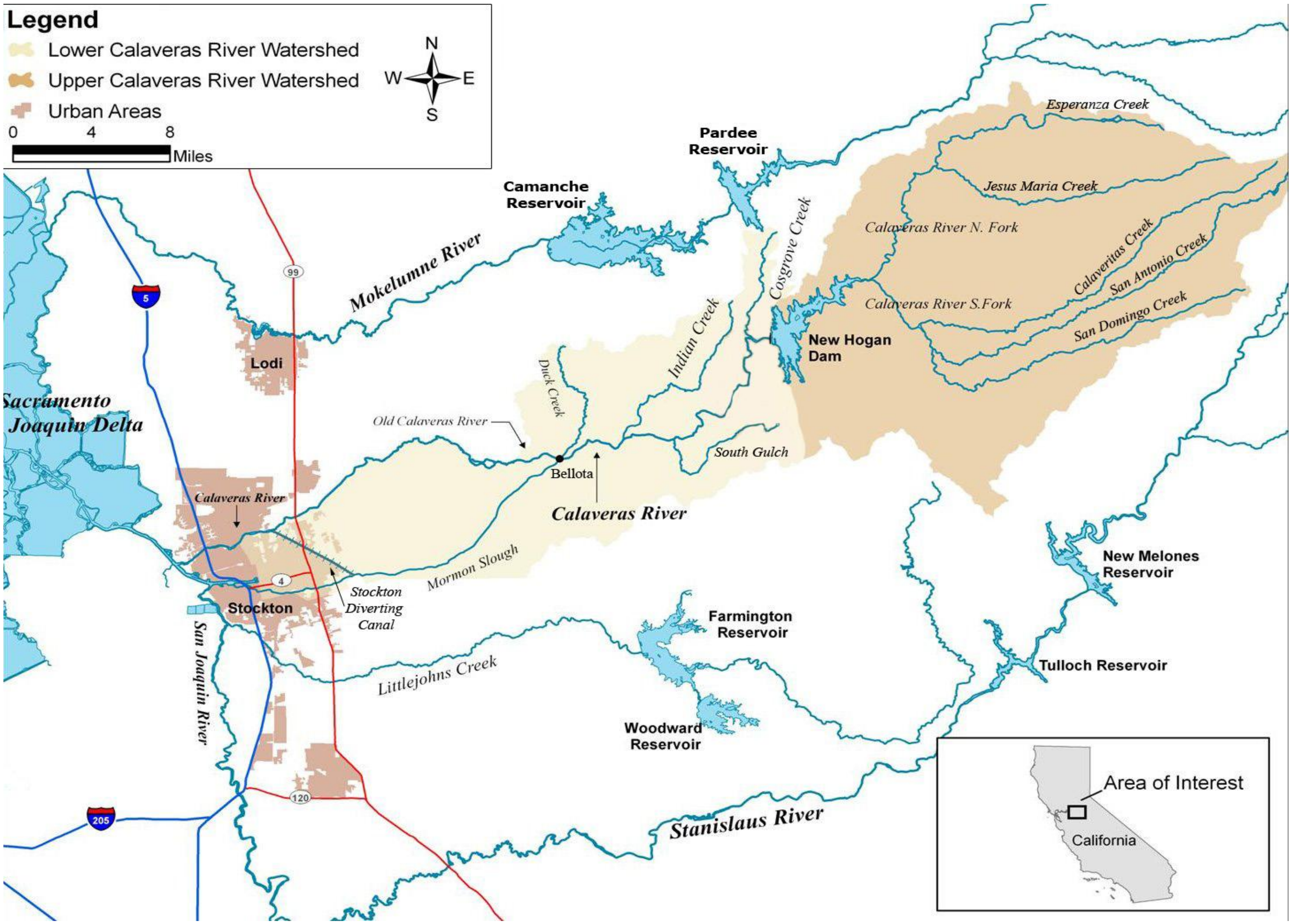


Figure B-1. Map of Calaveras River watershed.

The project provides flood protection for about 46,000 acres of highly developed agricultural land, and about 14,000 acres of urban and suburban land in and adjacent to the City of Stockton (USAED 1981). The reservoir has an average unimpaired inflow of 157,000 AF, nearly all of which occurs from December through March (Tetra Tech 2001).

In 1978, SEWD began the year-round operation of an unscreened, gravity-fed diversion (maximum capacity of 75 cfs) at Bellota, for which low but sustained flows are released from New Hogan during non-flood control periods. These releases provide year-round flows between New Hogan and Bellota during most years. In drought years, reservoir releases are not sustained during the summer and early fall, and winter flood releases are reduced or eliminated (Brown and Caldwell 1995).

Although no current agreements exist to maintain New Hogan releases for fishery purposes, flows sustained year-round to Bellota for diversion purposes also support rainbow/steelhead trout during most years and have improved stream habitat conditions during times of the year when the lower reaches of the river historically ran dry (i.e., July through October). For example, according to the United States Fish and Wildlife Service (USFWS 1960 and 1993), no flows occurred in the river between Hogan Dam and Jenny Lind (RM 37) for about two months in the late summer and fall of average water years, but several deep pools were maintained in the canyon reach that supported a good largemouth bass and sunfish fishery. From Jenny Lind to Bellota, there were very few permanent pools and the streambed went dry for about four months of every year (USFWS 1960). The streambed also went "completely dry for about four months of every year" between Bellota and the confluence with the San Joaquin River (USFWS 1960).

Today, the Calaveras River downstream of New Hogan Dam consists of seven distinct reaches containing several tributaries that influence flows in the lower river, as follows (note: river miles upstream of Bellota are via Mormon Slough/SDC route):

- **Reach 1 - New Hogan Dam to Canyon (RM 42.0 to RM 41.3)**. This reach is characterized by relatively low gradient with a broad floodplain. The dominant substrate is gravel and cobble. The floodplain consists of poor spawning habitat due to large, coarse embedded substrate. The water in Reach 1 is more turbid than the lower reaches and there also appears to be significantly more sand and sediment. Riparian vegetation is characterized by trees and shrubs, with both providing cover for fish. However, there is an obvious absence of large woody debris within the wetted channel; as a result, wood does not provide cover for fish or habitat complexity. In many places, the banks are eroded, apparently from high foot traffic by anglers, since this is the most heavily fished reach of the river. This erosion may increase stream sediment loads. One small, unscreened diversion pump and an infiltration gallery are located in this reach (note: the unscreened diversion pump is not within SEWD authority).

- **Reach 2 - Canyon to Jenny Lind (RM 41.3 to RM 34.6)**. This is the highest gradient section of the river, dropping approximately 300 feet in elevation over the course of a few miles. The reach is characterized by high-gradient riffles and plunge

pools. The dominant substrate is bedrock and large boulder. The high gradient makes fish observation difficult. If spawning occurs in this reach, it would have to take place in pools, pool tail-outs, and pocket water areas that are available. In the summer, pools are relatively deep as a result of steady reservoir releases, which provide a cold water supply for over-summering fish. Historically, there were no to minimal summer flows in this reach and water temperatures would have been quite warm, as evidenced by the types of fish observed such as largemouth bass, sunfish, and other "warmwater game fish" (CDFG 1963; USFWS 1960). Therefore, it is highly unlikely that anadromous fish used this reach during the summer months under natural conditions. Under current flow management, this section of the river may be used extensively by adult and/or juvenile *O. mykiss* during the summer months, especially considering that the river has a considerable population of resident or fluvial trout between 12 and 18 inches. One small privately owned diversion[1] is located in this reach, which may be operated during the irrigation season. In addition, there is one low-flow road crossing.

- **Reach 3 - Jenny Lind to Shelton Road (RM 34.6 to RM 29.3)**. This reach has a moderate gradient and meanders through a relatively unused and inaccessible area. The floodplain throughout the reach is relatively undisturbed, with agricultural development somewhat separated from the immediate riparian area. An abundance of large trees provides shade, cover, and instream habitat. Woody debris recruitment in this section is far greater than in any other reach. Although the first mile (approximately) of the river downstream of the dam is characterized by substrate that is embedded, gravel in this reach is more abundant than on any other San Joaquin tributary. This reach has been subject to historical gravel mining and the floodplain continues to be mined near Jenny Lind. The dominant substrate is gravel of sufficient quantity and quality for spawning. The gravel is largely free of silt, possibly due to the abundance of gravel recruitment from tailing piles. The river is noticeably clearer in this section. This reach is also characterized by abundant, complex trout habitat that appears ideal to support significant numbers of fish. Instream woody debris, undercut banks, overhanging vegetation, and turbulence provide substantial cover for fish in most individual habitat units. Aquatic insects, including caddis- and mayflies, appear to be present in large numbers. The downstream end of this reach is considered to be the lowermost extent of quality salmonid rearing habitat (SEWD unpublished data). Sixteen small, privately-owned diversions (one screened) are located in this reach, which may be operated during the irrigation season. In addition, there are two low-flow road crossings in this reach.

- **Reach 4 - Shelton Road to Bellota (RM 29.3 to RM 24)**. This stream reach is characterized by a low gradient and meanders through the valley, consisting mostly of glides with few riffles. Bank vegetation is brush and agricultural lands frequently abutt the stream. Although sand and silt are present, there is still a large supply of gravel and cobble, which appears to be recruited into the stream through bank

[1] Small diversions are considered to have an average intake diameter of 10" and a 1-10 cfs capacity. All diversions are unscreened except where noted.

erosion. Habitat appears to be excellent for smallmouth bass, and several bass anglers in the area have indicated that fishing is good in this reach. In addition to smallmouth bass, largemouth- and striped bass are probably common, as are other predators. Predation may substantially affect the survival of outmigrants through this reach. Ten small, privately owned diversions are located in this reach and are operated during the irrigation season. In addition, there is a relatively large (i.e., 75 cubic feet per second [cfs] capacity) diversion known as Bellota that is generally operated year-round, as well as two low-flow crossings, one culvert crossing, and one earthen dam in this reach.

- **Reach 5 - Old Calaveras River Channel (RM 24 to RM 5.6)**. The Old Calaveras River channel was historically the mainstem of the river but has been a secondary channel since 1934, when the Linden Irrigation District built the Old Calaveras Headworks Facility and flows were primarily directed into Mormon Slough (Crow 2006). It is characterized by a narrow channel with ample vegetative cover and large instream woody debris. However, much of the vegetative cover consists of agricultural and non-native or invasive plant species, such as Himalayan Blackberry which can grow across the channel and act as a barrier to fish passage. The Old Calaveras River becomes more channelized with less cover as it reaches the valley floor. The substrate in the upper third of this reach consists of sand and silt with limited gravel and cobble, and the lower two thirds of the reach consist of mostly sand, silt, and clay. Recent monitoring suggests that some sections of the channel are adequate for over-summer rearing under at least some conditions (SEWD unpublished data); however, current migration conditions are suboptimal due to several instream structures. This reach has nine flashboard dam foundations where flashboards are installed during the irrigation season and 62 small, privately owned diversions, which may be operated during the irrigation season. In addition, there are two head gate- and multiple bridge structures.

- **Reach 6 - Mormon Slough/Stockton Diverting Canal (RM 24 to RM 5.6**). Mormon Slough/SDC is now the principal channel and fish migration route instead of the historic Old Calaveras River channel. Mormon Slough was modified by the USACE to provide a 12,500 cfs flood control capacity, but under natural conditions, Mormon Slough flowed southwesterly about 20 miles to the harbor at Stockton. As part of the modification, the lower slough has been closed by a levee just east of Stockton, and the flows are diverted back into the lowermost Calaveras River through the SDC (USAED 1981). The channel is wide with steep contoured banks and little to no cover. The channel substrate consists of compacted clay, sand, and silt, with limited gravel and areas with concrete or rock riprap. Due to these channel characteristics, habitat for salmonid rearing is suboptimal under all potential flow conditions. Current migration conditions are suboptimal under low flows due to several instream structures (DWR 2007). The channel has 12 flashboard dam foundations where flashboards are installed during the irrigation season and 52 small, privately owned diversions, which may be operated during the irrigation season. In addition, there are two low-flow road crossings and multiple bridges and railroad trestles.

- **Reach 7 - Junction of Old Calaveras River/Stockton Diverting Canal to Confluence (RM 5.6 to RM 0)**. The upper end of this reach begins where the narrow, low capacity Old Calaveras River Channel joins with the much wider, higher capacity channel of the SDC. The channel continues through the City of Stockton with much of the same characteristics of steep levee banks confining a wide, low-gradient streambed. There is little natural riparian cover since the San Joaquin County Flood Control and Water Conservation District prevent the growth of shrubs and trees larger than one inch in diameter. The river shows signs of tidal influence within about four miles of the confluence with the San Joaquin River Stockton Deep Water Channel. There are multiple bridges and railroad trestles in this reach.

- **South Gulch, Indian, Duck, and Cosgrove Creeks.**
  The four main tributaries between New Hogan Dam and Bellota are South Gulch, Indian, Duck, and Cosgrove creeks. All are intermittent streams, drying up during the summer months and flowing during winter and spring run-off events. Among these lower tributaries, Cosgrove Creek—which enters the Calaveras River at RM 40.9—provides the largest contribution to the river, with an annual volume as high as 12,600 AF (observed in water year 2006; U.S. Geological Survey [USGS] gaging station data). Gaging records for the period of record (i.e., 1938-1969 and 1991-present) indicate that Cosgrove Creek average daily flows have ranged from 0 to 1,267 cfs. South Gulch, Indian, and Duck Creeks enter the Calaveras River at RM 29.8, 27.3, and 23.9, respectively. There are no stream gages on these three tributaries but it appears that together they can provide temporary inputs of up to 4,066 cfs based on calculations using existing gaging data (i.e., Mormon Slough flows minus flows from New Hogan releases and Cosgrove Creek flows equals potential flows from other tributaries).

- **Potter Creek**. Potter Creek, a tributary channel to Mormon Slough, receives water deliveries from the Calaveras River during the irrigation season for use in adjacent farmland. SEWD is able to divert or pump water into Potter Creek via several different facilities: the Bellota Pipeline; one 4,000 gallons per minute (8.9 cfs) and one 8,000 gallons per minute (17.8 cfs) pump located approximately 1 mile downstream of the Bellota Weir in Mormon Slough; or from Peters Pipeline. Water flows from Potter Creek back into Mormon Slough at two points, i.e., the old Southern Pacific Railroad Bridge and just upstream of Panella Dam. During the winter, Potter Creek receives natural surface runoff from within its own watershed, and then empties into Mormon Slough and substantially increases flows downstream of Bellota during runoff events. The channel has three flashboard dam foundations where flashboards are installed during the irrigation season, and 16 small, privately owned diversions, which may be operated during the irrigation season. In addition, there are two low-flow road crossings and one small, earthen dam.

- **Mosher Slough/Creek and Bear Creek.** According to Jones and Stokes (2005), Mosher Slough/Creek consists of disturbed banks with little riparian vegetation. During the irrigation season, SEWD operates a small headworks control structure with a slide gate (Mosher Creek Dam) to divert water from the Old Calaveras River channel into Mosher Slough/Creek for irrigators along the creek. During the winter, the control structure is closed for flood control. There is no mechanism to actively divert water from Mosher Slough/Creek into the Old Calaveras River channel.

  Approximately a quarter mile east of Alpine Road on Mosher Slough/Creek, San Joaquin County constructed a diverting canal between Mosher Slough/Creek and Bear Creek along with slide gates that cross Mosher Slough/Creek just downstream of this diverting canal for flood control. During the winter, the Mosher Slough/Creek slide gates are closed by SEWD per San Joaquin County direction, which forces water from Mosher Slough/Creek into Bear Creek through the diverting canal as a flood control measure. Mosher Slough/Creek downstream of the slide gates then does not receive water from the upper portion of Mosher Slough/Creek, but can receive water from natural inflows entering downstream of the slide gates. During the irrigation season, the slide gates are opened and the diverting canal is closed so that flows from the Old Calaveras remain in Mosher Slough/Creek for irrigation and recharge.

  Mosher Slough/Creek and the channel immediately north, Bear Creek, converge into Pixley Slough, which turns into Disappointment Slough, then enters the Sacramento-San Joaquin Delta. Woodbridge Irrigation District diverts water from Bear Creek to Mosher Slough/Creek at HWY 99 to provide irrigation water for their customers, which keeps the stretch of Mosher Slough/Creek downstream of HWY 99 connected to Pixley and Disappointment Sloughs during the irrigation season. In addition, Woodbridge Irrigation District occasionally diverts flows from the Mokelumne River into Mosher Slough/Creek via their distribution system. Like the Old Calaveras River channel, Mosher Slough/Creek is dry when there is no flow from surface run-off events. Except during major flood events, neither Mosher Slough/Creek nor Bear Creek typically provides upstream access from the San Joaquin River for anadromous fish. There are 22 privately owned diversions, which may be operated during the irrigation season.

1.1 Climate

The Calaveras River Basin climate is characterized by cool, relatively wet winters, and hot, dry summers. Winters are characterized as short and mild with relatively frequent rains, with snow only occurring in limited amounts within the upper reaches of the watershed. Due to the low elevation of the upper watershed, snowpack does not persist into late spring or summer. Summers are long and hot with little or no rainfall. Seasonal rainfall is variable, and can vary from less than 16 inches to over 45 inches (USAED 1981). In normal years, more than 90% of the precipitation occurs between November and April and average annual precipitation upstream of New Hogan Dam is 33.3 inches, ranging from 24 inches at New Hogan to 50 inches in the upper basin.

1.2 Geology

The area downstream of New Hogan Reservoir is located in the Sierra Nevada foothills and extends west to the San Joaquin Valley. The area near New Hogan extends from the geomorphic provinces of the Sierra Nevada to the Great Central Valley near Stockton (USACE 1989).

The soils in the upper elevations of the Calaveras River basin are fine textured meta-volcanic residual of moderate depth and good drainage (Tetra Tech 2001). Lower in the basin, near New Hogan, soils are residual, derived from meta-sedimentary slate and schist, meta-basic igneous rocks, granite rock, and volcanic conglomerate (Tetra Tech 2001). In the lower elevations of Calaveras County, the soils along the Calaveras River consist of dredge tailings (i.e., gravel and cobble). Tailings are under a cover of annual grasses with domestic crops in some areas (Gilbert 1989).

The Calaveras River Basin downstream of New Hogan consists primarily of four geologic formations (USACE 1989). The area near New Hogan belongs to the Western Metamorphic Belt and contains Jurassic and Triassic-age volcanic rock. The Valley Springs formation extends westward towards the Calaveras County border, and is composed primarily of Miocene-age tuff, claystone, siltstone, sandstone, and conglomerate. The formation in the northeastern section of San Joaquin County contains Pliocene/Pleistocene, non-marine, sedimentary rocks. West of this section and extending to the Stockton Diverting Canal, the area consists of Quaternary, non-marine, terrace deposits.

1.3 Hydrology / Streams / Drainage

The flows of the river are almost entirely supplied by rainfall, since only 5% of the basin occurs in elevations high enough to produce snowpack (i.e., greater than 4,000 feet; Tetra Tech 2001; USACE 2001). Due to the seasonal concentration of precipitation in the basin predominately as rainfall, the natural flow of the Calaveras River is intermittent and fluctuates from high flows in the winter to no flow in the summer and early fall (USAED 1981). As such, the Calaveras River is typical of many California stream systems that are

> subject to extreme variations (both within and among years) in rainfall, which can result in high-volume, flash flood runoff, or droughts lasting several years. Natural stream flow in these streams can vary greatly, both seasonally and annually. It is not uncommon, even under unimpaired conditions, for the lower reaches of many streams, such as the Calaveras, to become interrupted for extended periods during the dry season, and these conditions may persist for years (McEwan 2001).

The average annual run-off in the Calaveras Basin is only 157,000 AF (years 1907 to 1980). Due to its relatively small drainage area and limited snowpack, the hydrology of the Calaveras River is different than nearby snowpack-driven systems such as the Mokelumne

and Stanislaus rivers, which have average annual run-off amounts of 378,700 AF and 699,800 AF, respectively (Figure B-2: USFWS 1998). Instead, it is more characteristic of many North Coast California streams and rain-driven systems in California, whereby unimpaired flows range from low to non-existent during the dry season (summer and early fall) to moderately high with sporadic peaks during the wet season (late fall through spring). In terms of the natural hydrology of the Calaveras River, highest flows occur from December through April and fish passage opportunities would typically be limited to this time period. However, exceedance plots based on monthly flows (i.e., reported total volume in AF converted to cfs) from 1921-1992 indicate that under the river's natural hydrology, adult passage opportunities would occasionally be available as early as November (Figures B-3 and B-4; Table B-1). Prior to the District's operations, the lower river would frequently dry up during the late summer (CDFG 1963; USFWS 1960). Now, water stored in New Hogan Reservoir during wet seasons is released year-round for diversion, which results in sustained year-round flows between at least New Hogan Dam and Bellota Weir in all but drought years.

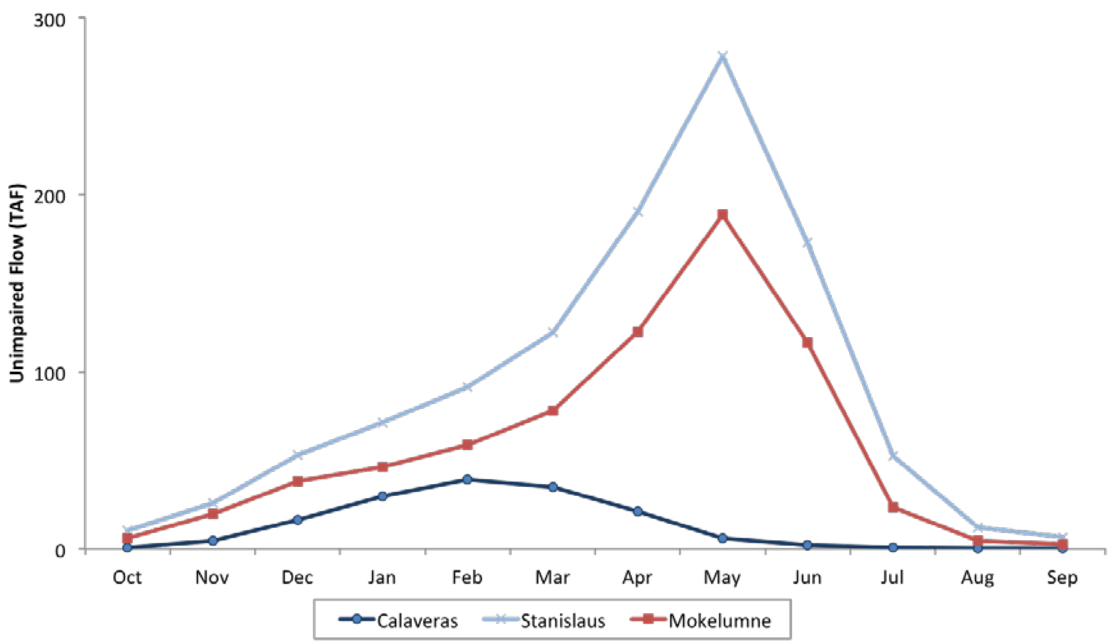


Figure B-2. Monthly average unimpaired flows on the Calaveras River and nearby tributaries to the San Joaquin River, 1921-1992. Data source: California Central Valley Unimpaired Flow Data (DWR 1994).

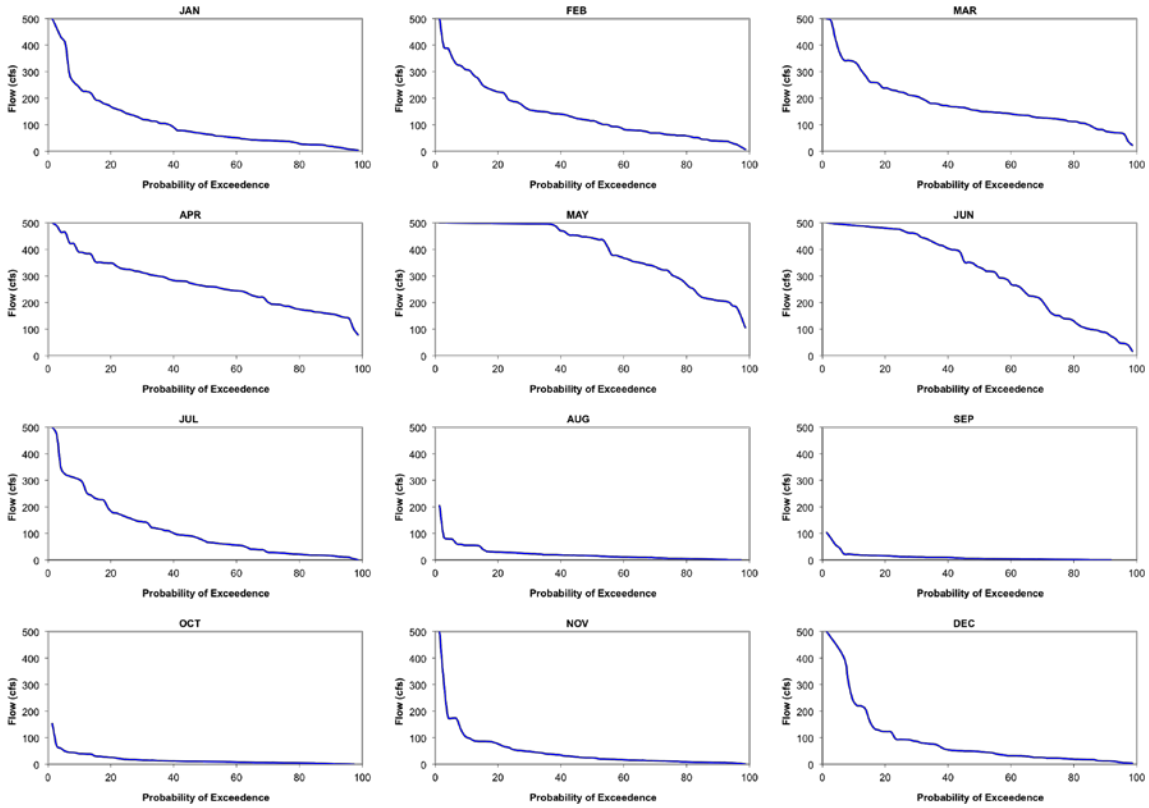


Figure B-3. Calaveras River monthly discharge exceedance curves generated from monthly unimpaired flow data. Data converted from AF to cubic feet per second. Data source: California Central Valley Unimpaired Flow Data, 1921-1992 (DWR 1994).

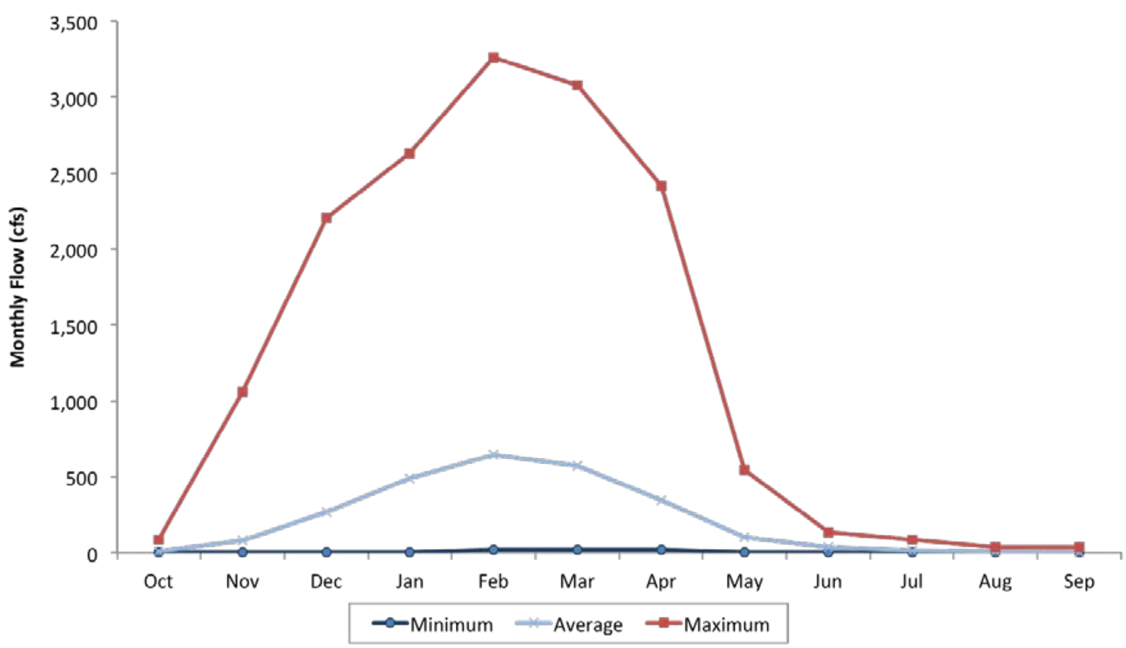


Figure B-4. Minimum, maximum, and average unimpaired Calaveras River flow. Data were converted from AF to cubic feet per second. Data source: California Central Valley Unimpaired Flow Data, 1921-1992 (DWR 1994).

Table B-1. Minimum, maximum, and average monthly unimpaired Calaveras River flow. Data were converted from AF to cubic feet per second.

Unimpaired Flow			
MONTH	**MIN**	**MAX**	**AVG**
JAN	0	2,590	479
FEB	18	3,553	704
MAR	16	3,030	564
APR	17	2,458	352
MAY	0	538	97
JUN	0	135	33
JUL	0	81	13
AUG	0	33	5
SEP	0	34	4
OCT	0	81	7
NOV	0	1,077	78
DEC	0	2,167	263

1.3.1 Flow Regimes of Calaveras River Tributaries Upstream of New Hogan Dam

The North and South Fork of the Calaveras River drain the western slope of the Sierra Nevada from their headwaters and confluence approximately seven miles upstream of New Hogan Reservoir. The headwaters of the North Fork stem from Pine Ridge near an elevation of 3,900 feet. The main tributaries that make up the North Fork include Esperanza and Jesus Maria creeks. Other, smaller tributaries include Murray and San Andreas creeks. The main tributaries flowing into the South Fork consist of the Calaveritas, San Antonio and San Domingo creeks. The headwaters of San Antonio stem from the Summit Level Ridge with an elevation of approximately 6,000 feet. Monthly average streamflows in the upper tributaries for the period of record (i.e., 1950 to 1966) were between 0 and 5 cfs during the months of July through October and ranged from 2 to 194 cfs during the remainder of the year (Table B-2).

Table B-2. Monthly average streamflow in the upper Calaveras Basin from 1950-1966. Monthly average flow calculated from daily average USGS gaging station data.

Month	North Fork Calaveras	South Fork Calaveras	Jesus Maria Creek	Esperanza Creek	Murray Creek	Calaveritas Creek	San Domingo Creek	San Antonio Creek
October	3	3	2	1	0	2	1	3
November	20	25	19	3	6	17	5	17
December	75	119	56	30	22	65	23	70
January	119	214	61	38	26	74	29	83
February	109	194	47	31	20	66	27	79
March	104	188	53	32	25	62	30	93
April	84	148	37	21	18	55	19	95
May	26	50	16	10	6	17	7	46
June	10	16	6	4	2	5	2	16
July	3	5	2	2	0	2	0	5
August	1	1	1	1	0	1	0	2
September	1	1	1	1	0	0	0	1

1.3.2 Flow Regimes of Calaveras River Tributaries downstream of New Hogan Dam

The four main tributaries downstream of New Hogan are Cosgrove Creek, South Gulch, Indian Creek, and Duck Creek (Figure B-5). Cosgrove Creek provides the largest run-off contribution to the Calaveras River and is the only tributary with a flow gage. Cosgrove Creek joins the Calaveras River upstream of Jenny Lind near Valley Springs, and has a drainage area of about 21 square miles that can contribute up to 8,500 AF per year to the Calaveras River (Brown and Caldwell 1995).

1.3.3 Lower Calaveras River Flow Regime

In the lower Calaveras River (i.e., downstream of New Hogan Dam), a flow gage was operated by the USGS at Jenny Lind (RM 37; elevation 243 ft; Figure B-5) between

January 1, 1907, and September 30, 1966. Although Hogan Dam was installed in 1930, it was run-of-the-river until 1948; therefore, unregulated flows were recorded at Jenny Lind prior to 1948. After daily flow measurements were discontinued at Jenny Lind in 1966, no flow gages were operated elsewhere in the lower river until October 21, 1995, when the USACE began operating a gage just upstream of Bellota Weir (RM 24; elevation 130 ft; Figure B-5). This gage was moved just downstream of Bellota Weir in 1997 to provide a more reliable reading.

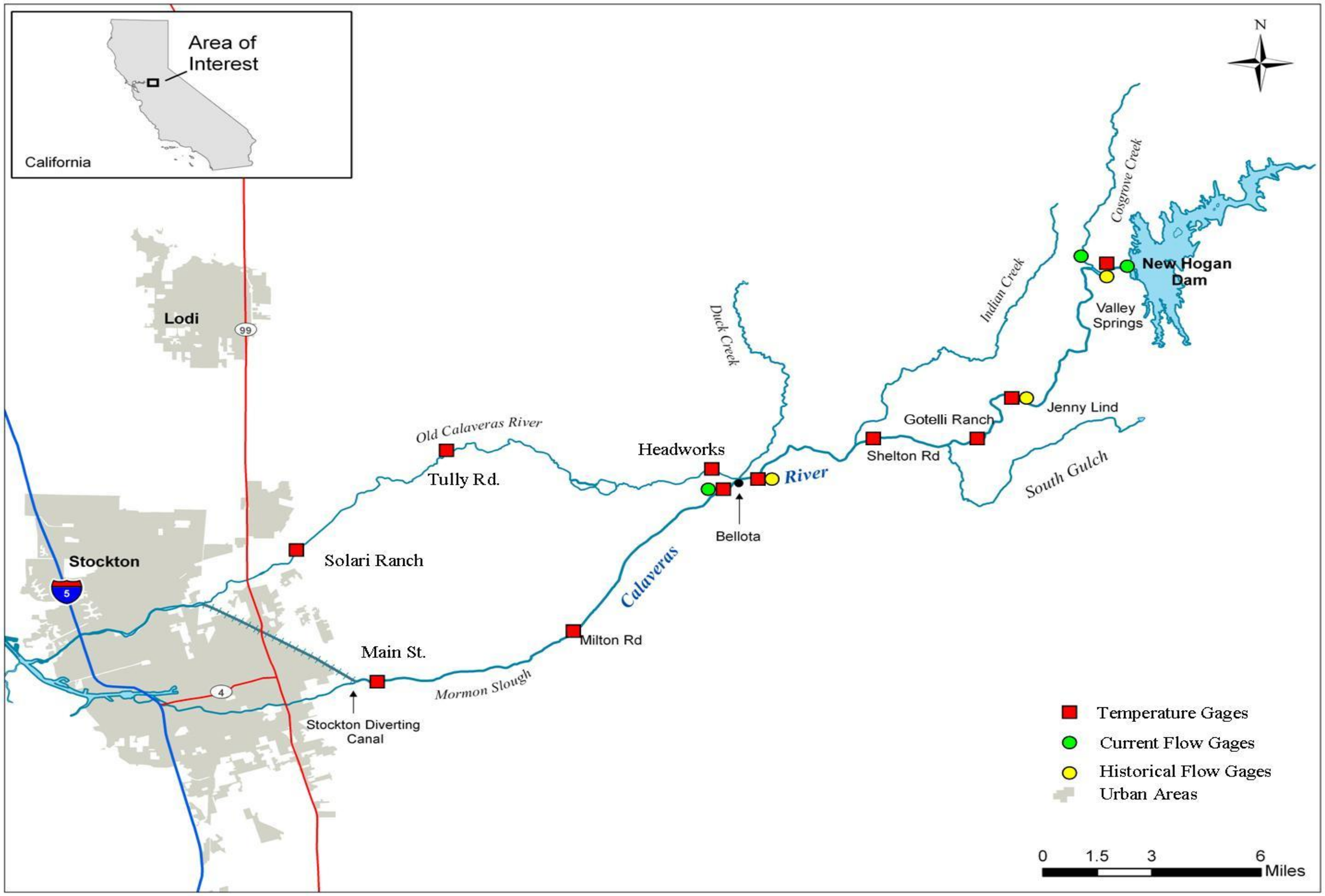


Figure B-5. Four main tributaries (Cosgrove Creek, South Gulch, Indian Creek, and Duck Creek) and gaging stations in the lower Calaveras River.

Based on USGS records at Jenny Lind prior to 1948, Calaveras River outflows varied substantially from year to year. The maximum annual runoff in the lower Calaveras at Jenny Lind between water years 1907 and 1948 was about 538,000 AF, which occurred in water year 1911 (October 1, 1910 to September 30, 1911). In contrast, the minimum annual flow was about 65,000 AF, which occurred in water year 1926 (October 1, 1925 to September 30, 1926).

In recent years, flow patterns in the lower Calaveras River have been altered as a result of the operation of New Hogan Reservoir (MBK 1969), which is consistent with streamflow pattern alterations found in other regulated streams. Due to flood control and water storage, naturally high winter flows have been attenuated. Water stored during the winter is then released throughout the summer and early fall for irrigation diversions, which results in continuous flows provided year-round in areas that historically went intermittently dry (i.e., between New Hogan and Bellota).

1.3.4 New Hogan Reservoir Storage and Operations (USACE 2001)

As stated previously, the New Hogan Project is operated for flood control, municipal and industrial water supply, irrigation, and recreation purposes, and the reservoir has a storage capacity of 317,000 AF at gross pool, with up to 165,000 AF of flood control storage space during the flood season and a minimum pool (inactive pool) of 15,000 AF for sediment storage, fish and wildlife, and general recreation. The controlled capacity through the outlet works is approximately 13,300 cfs with the power plant modification in place. The rated spillway capacity (gated, ogee) for the dam is approximately 106,400 cfs; however, a maximum release limit of 12,500 cfs is used as the “maximum non-damaging flow” for the Calaveras from New Hogan Dam to the San Joaquin River.

All of the reservoir capacity, except for the inactive pool, is used for conservation storage when not required for flood control. The water in conservation storage is released or withdrawn at the request of interests holding water rights. Rights to releases from New Hogan Dam and Lake Project are contracted by SEWD and the Calaveras County Water District (CCWD) through the Bureau of Reclamation (Reclamation).

Between 1965 and 2014, the smallest and largest annual fluctuation in monthly storage was 24,004 AF in 1989 (low of 17,397 in December and a high of 41,401 AF in April) and 160,566 AF in 1995 (low of 136,537 in January and a high of 297,103 AF in May), respectively (Table B-3). The average annual fluctuation in monthly storage has been 73,105 AF. Storage has rarely fallen below the inactive pool level (i.e., only in August-December 1977 and November 1988) and has been associated with extended drought conditions.

Table B-3. New Hogan Reservoir End-of-Month Storage in acre-feet, 1965-2014 (data from CDEC and USACE).

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1965	159,048	162,242	169,920	214,076	211,604	201,516	188,333	176,320	167,836	164,554	170,100	182,744
1966	186,233	200,277	203,813	199,497	189,882	177,266	163,177	149,272	142,244	137,953	139,026	165,440
1967	175,384	181,235	184,117	219,029	237,367	234,028	221,493	206,967	197,108	196,238	195,466	197,108
1968	203,594	202,772	200,809	199,246	190,046	178,252	164,321	151,177	142,816	139,834	141,456	155,628
1969	161,862	184,428	168,226	198,921	198,661	190,901	179,172	166,534	158,932	156,515	159,192	171,756
1970	--	172,328	172,057	173,837	169,179	160,147	147,658	134,149	125,368	122,703	134,334	158,528
1971	160,960	166,474	182,813	186,207	181,451	171,936	158,787	145,556	135,951	134,784	135,553	159,886
1972	163,206	180,063	177,425	172,539	164,527	151,656	137,124	123,436	115,091	112,044	113,780	119,895
1973	174,140	164,409	184,709	196,206	189,603	178,711	165,499	151,627	143,722	143,116	150,279	173,384
1974	184,678	192,554	234,969	272,456	267,963	255,798	244,015	228,823	218,615	215,011	194,760	172,268
1975	176,876	--	177,273	196,592	193,415	181,420	167,482	154,146	144,979	143,110	142,593	141,290
1976	140,479	136,754	137,874	129,104	116,381	103,400	88,678	77,183	70,900	68,964	68,180	67,672
1977	68,107	65,006	56,930	47,769	41,610	28,806	16,128	11,578	11,178	10,844	10,735	14,624
1978	73,416	118,834	171,608	220,112	222,165	206,890	189,497	171,187	161,805	152,980	151,149	151,908
1979	162,608	192,046	235,847	246,709	238,652	224,287	208,507	190,864	177,147	171,984	171,833	176,535
1980	166,519	198,991	209,746	215,633	207,270	193,905	178,957	161,441	148,801	142,039	138,776	137,627
1981	153,375	157,394	179,081	179,944	167,141	150,224	131,830	114,926	102,563	96,996	105,711	130,583
1982	170,421	184,890	252,639	276,189	275,913	264,291	249,440	232,632	221,992	220,678	208,373	158,804
1983	174,433	193,424	192,782	236,815	261,653	255,334	242,861	227,470	217,685	221,598	170,571	157,423
1984	158,084	180,438	199,905	200,494	190,991	177,239	159,266	141,307	127,828	124,448	130,143	135,186
1985	138,429	153,659	173,887	172,738	159,989	145,123	127,828	111,008	100,807	95,426	96,384	99,179
1986	108,938	186,901	195,808	202,234	194,582	179,574	162,461	145,123	135,503	131,000	127,400	125,380
1987	123,870	128,960	144,110	135,950	120,520	104,267	87,049	70,078	59,230	56,202	54,121	52,652
1988	55,187	55,250	55,412	52,000	48,302	39,000	28,480	19,448	15,431	15,431	14,933	16,006
1989	18,065	19,880	38,518	41,401	37,473	32,643	27,756	22,191	21,706	21,662	19,673	17,397
1990	21,255	31,507	42,390	44,369	40,820	36,053	30,242	23,592	20,164	17,135	15,604	15,275
1991	15,088	15,438	54,669	59,050	54,528	47,795	40,531	33,453	27,487	24,046	20,930	19,265
1992	20,939	57,212	70,952	71,944	62,201	51,690	41,894	33,232	29,138	25,449	22,255	27,311
1993	116,719	160,193	197,689	212,138	202,465	189,909	171,112	152,387	137,815	128,803	122,816	119,265
1994	117,792	128,623	127,726	118,773	107,469	90,339	71,484	54,106	40,938	34,062	30,440	30,860
1995	136,537	147,967	248,664	271,524	297,103	285,392	266,329	243,081	222,513	206,039	184,202	181,430
1996	190,195	194,357	221,335	223,834	218,577	202,696	182,020	160,831	148,384	143,536	144,028	172,135
1997	171,894	177,944	180,377	173,101	162,783	150,784	136,749	123,468	113,006	108,097	105,344	105,138
1998	169,524	167,854	214,307	241,188	239,665	237,859	222,652	205,042	191,247	185,581	185,675	182,331
1999	181,927	193,939	203,058	211,430	204,479	192,847	177,791	164,396	154,255	147,606	147,884	147,662
2000	178,497	205,906	198,959	201,741	201,052	190,386	177,545	164,425	155,678	151,908	150,840	150,364
2001	153,687	169,494	184,014	183,889	173,555	160,309	146,859	133,476	123,242	119,216	116,743	131,960
2002	147,579	158,545	181,678	180,223	174,130	163,427	150,028	138,055	128,572	124,121	122,116	134,501
2003	139,018	141,362	144,959	158,315	158,257	146,804	132,508	118,675	108,611	100,584	98,892	105,275
2004	116,160	137,735	146,528	140,013	129,705	117,915	105,046	93,162	83,850	81,610	80,208	95,426
2005	166,460	194,035	237,391	249,256	253,947	246,304	232,490	218,646	206,172	199,318	174,282	193,136

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2006	181,275	191,726	255,072	262,455	262,990	247,888	227,857	206,937	192,975	189,210	175,803	171,954
2007	169,972	187,849	191,471	187,849	178,374	165,751	151,711	136,431	127,113	123,217	120,574	119,093
2008	138,563	156,506	157,768	150,000	139,314	126,348	111,838	96,975	87,379	83,167	80,051	79,562
2009	81,472	93,806	118,970	114,276	107,446	95,600	81,313	69,462	61,308	58,869	55,948	56,762
2010	56,730	82,806	99,981	121,991	145,289	147,856	139,932	128,469	117,353	108,938	105,413	109,641
2011	166,194	182,424	217,411	225,578	241,806	243,044	234,951	217,891	202,037	189,655	186,146	172,829
2012	167,171	168,182	168,509	183,514	200,135	191,630	179,420	165,397	151,542	141,335	136,192	134,554
2013	166,283	167,617	165,308	159,700	149,107	13,6510	122,966	111,032	102,880	98,958	96,624	94,668
2014	92,841	96,624	100,517	97,523	87,359	75,346	63,068	51,859	44,093	41,163	40,465	49,624
Avg	**137,177**	**150,793**	**168,600**	**176,587**	**173,378**	**162,542**	**148,683**	**134,578**	**124,860**	**120,555**	**117,280**	**120,778**
Min	**15,088**	**15,438**	**38,518**	**41,401**	**37,473**	**28,806**	**16,128**	**11,578**	**11,178**	**10,844**	**10,735**	**14,624**
Max	**203,594**	**205,906**	**255,072**	**276,189**	**297,103**	**285,392**	**266,329**	**243,081**	**222,513**	**221,598**	**208,373**	**197,108**

The relatively low basin run-off, low volume of storage in the reservoir, and the need to maintain flood control space in winter are the primary factors that limit the amount of water that can be carried over from year to year. For instance, even if it were possible to fill the reservoir by fall each year, over 100,000 AF would need to be released prior to the flood control season to make room for flood control storage as required by the flood control diagram (i.e., storage required to be ≤152,000 AF by December 1, USACE 1983). If winter precipitation is average or above average, then the reservoir may be near capacity as spring approaches and water deliveries are needed. However, if it is a dry year, then, not only will the reservoir be low in spring, but the dry winter will require irrigation to begin sooner and a larger total volume of water will be required during the year to meet irrigation demands.

The release of water for irrigation and municipal needs are in accordance with daily requirements determined by SEWD and CCWD. M&I releases occur year-round, while irrigation releases normally occur during the spring and summer, the onset and duration of which are controlled by a variety of environmental factors. The volume of water released at New Hogan for irrigation and municipal supplies varies during different months of the year, as well as from year to year.

The water level in New Hogan fluctuates dramatically between seasons, with the highest pool level occurring during the spring and the lowest pool level occurring in fall. Dry summers ensure that the pool level is continually reduced throughout the summer season, and in dry winters the pool level may continue to decline throughout the year.

1.4 Water Temperature

Due to the ephemeral nature and low elevation range of the Calaveras River watershed, water temperatures are expected to be relatively cool beginning in late fall and extending through mid-spring, then become relatively high from late spring through early fall.

1.4.1 Calaveras River Tributaries upstream of New Hogan Dam Water Temperatures

Water temperature data is limited for upper tributary reaches; however, water temperatures were recorded during a few surveys conducted by the California Department of Fish and Wildlife (CDFW; formerly known as California Department of Fish and Game) on August 23, 1974, and June 28, 1984; during some fish stocking events conducted by CDFW during unknown dates[2]; and during fisheries inventories conducted by BLM in November 1979 and August 1980 (Meinz 1984; CDFW unpublished data; BLM 1980a and 1980b). Instantaneous temperatures taken in 1974 on Calaveritas Creek, Jesus Maria Creek, and North Fork Calaveras River ranged from 64°F to 70°F, while temperature recorded in 1984 on San Antonio Creek was 80°F (Meinz 1984). Temperatures recorded during unknown periods[1] on San Antonio, Calaveritas, and San Domingo Creeks ranged from 70 to 80°F. Temperatures taken in 1979 on numerous tributaries, including the six aforementioned tributaries and Indian, O'Neil, Murray, Jack Nelson, Wet Gulch, French Gulch, and Cherokee creeks, ranged from 43°F to 60°F (BLM 1980a). In 1980, temperatures in Indian, Jesus-Maria, Salamander, and San Antonia ranged from 63°F to 79°F (BLM 1980b). These temperatures are within the range expected for an intermittent, low-elevation stream such as the Calaveras River.

1.4.2 Lower Calaveras River Water Temperatures

No pre-dam water temperature records for the lower river are available; however, daily water temperatures were recorded at New Hogan Dam by the USACE from 1969 to 1994, and at various thermograph stations by SEWD's biologists from April 18, 2000 to the present. Thermograph stations are located within the lower river at New Hogan Dam (RM 42), Jenny Lind (RM 37), Gotelli Ranch (RM 31), Shelton Road (RM 28), and Bellota (RM 24); and within Mormon Slough at Milton Road, and near Stockton East Water District Office (Figure B-5).

Although historic pre-dam water temperatures are unknown, it is assumed that water temperatures in the lower river during high-flow events in the winter/spring were likely suitable for salmonids, but became sub-optimal to lethal during low-flow periods in the summer and early fall due to the lack of natural flows occurring in the river. In more recent years, due to SEWD's operation of New Hogan Dam for irrigation, sustained summer flows in the reach between New Hogan and Bellota have resulted in suitable water temperature conditions year-round in a majority of this reach during most years. An examination of average daily minimum and maximum water temperatures at New Hogan Dam between 1969 and 1994 (Figure B-6) and at two thermograph stations from 2000-2014 (Figure B-7) demonstrates that average daily water temperatures were below 60ºF year-round immediately downstream of New Hogan and extending to Jenny Lind. During most years,

[2] Stream survey data sheets containing temperature information were obtained from CDFW Rancho Cordova files. These data sheets do not have date stamps; however, associated records for fish stocking events indicate that stocking typically took place in either June or July and occasionally in May or August during years 1930-1954.

water temperatures in this reach are likely to be suitable throughout all, or portions of, salmonid spawning, incubation, and rearing periods. It is currently unknown what happens to temperatures in the lower river between New Hogan and Bellota during drought years, but water temperatures are likely to become suboptimal for salmonids in portions of this reach during very dry years.

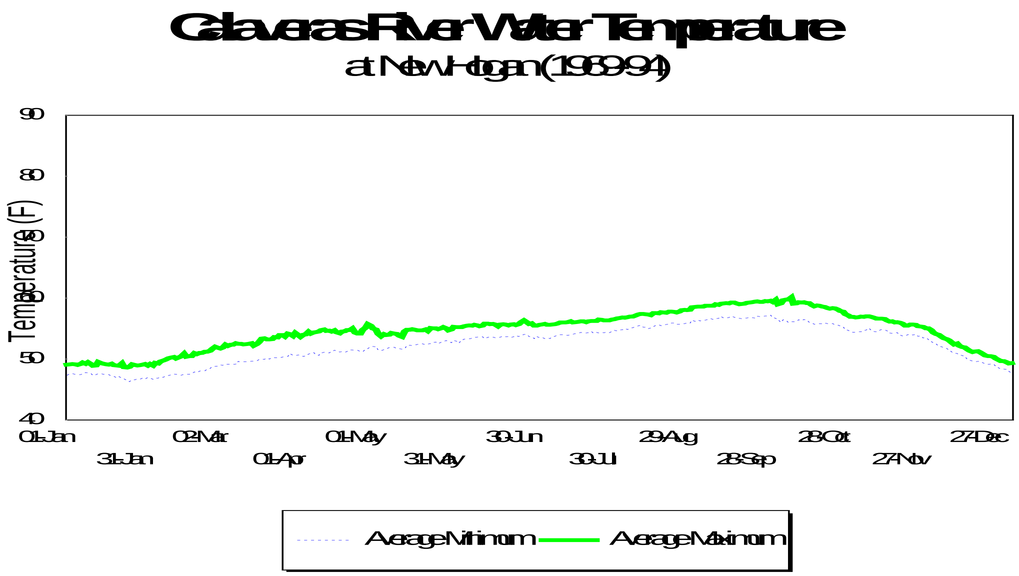
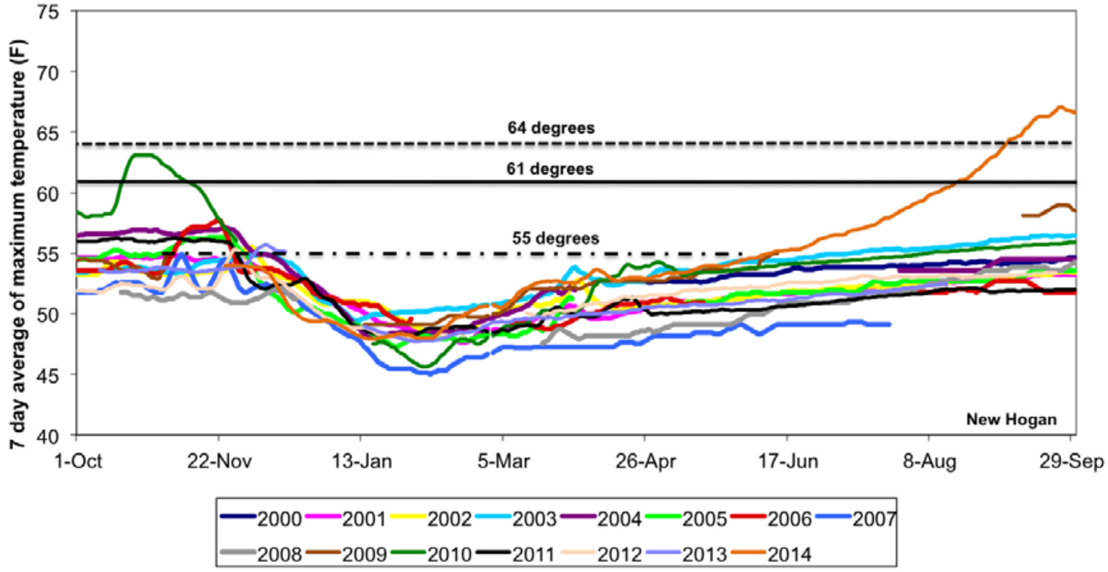


Figure B-6. Average daily minimum and maximum water temperatures (°F) in the Calaveras River measured at New Hogan Dam, 1969-1994 (USGS files from Pat Schiffer).



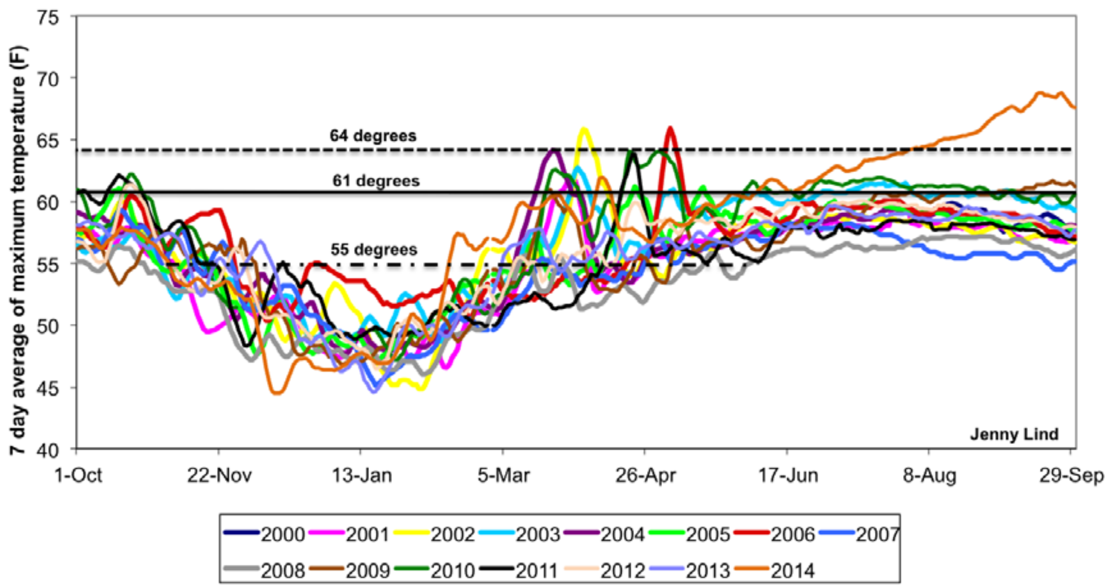


Figure B-7. Seven-day moving average of the daily maximum at New Hogan (RM 42) and Jenny Lind (RM 34.6), Water Years 2000-2014.

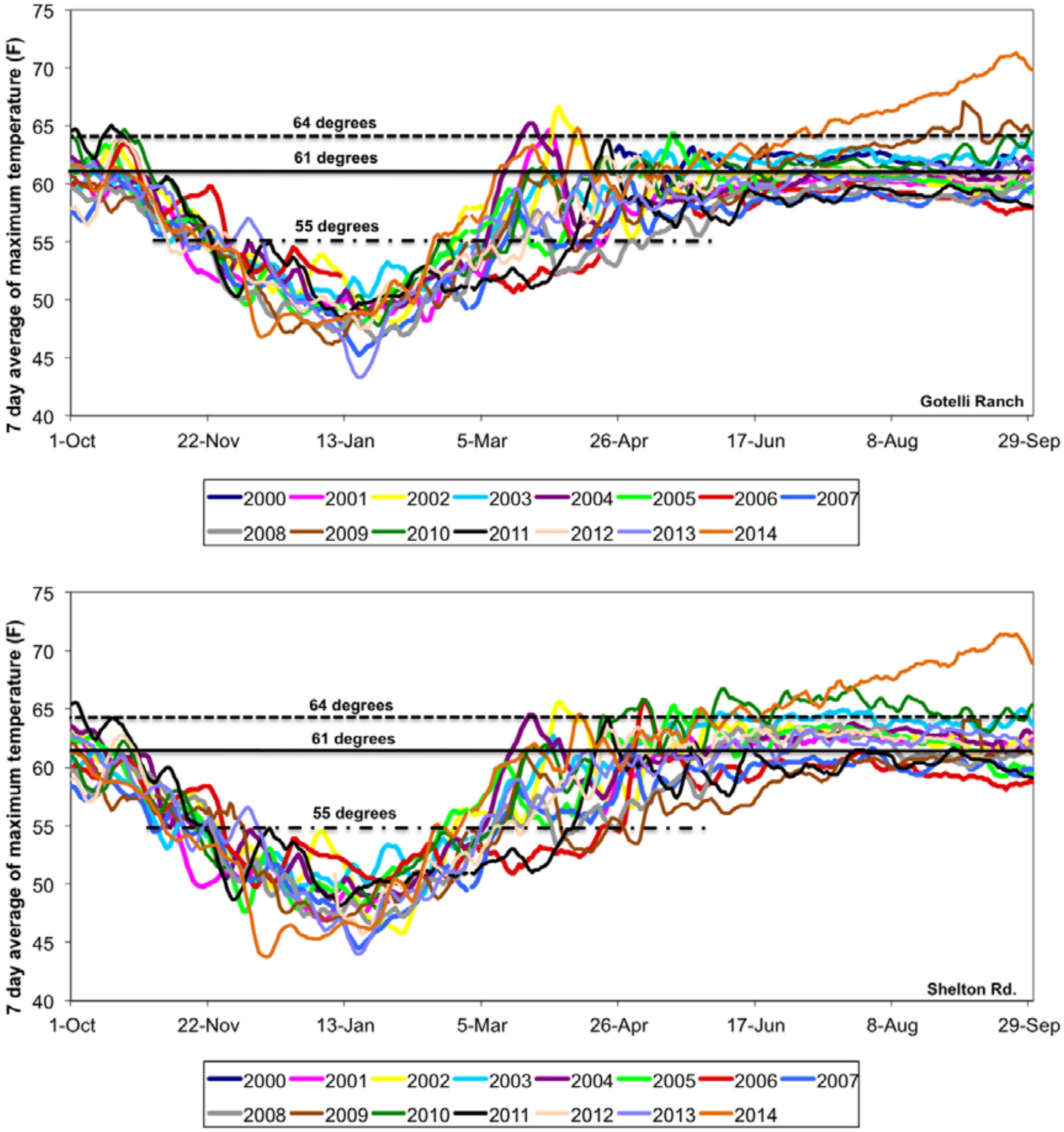


Figure B-8. Seven-day moving average of the daily maximum at Gotelli Ranch (RM 32) and Shelton Road (29.3), Water Years 2000-2014.

Daily average water temperatures recorded with thermographs located at Bellota (RM 24) and in Mormon Slough (Milton Road and Stockton East) from 2000-2014 indicate that temperatures in these lower areas become suboptimal (i.e., greater than 60°F) in March and remain suboptimal through the beginning of October (Figures B-7 and B-8). Suboptimal temperatures during these periods limit the suitability of this reach for adult salmonid immigration and juvenile salmonid rearing and emigration. In addition, there are instances when flows completely dry up in areas of Mormon Slough, as occurred historically.

1.5 Nutrients, Dissolved Oxygen, and Sediment (excerpts from Tetra Tech 2001)

EPA maintains historic water quality data collected from surface waters in the Calaveras River watershed in its STORET-LEGACY database. Water quality data are available for the years 1958 to 1987. The data correspond to monitoring performed by the California Department of Water Resources (DWR), USGS, and USACE. Data were collected by these agencies from a total of about 30 sites within the watershed that included the Calaveras River upstream and downstream of New Hogan Reservoir, at different locations and depths in New Hogan Reservoir, tributaries to the Calaveras River, Stockton Diverting Canal, Mormon Slough, and raw and treated water at the SEWD WTP. Some sites were sampled quarterly for up to 20 years, while others were only sampled once. Overall, the water quality data cover a wide spectrum of parameters, including major ions, nutrients, metals, organics (such as pesticides), and sediment. Flow data are available for some sites. Substantial variability occurred in sampling frequency, duration, and analyses among the sites for which data are available. The water quality data provided by EPA are currently in two formats: (1) site-specific data for individual sampling events, and (2) a statistical format that presents data (for any given site and water quality parameter) according to the number of samples collected and analyzed for a particular parameter. Specifically, mean, variance, standard deviation, and observed minimum and maximum data were provided for each parameter at each site over time.

1.5.1 Nutrients

Nitrate concentrations appear to be lower in the upper watershed and higher at sites downstream of New Hogan Reservoir. These data indicate that nitrate concentrations downstream of the reservoir can be as much as three times higher than nitrate levels in the upper watershed. Phosphate concentrations in New Hogan Reservoir appear to be influenced by season. During spring inflow, lake surface and lake bottom phosphate concentrations are higher than summer levels. The high levels of phosphate present in the reservoir and tributaries during the spring are likely the result of the presence of phosphorus in suspended sediment. The low levels of phosphate present in the reservoir and tributaries in the summer are likely the result of phytoplankton blooms consuming nearly all of the available phosphate.

1.5.2 Dissolved Oxygen

Data collected throughout the watershed between 1958 and 1959 suggest that dissolved oxygen (DO) levels were historically high enough to support cold water fisheries and were above current water quality standards. However, limited data from the 1970s indicate that DO levels were decreasing in the lower Calaveras River watershed.

1.5.3 Sediment

For both the North and South Fork of the Calaveras River, sediment load appears to be directly related to flow, regardless of year. Maximum and minimum sediment loads do not appear to be correlated to one another within a given year, and no observable increase or decrease occurs in sediment load over time.

1.6 Calaveras River Basin Existing Land Use

1.6.1 Recreation

New Hogan reservoir is the primary source of public recreation in the lower portion of the Calaveras River Basin, and is considered a valuable source of recreation within the area. Predominant use of New Hogan is by people from the Modesto and Stockton metropolitan areas, and the greater Bay Area (USACE 1989). Activities at the reservoir include camping, fishing, boating, water skiing, sightseeing, and hiking.

Fishing in the portion of the Calaveras River downstream of New Hogan is also popular, especially with fly fishermen. No estimates of the total number of angler hours are available, but during good weather fly fishers can be found in the river downstream of the dam every day of the week. Recent articles in fishing magazines and on the internet are believed to be responsible for significantly increased fishing pressure in the last few years. Unfortunately, public access to the lower river is poor, so the majority of angler hours occur in a concentrated section of river downstream of the dam. The Jenny Lind Bridge is the other public access location, with fishermen parking along the road and walking upstream and downstream from the bridge. Private property and a constricted river channel prohibit anglers from walking more than approximately one mile in either direction.

1.6.2 Mining

Historically, mining was an important part of Calaveras County's history, with gold being mined by several different operations beginning near the Gold Rush and continuing into the 1930s (Gilbert 1989). Gold placer mining occurred primarily in the mining district above Highway 49, but at least some placer and hard rock mining is known to have occurred along the lower river between the confluences with Cosgrove Creek to the South Gulch area near Jenny Lind. More recently, as many as 15 mines were actively mining gold, asbestos, industrial minerals, limestone, sand, and gravel (Tetra Tech 2001). Today, only one mining operation, the Hogan Quarry, is operated downstream of New Hogan reservoir. The Hogan Quarry began operation in 1965 and is an aggregate mining and processing facility on approximately 75 acres of land (CRWQCRB 2002). A portion of the facility is within the 100-year flood zone of the Calaveras River. The processing facility discharges a monthly average of 38,000 gallons of wastewater from the aggregate washing operations to a wash water settling/recycling pond and supplemental water supply for aggregate washing is supplied via pumping of water from the Calaveras River (CRWQCRB 2002).

1.6.3 Residential

The Calaveras River from New Hogan to the San Joaquin River lies within Calaveras, San Joaquin, and Stanislaus counties. Although there are metropolitan areas within these counties, the Calaveras River Basin primarily consists of small, rural communities. According to the California State Department of Finance, the estimated population in Calaveras County in the year 2000 was 41,870, but is projected to be 56,318 by 2020, and 80,424 by the year 2050 (CSDF 2007).

The estimated population of San Joaquin County in 2000 was 569,083 (CSDF 2007). San Joaquin County has seven incorporated cities and other residential development in the unincorporated area of the County. The estimated population of the City of Stockton in 2009 is 290,409 (CSDF 2009). San Joaquin County is projected to be 965,094 in 2020 and 1,783,973 in 2050 (CSDF 2007).

1.6.4 Agriculture (excerpt from Tetra Tech 2001)

Agriculture in the Calaveras River watershed includes a diverse list of crops, including field crops, apiaries, fruit and nut crops, livestock, poultry, and wine grapes. Agricultural land in the Calaveras River floodplain is very productive and extensively cultivated. Lowlands are used primarily for cultivation of orchards (walnuts, peaches, and cherries), vineyards, and irrigated row and field crops (corn, sugar beets, and vegetables). Other uses include pasture, hay, wheat, range, and dairying. The primary agricultural land use in the lower elevation hillsides of the watershed is cattle ranching. Cattle grazing in small numbers occurs throughout the watershed, primarily in the lower rolling foothills. At New Hogan Reservoir, cattle grazing occurs during the months of November through May, when 200 to 300 cattle graze near the reservoir on about 1,700 acres of land leased for horse and cattle grazing. Cattle are transported to higher elevations the rest of the year. The Forest Service does not have grazing allotments in the Calaveras River watershed portion of the Stanislaus National Forest (Brown and Caldwell 1995).

1.6.5 Forestry (excerpt from Tetra Tech 2001)

The Forest Service oversees the Stanislaus National Forest. Only a 25-square-mile portion of the eastern watershed is situated in the Stanislaus National Forest, while another small portion of the watershed, 3 square miles, lies within Calaveras Big Trees State Recreation Area (Brown and Caldwell 1995).

The Forest Service also manages timber harvest lands within the Stanislaus National Forest in the eastern watershed. Recently, there has been a concerted effort to minimize timber harvests on U.S. Forest land. In 1993, over 6,000 million board feet of timber were salvaged from the Old Gulch fire, near the upper reach of San Domingo Creek. Salvage sales involve timber that has been affected by fire or insect infestation.

Currently, Sierra Pacific Industries (SPI) is the only private industry that owns land within the Stanislaus National Forest. SPI owns about 5,000 acres in the Calaveras River watershed, of which 10 to 20 percent is harvested annually (Graves 2000). CCWD is currently working with SPI to implement a monitoring program for the timber harvest above White Pines Lake. The monitoring program includes continuous water quality sampling on San Antonio Creek at the lower extent of the timber sale as well as grab sampling at up to 5 locations within the timber sale. The data will be used to identify any potential impacts from the timber harvesting on water quality in San Antonio Creek.

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