DRAFT
Arroyo del Valle and Arroyo de la Laguna Steelhead Habitat Assessment

APPENDIX

A

STEELHEAD HABITAT ASSESSMENT

Cardno ENTRIX
Shaping the Future

Prepared by	Cardno ENTRIX
Prepared for	Zone 7 Water Agency
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Project Manager	Neil Lassettre and Jean Baldrige
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Prepared for:

Zone 7 Water Agency
100 North Canyons Parkway, Livermore, CA 94551

Prepared by:

Shaping the Future

Cardno ENTRIX
2300 Clayton Road, Suite 200
Concord, CA 94520

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Acronyms

°C	Celsius
ACN	Alameda Creek at Niles USGS stream gauge (#11179000)
ACWD	Alameda County Water District
ADLL	Arroyo de la Laguna
ADLLV	Arroyo de la Laguna at Verona Bridge USGS stream gauge (#11176900)
ADV	Arroyo del Valle or Arroyo Valle
ADVP	Arroyo del Valle near Pleasanton stream gauge (operated by Zone 7)
AVBLC	Arroyo del Valle below Lang Canyon USGS stream gauge (#11176400)
AVNL	Arroyo del Valle near Livermore USGS stream gauge (#1176500)
cfs	cubic feet per second
cm	centimeter(s)
DO	dissolved oxygen
DPS	distinct population segment
DWR	California Department of Water Resources
ft	feet
LiDAR	Light Detection and Ranging
LWD	Large Woody Debris
m	meter
mi^2	Square miles
MSL	Mean Sea Level
MWATs	Maximum Weekly Average Temperatures
RI	Recurrance Internal
SFEI	San Francisco Institute
SWP	State Water Project
USGS	United States Geological Survey
Zone 7	Zone 7 Water Agency

Appendix A
Steelhead Habitat Assessment

A.1 Introduction

In 1957, local voters approved the creation of the Zone 7 of the Alameda County Flood Control and Water Conservation District (Zone 7 or Zone 7 Water Agency), with a locally-elected board to oversee the vital matters of flood protection and water resource management in eastern Alameda County. As part of its water resource management activities, Zone 7 has a water right permit (Permit 11319) to put water diverted from Arroyo del Valle to beneficial use.

Four protest letters were filed in response to Zone 7 Water Agency's most recent petition for extension of time to achieve its California water right under Permit 11319: three related to environmental concerns over effects to steelhead and amphibians (red-legged frog [*Rana draytonii*] and foothill yellow-legged frog [*R. boylii*]) and one related to a senior water rights concern that was later dismissed. To resolve the remaining protests, Zone 7 Water Agency proposed environmental studies and hydrologic analyses to develop and identify measures to preserve sensitive habitats. This Appendix A summarizes a steelhead habitat assessment conducted along Arroyo del Valle and Arroyo de la Laguna.

The Arroyo del Valle and Arroyo de la Laguna (Alameda County, California) were surveyed in early spring (April 2, 3, and 18) and late summer (September 11) 2012 to assess current geomorphic and fisheries habitat conditions (Figure A-1). The surveys were conducted from the base of Del Valle Dam on Arroyo del Valle, downstream to the confluence with Arroyo de la Laguna, and along portions of Arroyo de la Laguna near the Verona Street Bridge (see Section A.2 below for more detailed description of the Study Area). The objectives of the surveys were to characterize the current condition of fisheries habitat, with specific focus on steelhead [*Oncorhynchus mykiss*] and geomorphic conditions.

A.2 Study Area

The Study Area includes Arroyo del Valle from the base of Del Valle Dam to the confluence with Arroyo de la Laguna and Arroyo de la Laguna from the confluence with Arroyo del Valle to the confluence with Alameda Creek (Figure A-2). Arroyo del Valle and Arroyo de la Laguna (described in greater detail below), occur within the Alameda Creek watershed, which drains 630 square miles (mi^2) over portions of Alameda, Contra Costa, and Santa Clara counties (ESA 2006). Arroyo del Valle is a tributary to Arroyo de la Laguna, which joins Alameda Creek before it flows through Niles Canyon, across bay lowlands, and eventually to the San Francisco Bay. The Alameda Creek watershed lies within the California Coast Ranges geomorphic province, which is seismically active, and composed chiefly of a complex assemblage of marine sedimentary rocks expressed as a series of northwest-trending ridges and valleys (ESA 2006). An area of major seismicity coinciding with the boundaries of the Pacific and North American tectonic plates, the watershed contains the Calaveras and Greenville faults, which are major and active, and the minor Las Positas, Pleasanton, Livermore, Mocho and Verona faults.

Elevations range from about 300 feet (ft) above mean sea level (MSL) within valleys to over 2,000 ft above MSL in the surrounding hills (ESA 2006). Upland areas are folded and faulted marine sedimentary rocks, including sandstones and shales, while the valleys are non-marine mudstones and sedimentary rocks. The Livermore-Amador Valley in the northern part of the Alameda Creek watershed, across which Arroyo del Valle flows before joining Arroyo de la Laguna, is a northwest trending valley bounded by belts of folded and faulted bedrock, overlain by several hundred feet of relatively young (deposited during the last 1.6 million years) fine to coarse-grained alluvium including silts, clays, sands, and gravels. This layer of alluvium forms the Livermore-Amador groundwater basin.

The natural hydrology of the watershed is influenced by patterns of precipitation and surface flow driven by a Mediterranean climate that produces cool, wet winters and hot, dry summers. The greatest mean monthly flows occur in February and the lowest occur in September (Figures A-3 and A-4). The greatest recorded peak flow occurred in 1955 (29,000 cfs; occurred in December 1955, which is in water year[1] 1956), with large events also occurring in 1958 (25,500 cfs), 1986 (16,400 cfs), and 1998 (17,900 cfs) (Figure A-5). Annual average precipitation ranges from about 30 inches near the headwaters of Alameda Creek in the southwest, to 20 inches near Pleasanton in the Livermore-Amador Valley, to about 12 inches near the east edge of the Livermore-Amador Valley (ESA 2006).

In general, the Study Area is affected by a number of land use activities including gravel mining, flood control, and adjacent urbanization. Extensive gravel mining has occurred along Arroyo del Valle since the early 1900s, as demonstrated by the presence of extensive gravel pits (Figure A-2) and sections of channel excavation apparent from historical and recent surveys. The Study Area has a history of flooding, and the construction of key pieces of infrastructure, such as the Del Valle Dam, and the deepening and channelization of portions of Arroyo del Valle and Arroyo de la Laguna are intended to reduce or control flooding (Hanson, et al. 2004; RMC 2006). Further, the population in the surrounding area of Livermore, Dublin, and Pleasanton has increased from 15,000, as listed on the original 11319 permit issued in 1958, to 220,000, as estimated in Zone 7's 2010 Urban Water Management Plan (Zone 7 Water Agency 2010). All of these changes have resulted in geomorphic, hydrologic, and biological changes to the Study Area.

A.2.1 Arroyo del Valle

Arroyo del Valle or Arroyo Valle (ADV) originates in the East Bay foothills at an elevation of 1,800 ft and flows into the Arroyo de la Laguna, a tributary to Alameda Creek, which empties directly into the San Francisco Bay. Del Valle Dam, built in 1968, intersects Arroyo del Valle approximately 11 miles upstream from the confluence with Arroyo de la Laguna (ADLL) and controls the upper 146 mi^2 of the watershed (Figure A-1); the remaining 22 mi^2 is located downstream of the dam, to where it joins the ADLL. The dam forms Lake Del Valle, which has a capacity of 77,100 acre-ft and is used for flood protection, recreation, and water supply. The Study Area on Arroyo del Valle begins at the release point of Del Valle Dam. Downstream of the dam, Arroyo del Valle flows past adjacent parkland and current gravel extraction sites, and through in-channel historical gravel extraction sites and flood protection/urban sections, all of which likely affect geomorphic conditions and steelhead habitat.

A.2.1.1 Water Releases on Arroyo del Valle

The California Department of Water Resources (DWR) owns and operates the State Water Project, which includes both the South Bay Aqueduct and Lake Del Valle. DWR will release water from either the South Bay Aqueduct or Lake Del Valle into Arroyo del Valle; 1) to meet conditions specified in water right permits 11319 and 11320; 2) to meet the water supply obligations of Zone 7 and the Alameda County Water District (ACWD) (Zone 7 Water Agency 2013); or 3) to satisfy United States Army Corps of Engineers permit conditions related to dam operation (see Figure A-6 and Attachment 1 for more detail). Zone 7 has been managing the Livermore-Amador Valley groundwater basin for more than 50-years, and as part of these management activities, Zone 7 implements an artificial recharge program that involves the release of State Water Project (SWP) water (as available) or water appropriated under Permit 11319 into Arroyo del Valle during the spring, summer, and fall when streams are normally dry or have little flow. One of the purposes of these releases is to help maintain groundwater levels in the Livermore-Amador Valley groundwater basin (ESA 2006). Groundwater resources are a major source of the public water supply within the Livermore-Amador Valley (ESA 2006). Additionally, although Zone 7 and ACWD can request that DWR release water to the Arroyo del Valle, State Water Project operations dictate whether the source of the water is from Lake Del Valle or the South Bay Aqueduct. DWR could release no water at

[1] A water year is defined as the period between October 1 of one year and September 30 of the next.

all if the supply is unavailable (e.g., no water in storage or loss of the Del Valle Branch Pipeline due to landslides or earthquakes) or due to other DWR permit conditions (e.g., copper sulfate use for algae control in the South Bay Aqueduct). Additional information on water operations of Arroyo del Valle is provided as Attachment 1.

A.2.1.2 Existing Live Stream Requirement

If local water supply is available, then the releases made from the SWP or Lake Del Valle must also comply with permit conditions, such as a live stream condition specified in water rights permits 11319 and 11320 issued by the California State Water Resources Control Board. The condition requires Zone 7 and ACWD to maintain a “live, flowing stream in the reach of Arroyo del Valle from Del Valle Dam to the Arroyo del Valle at Pleasanton stream gauge (formerly USGS Gauge #11176600, now operated by Zone 7 as Gauge Arroyo del Valle at Pleasanton [ADVP]) on Arroyo del Valle near the confluence with Arroyo de la Laguna when certain conditions exist, such as, when water stored pursuant to these permits is available.” ADVP was selected since downstream reaches are flow-neutral or gaining; thus, a live stream to ADVP is expected to maintain water further downstream as well.

The magnitude and frequency of flow required to meet the live stream requirement changes throughout the year based on hydrologic or system constraints, but typically, Zone 7 and ACWD request that DWR release a combined flow of 8 to 10 cfs during the summer and 0 to 2 cfs during the winter to supplement natural runoff downstream of the dam to maintain a live stream (Zone 7 Water Agency 2013). Winter releases from Lake Del Valle are low because storm water runoff is sufficient to provide a live stream. Lake Del Valle is kept nearly full throughout the summer for recreational purposes, and the DWR will only release previously-stored SWP water from the lake in the summer to address water quality concerns arising in contractor treatment plants or to supplement South Bay Aqueduct water supplies.

A.2.1.3 Historical and Current Effect of Releases to Arroyo del Valle

The historical and current effect of water releases from the South Bay Aqueduct and Lake Del Valle on flow patterns can be shown by examining median average daily flow for the Arroyo del Valle near Livermore (AVNL; USGS Gauge #11176500) and ADVP gauges, and the mean monthly flow for gauges above and below Lake Del Valle (Arroyo del Valle below Lang Canyon [USGS Gauge # 11176400] and AVNL stream gauges, respectively) (Figures A-8 through A-11). Seasonal exceedance curves (Figure A-11) for ADVP also illustrate the flashy and transient condition of the Arroyo Valle downstream of the dam.

Median average daily flow values for the periods of record before emplacement of Del Valle Dam shows high average daily flows occurring from January to March or April at AVNL and ADVP (with highest median average daily flow in February), and little or no flow for the remainder of the year (Figures A-8 and A-9). Post-dam, high spring flows are largely absent or reduced and base flow is relatively constant throughout the year. Comparison of identical post-dam periods of record (1969-2011) shows higher December to May and lower June to November mean monthly flows upstream of Lake Del Valle (Figure A-7) than downstream (Figure A-8). This likely reflects a reduction in peak flows downstream due to dam regulation in winter and spring and an increase in base flow during summer and fall due to releases required to meet the live stream requirement and water supply or water quality needs. Figure A-11 shows that runoff downstream of dam can exceed 100 cfs in the winter and spring months.

A.2.2 <u>Arroyo de la Laguna</u>

Arroyo de la Laguna is the main tributary to Alameda Creek from the northern portion of the watershed (Figure A-2). Five major arroyos (South San Ramon Creek, Alamo Creek, Arroyo Las Positas, Arroyo Mocho, and Arroyo del Valle) feed or join Arroyo de la Laguna before it flows into Alameda Creek near the town of Sunol (Figure A-6). The approximately 15-miles wide by 45-miles long basin collects and drains runoff from the cities of San Ramon, Livermore, Dublin, and Pleasanton (U.S. Army Corps of

Engineers 2012). The Study Area on Arroyo de la Laguna begins at the confluence with Arroyo del Valle and extends to the confluence with Alameda Creek (approximately 5 miles).

Arroyo de la Laguna was historically the outlet of a permanent marshy lagoon called Lake Tulare that occurred at a low point in what is now northwest Pleasanton (Sowers 2003; Hanson et al. 2004). Streams that currently drain to the Arroyo de la Laguna, such as Arroyo del Valle and Arroyo Mocho, likely terminated before the lagoon, percolating into the alluvium layer covering the Livermore-Amador Valley, although Arroyo del Valle may have occasionally connected with the lagoon depending on hydrologic conditions (Sowers 2003; Hanson et al. 2004). Historical maps show that Lake Tulare was drained and the final mile of Arroyo del Valle straightened before 1911 to lower groundwater levels for farming. Connecting creeks, including Arroyo del Valle, were confined to prevent flooding of agricultural fields. As such, most channels dried before reaching Lake Tulare, although, surface flow likely reached the lake during floods. The draining of Lake Tulare and the subsequent channelization of Arroyo de la Laguna and Arroyo del Valle created a continuous channel downstream to Alameda Creek.

The effect of increased runoff into and through Arroyo de la Laguna can be seen by examining average daily flow records for the Arroyo del Valle at Verona (ADLLV; USGS Gauge # 11176900) and the Alameda Creek at Niles (ACN; USGS Gauge #11179000) stream gauges. For the period of record before 1968, both ADLLV and ACN show the highest average daily flows occurring from January through April or June and little to no flow during the rest of the year (Figures A-13 and A-14), similar to Arroyo del Valle (Figures A-8 and A-9) (Note: the period of record for ADLLV [1912 to 1930] is shorter than ACN [1900 to 1967] but shows the same trend as ACN). After 1968 (post-dam), the highest daily average flows still occur from January to April or June, but at a greater magnitude than historically, and average base flows of 15-30 cfs occur perennially.

The historical and recent hydrologic comparisons for Arroyo del Valle and Arroyo de la Laguna focus on similar time periods (before and after 1968). On Arroyo del Valle, these periods correspond to the presence of Del Valle dam, while on Arroyo de la Laguna, the periods generally correspond to pre- and post-urbanization (and associated runoff), wastewater systems, water systems, and flood/runoff control measures developed for the Livermore-Amador Valley. As such, runoff magnitude increased from historical levels as modern storm water systems directed flows to Arroyo de la Laguna and other urban streams and waterways, and base flow increased in response to water management and to decreases in infiltration caused by the presence of impervious surfaces.

A.3 Fisheries

A.3.1 Fish Community Composition

The fish fauna in Alameda Creek and its tributaries has changed through time in response to changes in the system and introduction of nonnative fishes (Stanford et al. 2013). According to a recent study conducted by Leidy (2007), there are 41 species present in the Alameda Creek watershed, including 19 native species and 22 nonnative species. In 1860, there are records of 9 native species and suspected presence of 14 more (Table A-1). The first nonnative species were found in 1948, brown trout and smallmouth bass). Almost 40 years later in 1987, nonnative species outnumber native species.

There have been few previous surveys to confirm the presence of these fish within the Arroyo del Valle or Arroyo de la Laguna. Leidy et al. (2003) found a historical record describing Arroyo del Valle as “full of fish” in 1910. Hanson et al. (2004) reviewed historical newspapers and found several accounts of steelhead occurring within Arroyo del Valle during high flow years. Gunther, et al., (2000) and Leidy et al. (2003) summarize the results of a 1962 California Department of Fish and Game study (Snyder 1962) that notes Arroyo del Valle and Arroyo de la Laguna were historical migration routes for steelhead and/or coho salmon and that Arroyo del Valle was habitat for steelhead and/or coho salmon, but "lightly used.” More recent electrofishing surveys were conducted in 1992, 1993, 1994, and 1996 (described in Leidy et al. 2003). Although these surveys focused on steelhead, they did not record any occurrences in Arroyo del Valle or Arroyo de la Laguna. Gunther et al. (2000) performed visual surveys in 1999 within Arroyo del Valle downstream of East Bay Regional Park's Shadow Cliffs Regional Recreation Area and observed non-native species bluegill () and largemouth bass (and native Sacramento squawfish. The large pools located on Arroyo del Valle in the vicinity of Shadow Cliffs currently support a bass fishery. Additional spot surveys were conducted by Leidy in 2013 (Leidy, 2013 pers comm). In the reach below Del Valle dam Leidy recorded seeing prickly sculpin, hitch, and largemouth bass. At Sycamore Grove Park, he reported finding hitch, Sacramento sucker, roach, prickly sculpin and largemouth bass. (Leidy, 2013 pers comm)

Table A-1 Changes in the Fish Fauna of the Alameda Creek Watershed, 1865–2012, Alameda and Santa Clara Counties[1]

Common Name	Period of Record				
	1855–1860 (1)	1895–1948 (2)	1953–1969 (3)	1972–1987 (4)	1992–2013 (5)
Native Species					
Sacramento splittail *Pogonichthys macrolepidotus*	X	P	X		
River lamprey *Lampetra fluviatilis*	P	P	X		
Coho salmon *Oncorhynchus kisutch*	P	P	X		X
Chinook salmon *Oncorhynchus tshawytscha*	X	?	?	?	?
Speckled dace *Rhinichthys osculus*	P	X	?	?	X
Riffle sculpin *Cottus gulosus*	P	X	?	?	X
Hardhead *disambiguation*	P	X	X	P	X
Tule perch *Hysterocarpus traskii*	X	X	P	X	X
Shiner perch *Cymatogaster aggregata*	P	P	P	X	X
Pacific brook lamprey *Lampetra richardsoni*	P	P	P	P	X
Pacific lamprey *Entosphenus tridentatus*	X	X	X	X	X
Hitch *Lavinia exilicauda*	P	X	X	X	X
California roach *Lavinia symmetricus*	X	X	X	X	X

Table A-1 Changes in the Fish Fauna of the Alameda Creek Watershed, 1865–2012, Alameda and Santa Clara Counties[1]

Common Name	Period of Record				
	1855–1860 (1)	1895–1948 (2)	1953–1969 (3)	1972–1987 (4)	1992–2013 (5)
Sacramento blackfish *Orthodon microlepidotus*	P	X	X	X	X
Sacramento pikeminnow *Ptychocheilus oregonensis*	P	X	X	X	X
Sacramento sucker *Catostomus occidentalis*	X	X	X	X	X
Coastal Rainbow trout *Oncorhynchus mykiss*	P	X	X	X	X
Threespine stickleback *Gasterosteus aculeatus*	X	X	X	X	X
Sacramento perch *Archoplites interruptus*	X	X	X	X	X
Prickly sculpin *Cottus asper*	X	X	X	X	X
Staghorn sculpin *Leptocottus armatus*	P	P	P	X	X
Longjaw mudsucker *Cyprinodon macularius*	P	P	P	X	X
Starry flounder *Platichthys stellatus*	P	P	P	P	X
Non-Native Species					
Smallmouth bass *Micropterus dolomieu*		X	X	X	X
Brown trout *Salmo trutta*		X	X		
Common carp *Cyprinus carpio*			X	X	X
White catfish *Ameiurus catus*			X	X	X
Brown bullhead *Ameiurus nebulosus*			X	X	X
Mosquitofish *Gambusia affinis*			X	X	X

Table A-1 Changes in the Fish Fauna of the Alameda Creek Watershed, 1865–2012, Alameda and Santa Clara Counties[1]

Common Name	Period of Record				
	1855–1860 (1)	1895–1948 (2)	1953–1969 (3)	1972–1987 (4)	1992–2013 (5)
Black crappie *Pomoxis nigromaculatus*			X	X	X
Green sunfish *Lepomis cyanellus*			X	X	X
Bluegill *Lepomis macrochirus*			X	X	X
Largemouth bass *Micropterus salmoides*			X	X	X
Goldfish *Carassius auratus*			X	X	X
Golden shiner *Notemigonus crysoleucas*			X	X	X
Rainwater killifish *Luciana parva*			X	X	X
Threadfin shad *Dorosoma petenense*				X	X
Channel catfish *Ictalurus punctatus*				X	X
Black bullhead *Ameiurus melas*				X	X
Inland silverside *Menidia beryllina*				X	X
Striped bass *Morone saxatilis*				X	X
Redear sunfish *Lepomis microlophus*				X	X
Bigscale logperch *Percina macrolepida*				X	X
Yellowfin goby *Acanthogobius flavimanus*				P	X
Redeye bass *Micropterus coosae*					X

Table A-1 Changes in the Fish Fauna of the Alameda Creek Watershed, 1865–2012, Alameda and Santa Clara Counties[1]

Common Name	Period of Record				
	1855–1860 (1)	1895–1948 (2)	1953–1969 (3)	1972–1987 (4)	1992–2013 (5)
Tui chub *Gila bicolor*					X
Total Number of Species	**23**	**24**	**33**	**37**	**41**
Number Native Species	**23**	**22 (+1?)**	**20 (+3?)**	**17 (+3?)**	**19 (+1?)**
Percent Native species	**100**	**92**	**61**	**46**	**46**

[1] Changes to the system occurred when gravel mining started in the 1800's, the Pleasanton Marsh complex was drained in the early 1900's, and dams, reservoirs, and flood control projects were built (Sunol Dam 1890 Calaveras Dam 1925; Flood Control Channel 1960s; James H. Turner Dam, forming the San Antonio Reservoir, 1965; and Del Valle Dam 1968)

Abbreviations:

X = present

P = not recorded but likely present

? = status uncertain shading denotes species with reproducing populations primarily restricted to elevations below 100 m.

Source: Leidy 2007

A.3.2 Central California Coast Steelhead

Steelhead found in the Study Area belong to the Central California Coast Distinct Population Segment[2] (DPS), which includes coastal drainages from the Russian River to Aptos Creek and the drainages of San Francisco and San Pablo Bays, excluding the Sacramento-San Joaquin River watershed (NMFS 2000, 2006). This DPS was federally-listed in 1997 as threatened under the Endangered Species Act (NMFS 1997).The listing status was reaffirmed by NMFS in 2006 (NMFS 2006). The DPS includes only populations below natural and manmade impassable barriers; therefore the entirety of the Alameda Creek watershed is presently excluded until the "BART" weir is modified to accommodate migration to and from San Francisco Bay, which is expected by 2013 or 2014 (NMFS 2011).

There is no critical habitat[3] for California Central Coast steelhead within the Study Area or within the Alameda Creek basin (NMFS 2000, 2005, 2011). Accurate adult population size estimates for the Study Area and other Bay Area watersheds are not available. Despite few surveys or sightings, habitat for steelhead may exist within the Study Area. Visual surveys by Gunther et al. (2000) suggest poor habitat within Arroyo del Valle and Arroyo de la Laguna, but Hanson et al. (2004) concluded that potentially suitable habitat for steelhead exists in Arroyo del Valle just below Del Valle Dam downstream 2.3 miles to the confluence with Dry Creek, which enters from the north bank (Figure A-2).

[2] Distinct population segment is a vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. The ESA provides for listing species, subspecies, or distinct population segments of vertebrate species.

[3] Section 3 of the ESA (16 U.S.C. 1532(5)) defines critical habitat as ''(i) the specific areas within the geographical area occupied by the species, at the time it is listed on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed.

In general, steelhead stocks throughout California have declined substantially (Busby et al 1996). The most current estimate of the population of steelhead in California is approximately 250,000 adults, which is roughly half the population that existed in the mid-1960s (McEwan and Jackson 1996).

However, NMFS is preparing a Recovery Plan to address the Central California Coast DPS steelhead within its range, and is collaborating with nearly 30 agencies, including Zone 7 and ACWD, to provide relevant information about local steelhead habitat. The Recovery Plan is expected to be completed and available sometime in 2014.

A.3.2.1 Life History Overview

Central California Coast steelhead have a diverse life history (Figure A-14). They hatch in the gravel substrates of cool water streams, taking refuge in the gravel for several weeks (Moyle 2002). Steelhead embryos grow rapidly, relying on the energy reserves within their yolk sacs to meet early metabolic demands. Once their yolk sacs are exhausted, young fry then emerge from the gravel after about 2-3 weeks and begin actively feeding within the water column (Shapovalov 1937, as cited in Shapovalov and Taft 1954). As they grow, the juveniles move away from stream margins into deeper water at the base of riffles, in runs, and at the downstream and upstream section of pools (Baltz and Moyle 1984). They typically feed on aquatic insects as well as terrestrial insects that fall into the river; however, larger juvenile steelhead are also known to prey on younger steelhead fry (Shapovalov and Taft 1954). Some juvenile steelhead start to migrate downstream in the months following their emergence, while others continue to rear in their natal stream for a year or more. For the first year or two, juvenile steelhead are found in clear, cool, fast-flowing permanent streams and rivers where ample cover and riffle habitat predominates (Moyle 2002). This type of habitat supports the growth and development of juveniles from fry to Age 1+ or 2+ individuals. During the summer, juvenile steelhead face increased stress as their metabolic demands grow in response to increasing water temperatures. During these circumstances, juveniles may elect to move to fast riffle areas to increase to their access to food resources, in spite of the expense of exerting more energy to maintain their position in fast-flowing waters (Moyle 2002). Juveniles have been observed to move towards cooler water refuges when water temperatures approach their upper incipient lethal limit of 25°C (Celsius) (Nielsen et al. 1994). Fluctuating diurnal water temperatures also help improve the survivability of juveniles (Busby et al. 1996).

After about two years of rearing, disparate migratory behaviors for the steelhead juveniles emerge (Sogard et al. 2009). On one extreme, some juveniles may follow non-migratory, resident fresh water behavior (rainbow trout); on the other extreme, individuals exhibit anadromous behavior (steelhead), migrating to the open ocean (Shapovalov and Taft 1954), (Figure A-14). Physiological changes (smoltification) occur in anadromous steelhead smolts to allow them to make the transition from freshwater to saltwater (Zaugg and McLain 1972). There are some intermediate life-history patterns, including juveniles that migrate within the stream, juveniles that migrate only down to estuarine areas and juveniles that migrate only to near-shore ocean habitats (Shapovalov and Taft 1954). Some smolts that migrate downstream towards salt water will revert back to their freshwater form; these individuals are called residualized steelhead. These juveniles may smolt again at some later point when migration conditions improve (Hayes et al. 2011) or remain resident in the stream. Although there is no specific information available pertaining to the smolt out migration period for steelhead from the Arroyo del Valle and Arroyo del la Laguna watersheds, most California Central Coast steelhead typically emigrate from streams from March through June, with peak migration occurring in April and May (Fukushima and Lesh 1998).

Anadromous steelhead that migrate to the ocean or to brackish water areas as juveniles rear to maturity in these habitats, then eventually return to their natal freshwater stream as adults to spawn. Steelhead often spend 1 to 3 years in the ocean before returning upstream to reproduce (Shapovalov and Taft 1954). Steelhead can broadly be categorized as “spring-run,” “fall-run,” and “winter-run” depending on what time of year adults return to freshwater habitats to reproduce. “Spring-run” adults migrate upstream during the spring and summer months and hold over-summer before finally spawning in the fall months. Fall-run and winter-run return during the fall or winter months and spawn shortly after arriving at their natal stream. Only “winter-run” steelhead are found in the Central California Coast steelhead Distinct Population Segment (Busby et al. 1996).

Steelhead return to spawn in their natal stream, usually in their fourth or fifth year of life, with males typically returning to freshwater earlier than females (Shapovalov and Taft 1954; Behnke 1992). During the adult spawning migration period, the timing of upstream migration is often correlated to high seasonal flows. Winter–run steelhead generally enter spawning streams from late fall through spring (November through April, peaking in January and February) as sexually mature adults, and spawn in late winter or spring (Shapovalov and Taft 1954, Meehan and Bjornn 1991; Behnke 1992; NMFS 2011). Spawning occurs primarily from January through March but may begin as early as late December and may extend through April (NMFS 2011). Steelhead have strong swimming and leaping abilities that allow them to navigate against the river current, pass through shallow riffles, and jump past large obstructions in the river (e.g., small dams and natural waterfalls) (Bjorn and Reiser 1991).

Adult steelheads spawn in cool water stream habitats with gravel substrate. A female steelhead constructs a pit, or redd, by undulating her body against the gravel. The female subsequently deposits her eggs into these excavated pits, which is followed by fertilization of the eggs by an adult male. The female steelhead then covers the eggs with gravel to complete the redd (Moyle 2002).

Resident steelhead (rainbow trout) may produce progeny that exhibit anadromous behavior, while anadromous steelhead can produce progeny that do not migrate to the ocean (Zimmerman and Reeves 2000; Thrower and Joyce 2004). Both resident and anadromous steelhead may occur in the same river system with little to no genetic distinction (Pascual et al. 2001; Olsen et al. 2006). This plasticity in life-history behavior increases phenotypic diversity within the population, as shifting environmental conditions may temporarily favor one behavioral strategy over another. Unlike other Pacific salmonids, steelhead are capable of spawning multiple times before death (Busby et al. 1996). Adult steelhead that survive spawning are called “kelts,” and they may return to the ocean and spawn again in later years. Nearly 20 percent of adult spawners may be repeat spawners, with some individuals able to spawn 3 to 4 times (Shapovalov and Taft 1954). Individuals that spawn 3 or more times though are rare (about 2 percent or less). After spawning, some kelts may hold upstream for several months before commencing their downstream migration, while others return to the ocean immediately following spawning (Shapovalov and Taft 1954).

A.3.2.2 Habitat Requirements

Spawning Habitat

Adult steelhead select spawning areas with several characteristics. Spawning grounds must have gravel with which to construct a redd, and gravel must be situated in a zone of sufficient flow velocity to maintain circulation through the redd. The constant flow of water provides both a well-oxygenated micro-environment for the incubating eggs and also allows for transport of metabolic waste products away from the redds (Coble 1961, as cited in Bjornn and Reiser 1991). Female steelhead typically construct redds in pool tailouts or heads of riffles with well-oxygenated gravels (Shapovalov and Taft 1954). Gravels ranging in size from 0.5–4.6 inches in diameter are suitable for redd construction (Bjornn and Reiser 1991). Anadromous salmonids require sufficient quantity and quality of gravel to successfully spawn (Kondolf and Wolman 1993; Kondolf 2000). Spawning sites cannot have too much fine sediment, such as sand and silt, which can smother the redds and interfere with the circulation of oxygen to the eggs and transport of waste products. High sediment levels can also increase the gravel embeddedness, thus reducing the ability for spawning female steelhead to construct redds (Bash et al. 2001). The preferred flow velocity is in the range of 2-3 ft per second (Smith 1973, as cited in Bjornn and Reiser 1991). Average depth required for spawning by steelhead is approximately 14 inches and the minimum depth required is approximately 2.5 inches (Bovee 1978). The redds need to be constructed in areas that will neither receive high flows that may dislodge eggs nor in areas that could temporarily be de-watered.

NMFS has several metrics for evaluating whether substrates are suitable for spawning by anadromous salmonids (NMFS 1996). Habitats that are rated as “properly functioning” occur when cobble or gravels are the dominant substrate and there is less than 20 percent embeddedness. “At-risk” spawning conditions occur when neither gravel nor cobble is the dominant substrate and embeddedness is between 20-30 percent.

McCullough (2001) reviewed available literature on temperature requirements of steelhead and concluded that the optimal constant incubation temperature occurs below 11-12°C, and may be lower for resident rainbow trout. Reduced incubation survival has been observed in water temperatures between 12-16°C (Table A-2; Kamler and Kato 1983 and Rombough 1988, both as cited in McCullough et al 2001; Velsen 1987, as cited in Richter and Kolmes 2005). Water temperatures greater than 16°C result in very poor egg incubation survival (Velsen 1987, as cited in Richter and Kolmes 2005).

Table A-2 Temperature Thresholds for Steelhead Life Stages and Potential Effects

Life stage	Threshold	Effect	Citation
Incubation	12°C	Reduced incubation survival	Kamler and Kato 1983 and Rombough 1988, both as cited in McCullough et al 2001, Velsen 1987, as cited in Richter and Kolmes 2005
	16°C	Very poor egg incubation survival	Velsen 1987, as cited in Richter and Kolmes 2005
Juvenile rearing	20°C	May decrease feeding and growth	Bjornn and Reiser 1991, Carter 2008, NMFS 2011, R2 Consultants 2012
	22°C	Stressful to juvenile steelhead	Bjornn and Reiser 1991, Carter 2008, NMFS 2011, McBain and Trush 2007, R2 Consultants 2012
	25°C - 29°C	Potentially lethal	Carpanzo 1996 as cited by Moyle et al. 2008, Matthews and Berg 1997, Myrick and Cech, 2000, Boughton et al. 2009, R2 Consultants 2012
Smoltification	13°C	Prevent smoltification	Adams et al. 1973; Zaugg and Wagner 1973; Wedemeyer et al. 1980, McBain and Trush 2007
Adult migration	24°C	Migration avoidance	Rickter and Kolmes (2005)

Rearing Habitat

Within the San Francisco Bay area, steelhead fry generally emerge from spawning gravel from February to May (Hanson et al. 2004). After emergence, steelhead fry move to shallow water, low velocity habitats, such as stream margins and low–gradient riffles, and forage in open areas lacking instream cover (Hartman 1965). As fry grow and improve their swimming abilities in late summer and fall, they increasingly use areas with cover and show a preference for higher velocity, deeper mid–channel areas near the thalweg (the deepest part of the channel) (Hartman 1965; Everest and Chapman 1972). Juvenile steelhead occupy a wide range of habitats, using deep pools as well as higher velocity riffle and run habitats (Bisson et al. 1982, 1988). During periods of low temperatures and high flows that occur in winter months, steelhead prefer low velocity pool habitats with large rocky substrate or woody debris for cover (Hartman 1965; Raleigh et al. 1984; Swales et al. 1986). During high winter flows, juvenile steelhead seek refuge in interstitial spaces in cobble and boulder substrates (Bustard and Narver 1975). Larger juveniles may out-migrate to the ocean if the streams cannot provide sufficient rearing conditions for larger individuals.

Temperature is also an important factor for juvenile rearing conditions. Water temperature affects chemical and physical process rates and critically influences the survival, behavior, and production of steelhead. Impacts of high water temperatures include acute effects, such as decreased enzyme function, and chronic effects, such as increased metabolic rates and reduced immune system function that can reduce growth rates and overall production. Temperatures just below the lethal threshold though can also reduce survival rates of juvenile steelhead by factors such as increasing their susceptibility to disease, reduced ability to evade predators, and increased food requirements. The lethal temperature limit for steelhead may increase or decrease depending on the duration of exposure to rising temperatures and their ability to acclimate (Brett 1952). In general, water temperatures less than 15°C are suitable for summer rearing of juvenile steelhead, while temperatures greater than 25°C are potentially lethal. Temperatures above 20°C may decrease feeding and growth (Table A-2; Bjornn and Reiser 1991; Carter 2008; NMFS 2011; R2 Consultants 2012), rearing can still occur in temperatures up to 22°C (Wurtsbaugh and Davis 1977; Nielsen et al. 1994). Spina (2007) observed juvenile steelhead holding position and feeding in water temperatures up to 24°C, however Nielsen et al. (1994) observed juveniles avoiding water temperatures above 23°C. Myrick and Cech (2004) reviewed literature on thermal tolerances of California juvenile steelhead and found critical thermal maximums of 28-31°C and note that critical thermal maximums increase at higher acclimation temperatures. The incipient lethal limit (when rate of change in water temperature is less than 1°C/hour) for juvenile steelhead has been suggested between 25-29°C (Carpanzo 1996, Matthews and Berg 1997; Boughton et al. 2009; R2 Consultants 2012). In assessing instream flow and aquatic habitat in the Alameda Creek basin, McBain and Trush (2007) applied temperature thresholds of 20º C (marginal for juvenile growth) and 22.2º C as stressful to juvenile steelhead.

As described above, juvenile steelhead primarily use upstream reaches with cool water, low flows, and shaded pools (Bisson et al. 1982, 1988). Additionally, they can use warm water habitats downstream of dams or outfalls where summertime releases produce fast water habitat conducive for feeding. Juvenile steelhead feed on invertebrates, fish eggs, and small fishes (Shapovalov and Taft 1954). Warmer waters raise the metabolism of steelhead and cause a concomitant increase in food requirements (Myrick and Cech 2000). Steelhead may move into higher velocity microhabitats like riffles and runs where there is a higher abundance of food resources.

Juvenile steelhead are subject to predation loss primarily by predatory fishes (e.g., pikeminnow, largemouth bass, and smallmouth bass), and predation by these warm-water, non-native species can substantially affect native salmonid populations (Zimmerman 1999; Bonar et al. 2005; Fritts and Pearsons 2006; Tabor et al. 2007). Piscivorous birds (e.g., cormorants, gulls, herons, and mergansers also prey on juvenile steelhead (Shapovalov and Taft 1954; Wood, 1987; Collis et al. 2001; Collis et al. 2002). In addition, other predators for young fish include raccoons, otters, and garter snakes. Clear water conditions, such as during the summer rearing period when flow is low and the water column is not turbid, can also increase the effectiveness of visual predators such as birds, by reducing the ability for smolts to conceal themselves. Features including large woody debris (LWD) and undercut banks provide microhabitats for out-migrating smolts to find cover and decrease their exposure to predators.

Smolt Out-Migration

Juvenile steelhead out-migration commences during November and continues through May in the San Francisco Bay Area and the Central Valley of California, with the peak occurring between February and April (Hanson et al. 2004). Ocean survival to escapement (returning as an adult) is likely more dependent upon size (14 to 21 cm) at ocean entry than age (Shapavolov and Taft 1954; Barnhart 1986; Bond 2006). The period of freshwater residency ranges from one to four years, with longer residence times in northern latitudes, but most steelhead migrate to sea after two years (two summers and two winters) in freshwater (Barnhart 1986; Bjorkstedt et al. 2005). In basins with productive environments, such as warm, fast flowing water or coastal lagoons (a seasonal body of water created when a sand bar separates freshwater outflow from the ocean), juveniles can reach sufficient smolting size, and exit to the ocean after just one year (Busby et al. 1996; Bjorkstedt et al. 2005). Conditions for growth can be very good in lagoons relative to stream habitat, and fish rearing lagoons tend to achieve a larger size-at-age then their stream-reared counterparts (Smith 1990; Hayes et al. 2008). Upon out-migration, juvenile steelhead begin the process of smoltification[4] and proceed to migrate downstream toward the ocean. Steelhead spend one to four years in the ocean, more typically one to two years, before returning to spawn (Barnhart 1986). Some steelhead (10–20%) will survive to return to the ocean and migrate back to freshwater to spawn a second time, and less than 5 percent may spawn a third or even fourth time (Bjorkstedt et al. 2005).

Smolts need sufficient flows to successfully migrate downstream, later in the out-migration season, smolts face diminishing outflows and elevated water temperatures. Juvenile migration can be limited by channel drying and high water temperatures, preventing movement to suitable habitat or preventing downstream migration. Favorable smoltification water temperatures have been proposed as between 7-14°C (Bovee 1978; Bell 1986, as cited in McEwan and Jackson 1996; Myrick and Cech 2000; Environmental Protection Agency 2003a, 2003b). Inhibition of smoltification has been observed to begin in water temperatures between 13-15°C (Table A-2; Adams et al. 1973; Zaugg and Wagner 1973; Wedemeyer et al. 1980). In assessing instream flow and aquatic habitat in the Alameda Creek basin, McBain and Trush (2007) applied a temperature threshold of 13ºC as one that could prevent or impair smoltification.

Habitat needs for emigrating steelhead (smolts) are similar to those for rearing juvenile steelhead, with the exception of temperature, to which smolts have a lower tolerance than rearing juveniles (Table A-2). Migrating smolts are particularly vulnerable to predation, and physical structure and cover (refugia such as LWD) are important for survival of this life stage. As discussed above, juvenile steelhead are subject to losses by predatory fish, piscivorous bird species, water snakes, and some mammals; smolts are vulnerable to this same predation pressure. Artificial structures and obstructions in the migration corridor can create localized areas of turbulent flows which can disorient juvenile steelhead and increase their susceptibility to predation loss.

Adult Migration

Adult steelhead migration commences during November and continues through April in the San Francisco Bay Area and the Central Valley of California, with the majority of spawning occurring between December and February (Hanson et al. 2004). The pulse of upstream migration is believed to coincide during storm runoff conditions when flows are elevated. The minimum stream depth required for upstream migration of adult steelhead is approximately 5 inches (Thompson 1972). Adults often prefer flow velocities in the range of 1.3-3.0 ft/s, with flow velocities around 8 ft/s being the upper most limit for steelhead upstream migration (Thompson 1972). Steelhead have strong swimming abilities that enable them to ascend upstream; they can maintain a swimming rate of up to 4.5 ft/s for extended periods and can swim up to 14 ft/s for very short bursts (Bell 1986).

Upstream migration can also be affected by elevated water temperatures and physical barriers. The reported favorable upstream migration temperature is between 8-13°C (Bovee 1978 and Bell 1986, as cited in McEwan and Jackson 1996; NMFS 1996; SWRCB 2003). Rickter and Kolmes (2005) found that water temperatures between 21-24°C could act as barriers to adult steelhead migration (Table A-2). Natural or constructed features can block or impair the ability of steelhead to continue their upstream migration and reach their natal spawning grounds. Adult steelhead can exhibit leaping abilities in order to traverse past some of these natural and artificial migration barriers. Adults can vertically leap between 6 to 9 ft high, but need a pool depth at least 1.25 times the height of the jump (Bjornn and Reiser 1991).

[4] A process whereby physiological and behavioral changes prepare the juvenile steelhead for the marine environment.

During upstream migration and on the spawning ground adult fish are subject to predation by birds (eagles, osprey, and hawks) and mammals (raccoons and coyotes). In addition, domestic dogs can also capture adult steelhead in shallow water. Poaching is also a problem for adult steelhead.

A.4 Previous Assessments and Historical Information

A.4.1 Previous Geomorphic Assessments

The San Francisco Estuary Institute (SFEI) recently completed a report documenting the historical conditions in Arroyo del Valle (Stanford et al. 2013). They reviewed historical records, aerial photographs, still photos, and general land survey office records. They found that the Arroyo del Valle in its headwaters began as a single channel, transitioned to multiple distributary channels and back to a single channel, which only connected to the Pleasanton marsh complex in wet years. Arroyo del Valle's watershed was composed of erosive and tectonically active uplands. The water course transported and deposited coarse alluvium in large fans on the valley floor causing the many distributaries to form. These fans supported a wide riparian corridor, up to 3000-ft wide in some instances, consisting of sycamores, willows, alders, and poplars (Day 1853, as cited by Stanford et al. 2013). The fans also resulted in rapid percolation of surface water to groundwater. The multiple-channel segment was often dry with isolated pools found in the upper portion of this reach. Below these pools, the streamflow was subsurface. Summer water was rare in the Arroyo del Valle.

Another interesting historic feature of the Arroyo del Valle noted by Standford et al (2013) was the depositional pattern of the stream bed material. The streambed began as a gravel bottom, single channel, changing to a multiple channel bed shortly after entering the valley floor, and transitioned to a clay bottom stream with steep banks near the present location of Shadow Cliffs Regional Recreation Area. As it approached the Pleasanton marsh complex, Arroyo del Valle shifted again from a single channel into multiple distributary channels entering the Pleasanton marsh complex. The transition from braided to single-thread channel reflected the shift in transport capacity and sediment supply in the channel and the corresponding change in soil type from gravelly soils to the clay-based soils of the marsh (Holmes and Nelson 1917, as cited by Sanford et al 2013). An important feature of the Arroyo del Valle is the gravel mining activities which have changed the shape of the landscape in the 20th century. The coarse gravelly substrate found in Arroyo del Valle lent itself to gravel mining, and local extraction of gravel for road construction was documented beginning in the late 1800s (Echo 1894a,c, as cited by Standford et al 2013). Large-scale mining developed through the 20th century dropping the stream bed elevation by 30 to 60 ft. Today, as gravel resources are depleted, some of the mines have been turned over to the East Bay Regional Park District and Zone 7. Additionally, active gravel mining pits are scheduled to be turned over to Zone 7 for water management purposes once mining is completed.

Sowers (2003) and Hanson et al. (2004) described historical geomorphology, channel connectivity, and their potential relation to steelhead occurrence in Arroyo del Valle. Through analysis of historical maps and aerial photography, they described a permanent marshy lagoon (Lake Tulare) that occurred at a low point in what is now northwest Pleasanton. Streams that currently drain to Arroyo de la Laguna, such as Arroyo del Valle and Arroyo Mocho, likely terminated before the lagoon, percolating into the alluvium layer covering the Livermore-Amador Valley, although Arroyo del Valle may have occasionally connected with the lake depending on hydrologic conditions. Historical maps show that Lake Tulare was drained and the final mile of Arroyo del Valle straightened before 1911. Aerial photographs from 1939-1949 show the presence of ephemeral channels across the alluvial fan of Arroyo del Valle, suggesting that lower reaches of Arroyo del Valle likely went dry in the summer during most years, with perennial flow reaching Lake Tulare only during wet years. The lake was drained to lower groundwater levels for farming, while creeks were confined to prevent flooding of agricultural fields. The draining of Lake Tulare, and the subsequent channelization of Arroyo de la Laguna and Arroyo del Valle, created a continuous channel downstream to

Alameda Creek. Further, the construction of Lake Del Valle, which moderated winter peak flows, and the import of the State Water Project water, changed the hydrology of Arroyo del Valle (see Section A.2.1.3).

A search of historical records by Sowers (2003) and Hanson et al. (2004) found accounts of steelhead within Arroyo del Valle in 1910 and 1953. Analysis of Alameda Creek at Niles Canyon gauge (USGS Gauge #11179000, period of record: 1891 to present) shows these fish may have migrated upstream in 1909, during a 6-year RI flood, and in 1951 or 1952, during a 28- or 32-year RI flood. Sowers (2003) and Hanson et al. (2004) found no confirmed steelhead sighting in Arroyo del Valle since the construction of Lake Del Valle in 1968, when the dam eliminated access to potential upstream habitat. Historical records also document the planting of hatchery-raised rainbow trout in Arroyo del Valle from the late 1800s to the early 1900s (Hanson et al. 2004) and the presence of steelhead/rainbow trout in Arroyo del Valle in 1962 (Skinner 1962, as cited in Gunther et al. 2000). As late as 2000, an unknown amount of hatchery-origin rainbow trout were planted in Lake Del Valle and Shadow Cliffs Lake by the East Bay Regional Park District (Gunther et al. 2000).

Valley and Mountain Associates (2007) assessed the geomorphic condition of Arroyo de la Laguna by determining channel evolution stage, and bed and bank conditions. Valley and Mountain Associates (2007) used a six stage classification system describing how the channel changes in response to alterations in sediment or hydrologic conditions (Simon and Hupp 1986). The channel “evolves” through a series of characteristic changes, or channel evolution stage. They found that almost two-thirds of the length of Arroyo de la Laguna was responding to anthropogenic changes in sediment load and hydrology and was either in a degradational or aggradational channel evolution stage. They also recorded that 25 percent of the channel length was heavily modified through construction related to flood protection, and 10 percent of the channel length was modified by bank stabilization or bed (grade) control. They concluded that all of Arroyo de la Laguna experienced historical incision, bank erosion, bank or bed modification, and some natural channel adjustment, while no portions were natural channel with intact floodplain.

A.4.2 Steelhead Habitat Assessments

Gunther et al. (2000) assessed the feasibility of restoring steelhead to the Alameda Creek Watershed, including Arroyo del Valle and Arroyo de la Laguna. They assessed existing habitat and beneficial uses of the watershed to develop management actions and structural changes (such as improving fish passage) to restore a viable steelhead population, identify potential factors limiting success of restoration, and recommend additional studies to fulfill knowledge gaps. They examined Arroyo del Valle from the confluence of Arroyo de la Laguna to Del Valle regional park (Lake Del Valle), and Arroyo de la Laguna from Alameda Creek to Alamo Canal. In general, Gunther et al. (2000) found that although lowermost sections in Arroyo del Valle contained patches of suitable spawning gravel, it did not contain extensive steelhead spawning or rearing habitat, and Arroyo de la Laguna was likely used as a migration corridor as bed substrate may be too fine to support spawning and water temperatures too warm to support rearing.

Hanson et al. (2004) assessed current steelhead habitat conditions within Arroyo del Valle. They found water temperature unsuitable for summer rearing through Shadow Cliffs Regional Recreation Area, but recorded suitable temperatures within Sycamore Grove Park. They also identified the portion of Arroyo del Valle from Sycamore Grove Park to Del Valle Dam as potentially suitable summer rearing habitat.

A.4.3 Historical Information

Reviewing historical conditions and tracing perturbations and changes that lead to existing habitat conditions, can help one understand the interactions of existing geomorphic conditions with current habitat features and associated fish communities. SFEI has completed such a review. A summary of their findings along with other historical information follows (see Figure A-15 for historical timeline of geomorphic changes on Arroyo del Valle).

A.4.3.1 Historical Changes Associated with Land Development

SFEI notes that currently over half of the valley floor is covered by urban development and many creeks flow through artificially constructed or altered channels. Historically, much of the Alameda Creek watershed was covered by wetlands, comprising 45% of the Livermore-Amador Valley, where channelized portions of the Arroyo del Valle and Arroyo Mocho now exist. One of the most notable features of the historic landscape in Livermore-Amador Valley was the presence of the Pleasanton Marsh Complex. The marsh covered more than 2,600 acres. It was surrounded by seasonal wetlands with open water ponds, freshwater marsh and dense willow thickets. The streams and ground water all drained towards the marsh. People began draining portions of the marsh in the early 1800’s. In the late 1800s and early 1900’s there was a concerted effort to drain the marsh to provide land for agricultural fields as well as the growing community, and to provide a water supply to San Francisco. By 1912 only remnants of the marsh remained.

During the process of draining the marshland, streams were channelized to prevent flooding, resulting in greater connectedness. The present-day stream network is now highly connected in comparison to the historical network and conveys water through the valley more quickly. The fast transit of water reduces recharge and creates high flood peaks. SFEI found that in the Livermore-Amador Valley, total channel length has increased by 30 percent, from 197 miles in 1800 to 256 miles in 2010, largely due to the construction of channels through former wetlands.

Historically, Arroyo Valle drained into the Pleasanton Marsh Complex. Before the marsh complex was drained and the streams channelized, SFEI found no indication that Arroyo del Valle was connected directly with Arroyo de la Laguna. They found maps showing that this connection was created over time as the marsh was ditched and drained, with a substantial connection in place by 1910. The watershed upstream of the marsh was composed of erosive and tectonically active uplands. Because of this, Arroyo Valle deposited large amounts of coarse alluvium in the valley. The valley floor was covered by an open, sycamore-oak woodland. Arroyo Valle shifted from a fairly narrow, single-thread system to a broad, braided channel and then back to a single channel before bifurcating into multiple distributary channels feeding the Pleasanton marsh complex. The narrow channels carried perennial water while the braided portions carried flow intermittently. The narrow channels would have provided year-round habitat for fish and other aquatic fauna, while the intermittent habitat could be used only when it carried water. Steelhead migrating upstream through the marsh complex may have had a difficult time crossing the course alluvium in the valley to reach areas of perennial flow except under storm flows. The marsh would have provided excellent holding and rearing habitat for steelhead and other fish. Hanson et al (2004) postulate that channels connected the Arroyo del Valle with the Pleasanton Marsh Complex sufficient for migrating salmon and steelhead to pass only in wet years. In addition, Hanson et al (2004) noted that the historical aerial photographs also show a general increase in the presence, lateral extent and density of the riparian corridor adjacent to Arroyo del Valle from the 1930s to the present day. This is likely related to the transition from braided to a single threaded channel and flow releases from either the South Bay Aqueduct or Lake Del Valle providing a constant, reliable water source for riparian vegetation.

One of the earliest diversion dams was built to support the Cresta Blanc Winery located on Arroyo del Valle near the present site of the Veteran hospital. The dam was likely in operation by 1900. In 1920 the winery was shut down when prohibition took effect. The winery was opened again in 1933 and is owned and operated today by the Wente family, but the diversion dam is no longer in operation, and has not likely operated since the early 1930s.

Arroyo de la Laguna originally had its source in the Pleasanton marsh complex and the stream flowed year round through a narrow valley with willow thickets near the marsh grading into live oak and sycamores. Then these trees gave way to extensive grasslands later used for grazing. The channel alternated between a single channel and multiple channels. Arroyo de la Laguna was also heavily modified as part of the draining of the Pleasanton marsh complex. The stream was used as part of the water system of the Spring Valley Water Company to provide water to San Francisco and the local area. Spring Valley Water Company built canals to drain the Pleasanton marsh complex. These canals allowed water and sediment to move down stream rapidly where historically, the marsh would have attenuated flows and trapped sediment. In addition to increasing the flood flows and sediment loads, the riparian zone on Arroyo de la Laguna was cleared and the channel mechanically enlarged resulting in rapid incision and increased erosion. The broad marshy character of the perennial Arroyo de Laguna was transformed into a deeply incised highly erodible, intermittent stream seen today.

A.4.3.2 Historical Changes Associated with Gravel Mining

In addition to the changes wrought from land development, gravel mining left its mark on the water ways as well. Extraction began on the large gravel deposits near Pleasanton in the late 1800s. Early gravel mining likely caused channel straightening in Arroyo de Valle. Large scale gravel mining developed in the 1930s and 40s to support road development and urban development of the valley. Gravel extraction has changed the topography of the valley and dropped the elevation of the Arroyo de Valle’s streambed. In a report on the water supply for the Alameda Creek watershed, Williams (1912) estimated the bed elevations of Arroyo del Valle (from Arroyo de la Laguna to the Vallecitos Road Bridge) from a 1911 topographic map.

Comparison of these bed elevations to more recent (1979) survey and Light Detection and Ranging (LiDAR) data (2006) show substantial historical changes to the long-profile of Arroyo del Valle (Figure A-16). While all the potential data sources likely have some errors and inaccuracies associated with data collection methods, they do provide a general picture of historical changes to the long profile of Arroyo del Valle. The comparison shows decreased bed elevations from the Vallecitos Road Bridge to the Bernal Road Bridge. Elevations decrease rapidly downstream to their lowest point within Shadow Cliffs Regional Recreational Area. The magnitude of bed lowering decreases near the Bernal Road Bridge, where elevation approaches the historical 1911 bed surface. These changes likely reflect in-channel gravel extraction, and bed lowering associated with channel maintenance and straightening. Downstream of the Bernal Road Bridge toward Arroyo de la Laguna, the 1979 and 2006 elevation data are consistently lower than historical bed elevations, likely associated with channel excavation, maintenance, and straightening for flood protection purposes.

Recent (2012) bathymetric data and a more detailed long profile of the Arroyo and Island ponds within Shadow Cliffs Regional Recreation Area also shows the magnitude of excavation (Figures A-17 and A-18). Current pond bottom elevations range from 20-25 ft below current Arroyo del Valle bed elevation, and up to 60 ft below current floodplain elevation.

The effect of mining on habitat was to straighten the stream, altering pool riffle ratio, removing streamside riparian habitat that probably provided cover and shading for the stream, and destabilizing stream banks causing more sedimentation and loss of near bank habitat. The excavation of the channel resulted in creating very large deep pools that provide excellent habitat for nonnative fish that compete with, or prey on, native fish. The large pool and the lack of riparian habitat may have increased stream temperatures in the affected reach.

A.5 Methods

Habitat Survey

This assessment relied upon collecting geomorphic data and observations, inventorying and describing salmonid habitat types, collecting continuous water temperature data, identifying potential steelhead migration barriers, and collecting water quality and fish abundance data in the ponds at Shadow Cliffs Regional Recreation Area. The Study Area was divided into 11 reaches based upon changes in geomorphic condition associated with differences in adjacent land-use, and coincided with reaches delineated in the Zone 7 Stream Management Master Plan (RMC 2006). Accordingly, the reaches are designated using the naming conventions from RMC (2006), rather than sequentially (Figure A-19, Table A-3). For the geomorphic and salmonid habitat surveys on Arroyo del Valle, crews surveyed 20 percent of the length of each reach, with the starting point randomly chosen from the set of 330 ft segments making up 80 percent of the downstream length (to ensure at least 20 percent of the reach was sampled regardless of the starting point). Zone 7 owns approximately 15 percent of the land along Arroyo del Valle, the remaining 85 percent is owned by others. As such, Zone 7 sought and gained approval to access these other areas. For Arroyo de la Laguna we relied on recent observations from Valley and Mountain Associates (2007), which performed an in-depth geomorphic investigation from Arroyo Mocho to Alameda Creek. We performed field work to confirm geomorphic observations reported by Valley and Mountain Associates (2007) and to collect fish habitat data on approximately 2,750 ft of channel upstream and downstream of Verona Bridge. Based on information provided by Valley and Mountain Associates (2007), we believe this sample generally represents geomorphic and fish habitat conditions on Arroyo de la Laguna between Arroyo del Valle and Alameda Creek.

Table A-3 Study Reach Location and Length

Waterway	Reach[1]	Location	Length
Arroyo del Valle	4a	Dam to Arroyo Road Bridge	4,700 ft
Arroyo del Valle	4b	Arroyo Road bridge to Dry Creek	8,300 ft
Arroyo del Valle	4c	Dry Creek to Upstream end of Lake A	6,700 ft
Arroyo del Valle	7a	Lake A to Isabel Ave.	6,300 ft
Arroyo del Valle	7b	Isabel Ave to downstream end of Lake B	8,900 ft
Arroyo del Valle	7c	Downstream end of Lake B thru Shadow Cliffs	6,500 ft
Arroyo del Valle	7d	Shadow Cliffs to Bernal Ave	1,900 ft
Arroyo del Valle	7e	Bernal Rd. Bridge to Hopyard Rd bridge	9,000 ft
Arroyo del Valle	7f	Hopyard Rd Bridge to ADLL	7,100 ft
Arroyo de la Laguna	10a	Arroyo del Valle to Bernal Road Bridge	11,000 ft
Arroyo de la Laguna	10b	Bernal Road Bridge to Alameda Creek	22,600 ft

[1] Reaches generally correspond to reaches in the Zone 7 Stream Management Master Plan (RMC 2006)

A.5.1 Geomorphic Assessment

Along the selected lengths of each reach, we collected geomorphic data at a minimum of three locations. The data included qualitative observations on dominant channel morphology, dominant and sub-dominant bed substrate, and measurements of bankfull width and depth. Channel morphology was described using the conceptual framework of Montgomery and Buffington (1997), which describes a downstream sequence of channel types based upon longitudinal trends in sediment transport capacity and supply, where sediment transport capacity decreasing downstream with channel slope and sediment supply increasing with watershed area. Based upon the potential range of channel gradients within the Study Area step-pool, plane-bed, and pool-riffle channel morphology types are most likely to occur within Arroyo del Valle and Arroyo de la Laguna. Step-pools occur in relatively steep gradients where sediment transport capacity exceeds the sediment supply, leaving bedrock cascades and large boulders that form steps in the channel profile. Plane-bedded channels typically occur downstream of step-pool channels, in less steep gradients, and are relatively featureless with few pools, riffles, or gravel bars. Pool-riffle channels typically occur downstream of plane-bedded channels and are characterized by an undulating bed with sequences of pools, riffle, and gravel bars. “Forced” pool-riffle bed channels can form in plane-bedded environments in the presence of flow obstructions, such as large woody debris (LWD) (Montgomery et al. 1995). Dominant and sub-dominant bed substrate was described using the Wentworth scale, which defines substrate size in millimeters (mm) and with intervals that increase by powers of 2. Crews visually categorized substrate into clay (<0.0002 inch (in) [<0.0039 mm]), silt (0.0002 to 0.002 in [0.0039 to 0.0625 mm]), sand (0.002 to 0.08 in [0.0625 to 2 mm]), gravel (0.08 to 2.5 in [2 to 64 mm]), cobble (2.5 to 10 in [64 to 256 mm]), or boulder (>10 in [>256 mm]), and described the bed overall by sub-dominant and dominant size categories (e.g. sandy-gravel for a bed dominated by sand and gravel, but more gravel than sand) (Buffington and Montgomery 1999). Crews also noted the presence and type of depositional features (e.g., gravel bars), and the presence of infrastructure within or proximal to the selected length that may substantially affect geomorphic processes or salmonid habitat.

A.5.2 Steelhead Habitat Assessment

Steelhead habitat was inventoried using habitat types described in the California Salmonid Habitat Restoration Manual (Flosi et al. 2010). These habitat types are distinguished by differences in local channel gradient, water velocity, depth, and substrate size. Flosi et al. (2010) use four hierarchical levels of classification to describe physical fish habitat, with each successive level providing greater detail. The most elementary descriptions (Levels 1 and 2) break stream channels into pool, riffle, or flatwater habitat types. Successive levels differentiate habitat types by location within the stream channel (e.g., mid-channel pools, Level 3) or by cause or agent of formation (e.g., lateral-scour, log-formed pools, Level 4). In this survey, steelhead habitat was inventoried to Level 4 habitat types. As noted above, we surveyed a minimum of 20 percent of the length of each study reach. This differs from Flosi et al (2010) that suggests a 10 percent sampling protocol where the stream is segmented into sub-reaches of 10 consecutive habitat units and a habitat unit is randomly selected within a sub-reach. Flosi et al. (2010) also suggests habitat data be collected in the randomly selected unit, while the habitat type and length are noted for the remaining units. The protocol calls for sampling the first occurrence of each habitat type. While the revised procedure had the potential to introduce sampling bias, we consider the delineation of distinct reaches and a relatively long sampling length (20 percent of the total sub-reach length) limits potential bias and provides an accurate description of geomorphic conditions and salmonid habitat.

We assessed the general quantity of steelhead spawning habitat by noting the number of pool tails along the bed with suitable spawning substrate (0.5-4.6 inches in diameter) and assessed the quality of spawning gravel by estimating the percent embeddedness by finer material. Greater volumes of fine sediment at pool tail outs will likely be reflected in greater embeddedness and may be an indicator of gravel quality and eventual spawning success (Kondolf 2000). Based on information in the literature (Bjornn and Reiser 1991, Kondolf 2000), survival to emergence of steelhead fry begins to decrease at 20 percent embeddedness, and is completely restricted at 80 percent embeddedness. As such, pool tails with >20 percent embeddedness were considered impaired but usable to steelhead, with levels up to 80 percent increasingly impaired, and >80 percent considered unusable.

Crews assessed the general quality of steelhead summer and winter rearing habitat by noting the number, depth, and cover complexity of pools. Properly functioning steelhead habitat is generally characterized by pools making up 40 to 50 percent of the total stream length or a 2:1 to 1:2 pool to riffle ratio (CDFG 2002, NMFS 2008). In the summer and late-fall, as flows lessen and riffle area decreases, juveniles may move into pools (Barnhart 1986). In general, deeper pools provide adequate thermal refuge for juvenile steelhead and a benchmark of 2.0 ft depth is used in California Department of Fish and Wildlife (CDFW, formerly California Department of Fish and Game) Stream Habitat Inventory Reports (see for example Alameda Creek Stream Inventory Report [CDFG 1996]). During periods of low temperatures and high flows that occur in winter months, steelhead prefer low–velocity pool habitats with large rocky substrate or woody debris for cover (Hartman 1965, Raleigh et al. 1984, Swales et al. 1986). During high winter flows, juvenile steelhead seek refuge in interstitial spaces in cobble and boulder substrates (Bustard and Narver 1975). Flosi et al (2010) describe pool cover complexity by multiplying the number of cover types (0 = no cover; 3 = multitude of cover types) by the percent of overhead area occupied by cover (maximum value = 3 x 100 = 300). In general, values ≥100 indicate adequate cover for salmonids (CDFG 1996).

Steelhead habitat was further characterized by analyzing water temperature data collected as part of an ongoing stream water temperature study conducted by Zone 7 and temperature data available on the USGS website, by inventorying potential barriers to migration, and by collecting water quality and fish abundance data in the pools in the Shadow Cliffs Regional Recreation Area.

Continuous water temperature data were collected at selected sites within with Arroyo del Valle and Arroyo de la Laguna to characterize trends along the study area and within study reaches (Figure A-19). Water temperature data loggers (HOBO data loggers, Onset Computer Corporation, Cape Cod, MA) collected data at 15 minute intervals beginning in March 2012 and will continue beyond this study. Sites were chosen to represent the potential range of conditions from the upstream end of the Study Area (base of Del Valle Dam) to the downstream end (Arroyo de la Laguna near Verona Bridge).

Available continuous water temperature data was also downloaded from the USGS website for stream gauges located along Arroyo del Valle and Arroyo de la Laguna. The available continuous water temperature data was limited to two USGS stream gauges (ADLLV and ACN), and only extended as far back as October 2007. Although sporadic average daily water temperature data was available for AVBLC and AVNL, it was not included in the analysis, as further investigation indicated that most of the measurements were one instantaneous measurement taken on one day and therefore, considered inappropriate.

Water temperature data were used to calculate mean weekly average temperatures. These running averages were calculated by averaging the mean daily temperature for the preceding seven day period. The maximum MWAT was determined by selecting the largest MWAT observed from March 2012 to July 2013. The running average give a more balanced picture of ambient water temperature than instantaneous readings or mean weekly maximum temperatures (SFBRWQCB 2007; Sullivan, K., D. J. Martin, R. D. Cardwell, J. E. Toll, and S. Duke. 2000).

Barriers were inventoried using field observations and previous reports. Barriers were qualitatively described as potential impediments to migration and not analyzed hydraulically for passage under a range of flows, which was beyond the scope of this habitat assessment.

To describe water quality conditions of the ponds within Shadow Cliffs Regional Recreation Area, crews collected instantaneous water temperature and dissolved oxygen [DO] concentration along a vertical profile using a calibrated Hydrolab Quanta (EcoEnvironmental, Perth, Australia) in late October 2012. Fish abundance data were also collected on the same day as the water quality data to analyze predator populations within the ponds.

A.6 Results

A.6.1 Geomorphic and Steelhead Habitat Assessment

Geomorphic conditions along Arroyo del Valle varied within the Study Area, which extended from the base of Del Valle Dam downstream to its confluence with Arroyo de la Laguna and along Arroyo de la Laguna from its confluence with Arroyo del Valle to the confluence with Alameda Creek. A single-threaded channel flowed through a relatively steep, narrow canyon out onto the valley floor where it flowed past adjacent parkland, adjacent current gravel extraction, adjacent in-channel historical gravel extraction, and flood protection/urban sections (Table A-4).

Table A-4 Geomorphic Characteristics of Study Reaches

Waterway	Reach[1]	Geomorphic Influence	Morphology	Bankfull Width	Bankfull Depth	Dominant Bed Material[2]
Arroyo del Valle	4a	Canyon	pool-riffle	25-40 ft	2-5 ft	gravelly cobble to sandy gravel
Arroyo del Valle	4b	Adjacent Parkland	pool-riffle	40-50 ft	3-4 ft	gravelly cobble
Arroyo del Valle	4c	Adjacent Parkland	pool-riffle to plane-bedded	25-65 ft	4-6 ft	gravelly cobble
Arroyo del Valle	7a	Adjacent current gravel extraction	pool-riffle to plane-bedded	65-95 ft	2-4 ft	sandy-gravel to silty-sand
Arroyo del Valle	7b	Adjacent current gravel extraction	plane-bedded	45-60 ft	3-5 ft	silty or sandy grave, stretches of clay and silt
Arroyo del Valle	7c	In-channel historical gravel extraction	gravel ponds separated by short, shallow chutes	80-120 ft	3-40 ft	sand and silt
Arroyo del Valle	7d	In-channel historical gravel extraction	constructed pond	80-120 ft	2-12 ft	silt, clay, and sand
Arroyo del Valle	7e	Flood protection/urban	plane-bedded	30-40 ft	3-5 ft	sandy-gravel, stretches of gravelly-sand
Arroyo del Valle	7f	Flood protection/urban	pool-riffle to plane-bedded	25-35 ft	3-4 ft	sandy-gravel
Arroyo de la Laguna	10a	Flood control/urban	pool-riffle to plane-bedded	75-85 ft	8-10 ft	sandy gravel
Arroyo de la Laguna	10b	Flood protection/urban	pool-riffle	60-70 ft	3-5 ft	sandy gravel

[1] Reaches generally correspond to reaches in the Zone 7 Stream Management Master Plan (RMC 2006)

[2] Range of bed material particle sizes: clay (<0.0002 inch [<0.0039 mm], silt (0.0002 to 0.002 in [0.0039 to 0.0625 mm]), sand (0.002 to 0.08 inch [0.0625 to 2 mm]), gravel (0.08 to 2.5 inches [2 to 64 mm]), cobble (2.5 to 10 inches [64 to 256 mm]), or boulder >10 inches [>256 mm])

Fisheries habitat conditions also varied along the Study Area in Arroyo del Valle and Arroyo de la Laguna. Canyon and adjacent parkland reaches (Reaches 4a-c) had potential spawning and rearing habitat, while the amount of available habitat through current and historical gravel extraction reaches (Reaches 7a-d) was severely reduced (Table A-5). Spawning and rearing habitat improved through flood protection/urban reaches (Reaches 7e-f and 10a-b).

Table A-5 Steelhead Habitat Characteristics of Study Reaches

Waterway	Study Reach	Pool/Riffle/ Run Ratio (% channel length)[1]	# Pool Tails with Suitable Substrate	Dominant Pool Tail Substrate[2]	% Embeddedness of Pool Tails[3]	Average Pool Depth (ft)[4,5]	Mean Pool Cover Complexity[6,7]
Arroyo del Valle	4a	12/9/4 (52/25/23)	9	Gravel	37	1.8	46
Arroyo del Valle	4b	6/4/3 (51/16/33)	6	Gravel	18	2.4	30
Arroyo del Valle	4c	4/6/2 (50/43/7)	4	Gravel	14	2.5	28
Arroyo del Valle	7a	2/4/11 (8/10/82)	2	Sand	50	2.0	80
Arroyo del Valle	7b	2.4.7 (7/14/80)	1	Silt	100	1.6	240
Arroyo del Valle	7c	1/0/1 (99/0/1)	0	NA	NA	>10	NA
Arroyo del Valle	7d	1/0/0 (100/0/0)	0	NA	NA	>4	NA
Arroyo del Valle	7e	10/9/4 (58/22/20)	9	Sand	49	2.5	46
Arroyo del Valle	7f	10/4/3 (80/6/14)	8	Gravel	40	2.6	32
Arroyo de la Laguna	10a	3/2/3 (33/9/58)	3	Gravel	17	2.0	33
Arroyo de la Laguna	10b	5/3/3 (61/15/25)	4	Gravel	60	2.0	44

[1] Reference value(s): 40 to 50 percent pools by length or 2:1 to 1:2 pool to riffle ratio (CDFG 2002, NMFS 2008)

[2] Reference value(s): gravel or larger substrate (Bjornn and Reiser 1991)

[3] Reference value(s): <20 percent = unimpaired, 20 to 80 percent increasingly impaired, >80 percent = unusable (Bjornn and Reiser 1991)

[4] Reference value(s): ≥2 ft (CDFG 1996)

[5] Although the average pool depth in Reaches 4a and 7b in Arroyo del Valle was <2 ft, the reaches did contain several pools >2 ft deep

[6] Pool cover complexity = number of cover types (0 = no cover; 3 = multitude of cover types) multiplied by the percent of overhead area occupied by cover (maximum value = 3 * 100 = 300)

[7] Reference value(s): ≥100 (CDFG 1996)

A.6.1.1 Arroyo del Valle

Reach 4a (Canyon)

Reach 4a extended 4,700 ft downstream from the State Water Project turnout (Arroyo Valle #2 [AV2]) to the Arroyo Road Bridge and flows through a narrow canyon with moderate to high riparian canopy (Figures A-19 and A-20). Estimated average channel gradient was up to 0.5 percent, with the channel displaying a pool-riffle channel morphology. Average bankfull width and depth ranged from 25-40 ft and 2-5 ft, respectively (Table A-4). Overall, in-channel substrate was dominated by gravel with some areas dominated by sand and cobble.

The entire reach was influenced by the presence of two historical instream structures that caused ponding from the AV2 release point downstream to the first instream structure, the remnants of an old flashboard dam that appeared to no longer be in operation (Figure A-21). Downstream of the first instream structure, the channel split around a vegetated island, with the east channel (right, facing downstream) flowing unimpeded to the Arroyo Road Bridge, while the west (left) channel was impounded by the second instream structure (Figure A-21). The second instream structure was a cement weir with a shallow notch on the right side, impounding a long (>600 ft) and deep (>6 ft) pool. Downstream of this pool formed by the instream structure, the channel flowed through a short pool-riffle section before connecting with the east (right) channel just upstream of the Arroyo Road Bridge.

The reach is predominantly pool habitat with a lesser amount (by frequency and length of surveyed channel) of riffle and run habitats (Table A-5). This reach contained the greatest amount of pool tails with suitable unembedded spawning substrate (gravel; 37 percent embedded). Although average pool depth was <2 ft (average = 1.8 ft) the reach contained several pools >2ft deep that could be used for juvenile summer rearing. Pools within the reach generally lacked complex cover that could be used as hydraulic refuge during high winter flows and escape cover from predators.

Reaches 4b and 4c (Adjacent parkland)

Downstream of Reach 4a, Arroyo del Valle flows out onto the valley floor through Reaches 4b and 4c before reaching the Vallecitos Road Bridge (Figures A-19, A-22, and A-23). Reach 4b extends 8,300 ft downstream from the Arroyo Road Bridge through Sycamore Grove Park to the edge of the Diablo Foothills. Reach 4c extends 6,700 ft from Reach 4b through Sycamore Grove Park to the Vallecitos Road Bridge. The two reaches are geomorphically similar, with estimated average channel gradient dropping to <0.5 percent and a pool-riffle channel morphology (Table A-4). Average bankfull width and depth along the surveyed lengths ranged from 25-65 ft and 3-6 ft, respectively. In-channel substrate was dominated by gravel with intermixed cobble. In general, there were few depositional features, although crews did observe some mid-channel bars and vegetated islands. The banks appeared stable with some evidence of past erosion. The AVNL stream gauge is located at the upstream end of Reach 4b within Sycamore Grove Park.

Reaches 4b and 4c contained a moderate amount of pool tails with suitable spawning substrate, and were the least embedded by fine substrate within the Study Area (18 percent and 14 percent, respectively, Table A-5), Pool depths were fairly deep (average depths = 2.4 ft [Reach 4b] and 2.5 ft [Reach 4c]). Pools within Reaches 4b and 4c have the lowest cover complexity with the Study Area, suggesting a lack of hydraulic and escape cover for juveniles.

Reaches 7a and 7b (Adjacent current gravel extraction)

Reaches 7a and 7b extend downstream from the Vallecitos Road Bridge to the upstream edge of Shadow Cliffs Regional Recreation Area (Figure A-19). Both reaches are adjacent to active gravel mining pits (currently operated by CEMEX) and the channel is leveed on both banks and has likely been straightened and relocated in some portions. The channel gradient is very low (<0.01 percent), likely affected by a combination of excavation, straightening, and relocation. Reach 7a extends 6,300 ft downstream from the Vallecitos Road Bridge to the Isabel Avenue Bridge and Reach 7b extends 8,900 ft downstream from the Isabel Avenue Bridge. The reaches are geomorphically similar and are relatively wide, with bankfull widths ranging from 45-95 ft, and shallow, with bankfull depths ranging from 2-5 ft (Table A-4). They are characterized by dense growth of willows and emergent vegetation within the channel. Both reaches are plane-bedded with few depositional features and dominated by highly embedded gravel (Figures A-24 and A-25).

Reaches 7a and 7b were dominated by long run habitats with little usable spawning substrate, but substantial complex cover. Crews noted only 3 pool tails with potentially suitable spawning substrate, but all were dominated by sand or silt and highly embedded with fine sediment (50-100 percent; Table A-5).

As such, these potential sites are likely of poor quality for spawning. Few pools occurred within Reaches 7a and 7b and they were relatively shallow compared to those occurring in other reaches, but had the observed highest cover complexity within the Study Area, likely related to the presence of dense overgrown sections of willows and pads of tule reeds.

Reaches 7c and 7d (In-channel historical gravel extraction)

Reach 7c extends 6,300 ft downstream through East Bay Regional Parks District's Shadow Cliffs Regional Recreation Area (Figure A-19). The reach is highly altered, flowing directly through several historical gravel mining pits (Figure A-26). In-channel excavation appears to have lowered the base level substantially (up to 30 ft; see Section A.4.3.2 and Figures A-16 through A-18). The reach lacked discernible fluvial features (pools, riffles, gravel bars). Channel gradient is very low (<0.1 percent) through and between ponds, and average channel width and depth are driven by pond width (up to 120 ft) and depth (up to 30 ft).

Reach 7d extends 1,900 ft downstream from Shadow Cliffs Regional Recreation Area to the Bernal Road Bridge (Figure A-19). The in-channel excavation apparent in Reach 7c likely continued downstream into Reach 7d, which also appeared straightened and widened. As with Reach 7c, there were no discernible fluvial features; rather the reach appeared to be a wide (up to120 ft wetted width) and shallow (2–12 ft) homogeneous channel characterized by sand, silt, and clay on the bed (Figure A-27). Vegetation was dominated by emergent aquatic vegetation within the channel, and occasional riparian trees, such as alder and sycamore.

Reaches 7c and 7d contain little, if any, habit for steelhead, other than as a migration corridor. As noted above, the reaches contained no discernible fluvial features, rather the channel was formed through excavation for gravel mining, and both were dominated by homogeneous long, deep pools. As such, there was no spawning or rearing habitat observed within the reach.

Reaches 7e and 7f (Flood protection/urban)

Reaches 7e and 7f flow downstream from the Bernal Road Bridge to the confluence with Arroyo de la Laguna (Figure A-19). Both reaches flow through an urbanized area, have been straightened and channelized with levees (RMC 2006) (Figures A-28 and A-29). Reach 7e extends 9,000 ft downstream from the Bernal Road Bridge to the Hopyard Road Bridge, and Reach 7f flows 7,100 ft to the confluence with Arroyo de la Laguna (Table A-3). The ADVP stream gauge, the downstream point to which Zone 7 and ACWD are required to maintain a live stream from Del Valle Dam, is located at the intersection of Reaches 7e and 7f (see Section A.2.1.2, above). The channel alternated between a pool-riffle and plane-bedded morphology with occasional gravel bars. There was evidence of historical channel incision in the form of undercut and steepened banks, and the presence of grade control structures downstream of bridges. Overall, the reaches appear stable with no active incision or aggradation. Bankfull widths ranged from 25-40 ft (largely controlled by channel revetments and levees) and bankfull depths ranged from 3-5 ft (Table A-4). The bed was dominated by sandy gravel. Banks and adjacent levees were also stable, supporting a fairly wide riparian corridor with moderate canopy cover.

Reaches 7e and 7f flowed through a highly modified flood protection/urban zone with multiple instream structures and outfalls. Still, habitat was of higher quality than upstream in Reaches 7c and 7d. Crews observed a relatively high number of pool tails with usable spawning substrate, but those in Reach 7e were dominated by sand and were highly embedded (50 percent, Table A-5). Pool tails in Reach 7f were dominated by gravel, but were also fairly embedded (41 percent). Pools were common within this section of the Study Area, and relatively deep compared to other reaches, but appeared to be lacking complex cover.

A.6.1.2 Arroyo de la Laguna

Reaches 10a and 10b

Geomorphic conditions along Arroyo de la Laguna reflect channel response to cycles of erosion and deposition, and channelization and flow conveyance. Bed and bank conditions also reflect response to changes in sediment load and hydrology. Valley and Mountain Associates (2007) visually estimated bed substrate and found that gravel, sand, or finer substrate covered 90 percent of the channel length, with some rip-rap or concrete sections, but observed no excessive sediment deposits. Bank heights for most of the channel length (85 percent) exceeded the water surface elevations for 2-15 year recurrence interval floods, indicating channel incision, and resulting in substantial bank failure.

Upstream of Verona Bridge the channel appeared to be degraded and widening, alternating between plane-bedded and pool-riffle sections. Bankfull width and depth ranged from 75-85 ft and 8-10 ft respectively, with a bed dominated by sand and gravel. Crews observed point and mid-channel bars, but also long stretches with no depositional features. Banks made up of sand and clay were high (6–20 ft) and steep, with multiple failures (Figures A-30 and A-31). Downstream of Verona Bridge, the channel appeared to be degraded and widening to quasi-equilibrium, with a pool-riffle morphology. Bankfull width and depth ranged from 60-70 ft and 3-5 ft, respectively with a similar bed composition to upstream of Verona Bridge (sand and gravel). Crews observed several large point and lateral gravel bars, along with high, steep banks with multiple failures (similar to upstream).

Reaches 10a and 10b were characterized by poorly defined pools and long runs, with short riffles. Along with point and lateral bars throughout the reaches, crews observed several pool tails with suitable steelhead spawning substrate (Table A-5). In both reaches, pool tails were dominated by gravel, but were less embedded upstream of the Verona Bridge in Reach 10a than downstream in Reach 10b (17 percent and 60 percent), respectively. In addition to gravel at pool tails, point and mid-channel bars contained spawning gravel potentially available during higher flows (Figures A-30 and A-31). Pools observed in the reach averaged 2 ft in depth, but appeared to lack complex cover for hydraulic and escape cover.

A.6.2 Temperature Assessment

Water temperatures during summer were warm throughout the Study Area, often above levels stressful to steelhead, but varied across reaches (Figure A-32); this is consistent with historical water temperature data collected at both ADLLV and ACN (compare Figures A-32 and A-33).

At most sites, daily water temperatures fluctuated but remained above 20°C for weeks or months at a time until early October, suggesting temperatures may have reduced feeding and growth of rearing juvenile steelhead during the over-summering season. Maximum daily water temperature at most monitoring locations exceeded 22°C until late-August, indicating conditions may cause stress to juvenile steelhead throughout a large portion of the season. At most locations (except through Reach 7c, Probe PSC-h), minimum daily water temperatures were below 22°C during the over-summering season, indicating some temporal refuge from stressful temperatures was available. Maximum daily water temperatures reached the potentially lethal threshold (25°C) in late June of 2013 at most stations (Figure A-32, Table A-2).

In general, water temperatures during the over-summering season are warm and well above stressful levels (22°C) in Reach 4a and 4b, with Maximum Weekly Average Temperatures (MWATs) at times exceeding 25°C. Water temperatures decrease slightly through Reach 4c. MWATs along Arroyo del Valle ranged from 22.8-26.4°C, with the greatest MWAT (26.4°C) occurring in Reach 7c (in the ponds adjacent to Shadow Cliffs Regional Recreation Area; Table A-6). Water temperatures measured in Reach 7c were well above stressful levels (22°C) and at times exceeded potentially lethal levels (greater than 25°C) for multiple days. Summer water temperature remained high downstream to the confluence with Arroyo de la Laguna. Water temperature data from Arroyo de la Laguna at Verona Bridge show instantaneous water temperature exceeded 25°C in early-July 2013 (Figure A-32), and have consistently done so since at least 2007 (Figure A-33). MWAT reached a maximum of 26.7°C in early July (Table A-6).

Table A-6 Maximum Weekly Average Temperatures (MWATs) Observed in the Study Area in 2012

Waterway	Study Reach	Reach MWAT Celsius (°C)[1]	Week Ending Date (MM/DD/YY)	Probe Name[2]
Arroyo del Valle	4a	23.8 25.5	07/06/13 07/06/13	AV2-h APT-h
Arroyo del Valle	4b	25.0	07/05/13	AVL-h
Arroyo del Valle	4c	24.7 22.8	07/05/13 08/16/12	DCC-h[3] SGP-h
Arroyo del Valle	7a	23.0[3]	07/04/13	ISA-h[3,4]
Arroyo del Valle	7b	23.0[3]	07/04/13	ISA-h[3,4]
Arroyo del Valle	7c	26.4	07/06/13	PSC-h
Arroyo del Valle	7d	NA[5]	NA[5]	NA[5]
Arroyo del Valle	7e	25.8	07/05/13	AVP-h
Arroyo del Valle	7f	25.5	07/05/13	ALL-h
Arroyo de la Laguna	10a	26.7[6]	07/05/13	ALLP
Arroyo de la Laguna	10b	26.7[6]	07/05/13	ALLP

[1] MWAT = Maximum Weekly Average Temperature.
[2] See Figure A-19 for probe location
[3] Probe installed September 21st 2012
[4] Installed at the intersection of Reaches 7a and 7b
[5] Not available. Probe not installed in reach.
[6] Maximum of daily median water temperature recorded at Arroyo de la Laguna at Verona stream gauge (USGS Gauge #11176900)

Water temperatures exceeded stressful temperature thresholds for most steelhead life stages. Juvenile incubation within spawning gravels typically occurs from January to May in the San Francisco Bay area (Hanson, et al., 2004). While data collection started in early March, results show that temperatures exceeded 12°C from early March to mid-April in 2012 and again in early March 2013, suggesting reduced incubation survival, and temperatures exceeded 16°C from mid-April through the end of May, suggesting very poor incubation survival for steelhead within the Project Area (Figures A-32 and A-33, Table A-2). During the summer, temperatures exceeded 20°C at all sites at some time during the summer, suggesting decreased feeding and growth for rearing steelhead (Figures A-32 and A-33).

At all sites the smoltification inhibition threshold (13°C) was exceeded by early March in 2012 and 2013 (Figure A-32), suggesting that water temperature could limit steelhead smolt out-migration (Table A-2). The adult steelhead upstream migration avoidance threshold (24°C) was not exceeded for most of the migration season (November through April). At the very end of the migration season in April, daily maximum water temperature in Reaches 10a and 10b (Probe ALLP) were near 24°C. This observation was confirmed by reviewing available historical temperature data on Arroyo de la Laguna (Figure A-33). Please refer to Attachment 2 for figures showing temperature data for individual probes.

Lake Del Valle appeared to moderate water temperature downstream of the dam. Average daily temperature dropped sharply several times during summer periods (early and mid-June, mid-July) and in late-September at the SWP Turnout AV2 (Probe AV2-h), Arroyo Park Trail (Probe APT-h), Arroyo del Valle near Livermore (Probe AVL-h), and Dry Creek (Probe DCC-h) temperature probes in response to releases made from Lake Del Valle by California Department of Water Resources (Figure A-32).

As discussed previously and in Attachment 1, DWR can release water from Lake Del Valle using two release points located at 630 and 650 ft above mean sea level, which typically has a water temperature ranging from 10-15°C (Figure A-34). Typically, California Department of Water Resources starts lowering the lake in late September to bring storage levels down to 25,000 acre-ft by mid-November; allowing it to provide flood protection for the wet winter months and capture local inflow for water supply.

The cooler water from the reservoir also reduced the daily water temperature variability downstream in Arroyo del Valle as compared with substantially greater daily temperature ranges upstream of Lake Del Valle below Lang Canyon (Probe BLC-h) (Figure A-32). Maximum daily water temperatures exceeded the highest estimate of incipient lethal threshold (25°C) for multiple days at a time in May through August upstream of Lake Del Valle, indicating steelhead would be exposed to very stressful or potentially lethal conditions. During these times, daily minimum water temperatures fell below 20°C, and the MWAT was 19.9 °C (for the week ending August 2, 2012), indicating that for at least part of the day, and on average, conditions were not physiologically stressful for steelhead. Overall, State Water Project releases from Lake Del Valle likely moderate temperature variation in Arroyo del Valle from just downstream of the dam to at least the beginning of Reach 4c (2.3 miles downstream). Refer to Attachment 2 for figures showing temperature data for individual probes.

A.6.3 Migration Barriers

Several potential barriers to upstream steelhead migration exist within the Study Area (Figures A-19 and A-35 a–f). Gunther, et al., (2000) conducted a reconnaissance level survey of fish habitat, including the presence of potential migration barriers, and noted Del Valle Dam as the only complete migration barrier - other structures were considered partial barriers to migration. The Zone 7 Stream Management Master Plan (RMC 2006) indicated potential barriers at Santa Rita Road (intersection of Reaches 7d and 7e), Stanley Boulevard (within Reach 7e), Division Street (intersection of Reaches 7 e and f), and at the confluence of Arroyo del Valle and Arroyo de la Laguna (Figures A-19 and A-35a–f). Additionally, during 2012 spring geomorphic and fish habitat surveys, crews observed two historical instream structures in Reach 4a that may act as migration barriers (see Section A.6.1.1.1 and Figure A-21).

Valley and Mountain Associates (2007) evaluated fish passage conditions along Arroyo de la Laguna to Arroyo del Valle. A complete barrier (adult steelhead likely unable to pass upstream at any typical migration season flows) at the grade control structure just upstream of the Castlewood Golf Course footbridge originally observed by Valley and Mountain Associates. This structure was severely damaged in December 2012 and was removed by Zone 7 in October 2013, improving passage condition for steelhead migrants (Figure A-35e; upstream of Castlewood Drive). Additional partial barriers (adult steelhead likely unable to pass upstream under some of the typical migration season flows) were found in Arroyo Del Valle: 1) at a grade control/protected pipeline crossing just upstream of Hwy 84 (Figure A-35f) 2) at the confluence with Arroyo del Valle (also noted by RMC [2006]), and 3) a minor barrier (adult steelhead likely to be able to pass upstream under typical flows during the migration season, but not likely to pass at very low flows) at the rip-rap protecting the footing of the Bernal Road Bridge.

A.6.4 Water Quality

The ponds at Shadow Cliffs Regional Recreation Area (Reach 7c) showed no apparent vertical thermal stratification, but did show a reduction in DO from the water surface downward (Table A-7, Figures A-36 and A-37). Water temperature in both ponds (Island and Arroyo Ponds) showed little variation from the surface (17-19°C) to 20-25 ft below the water surface (15-16°C). The survey was conducted in early fall with relatively cool surface water input from upstream (approximately 15-17°C, Figure A-32). Dissolved oxygen concentration was 7-8 mg/l at the surface of both ponds, decreasing to 3-4 mg/l at 10 ft depth, and 0.3 to 1.6 mg/l at 20 ft depth. DO concentrations below 5.0 mg/L are considered unsuitable to steelhead and DO concentrations below 3.0 mg/L are considered highly stressful and potentially lethal. The water quality results suggest that conditions were suitable for steelhead at the time of sampling in the surface water of the Island Pond and Arroyo Pond down to depths of 7 and 8 ft, respectively. Water quality conditions with respect to DO concentration were highly stressful and potentially lethal to steelhead at depths below 13 ft and 15 ft in the Island and Arroyo Ponds, respectively. Extremely low DO levels near the bottoms of ponds likely preclude steelhead from the deepest portion of the ponds.

Table A-7 Temperature and Dissolved Oxygen Concentration in Island Pond and Arroyo Pond within Shadow Cliffs Regional Recreation Area

Depth	Island Pond[1]		Arroyo Pond[1]	
	Temperature (°C)	DO (mg/l)	Temperature (°C)	DO (mg/l)
0.25	18.23	8.04	16.93	7.32
3	16.7	8.08	16.8	7.62
5	16.3	7.91	16.79	7.1
7	16.13	5.7	ND[2]	ND[2]
8	ND[2]	ND[2]	16.77	7.14
10	15.88	3.3	16.73	4.4
12	ND[2]	ND[2]	16.68	3.71
13	15.7	2.35	ND[2]	ND[2]
15	15.6	1.8	16.59	3.16
17	15.5	1.16	16.55	2.64
20	15.36	0.25	16.45	1.61
23	ND[2]	ND[2]	16.27	0.24
24	ND[2]	ND[2]	15.79	0.1

[1] Survey conducted October 29, 2012
[2] ND = No data collected

A.6.5 Predators

The ponds at Shadow Cliffs Regional Recreation Area (Reach 7c) provide habitat for predatory warm water species. Surveys were conducted by the East Bay Regional Park District and Zone 7 in October 2012 using boat electrofishing. This effort found mostly largemouth bass (120/130 [93%]) in two ponds (Island Pond and Arroyo Pond, see Figure A-17) connected to Arroyo del Valle, along with bluegill, and common carp (goldfish; Table A-8). The largemouth bass ranged in size from 2 to 21 inches. Additionally crews observed several largemouth bass within a deep (4-5 ft) pool in Sycamore Grove Park in Reach 4c during reconnaissance surveys in mid-September 2012.

Table A-8 Fish Species Recorded in Island Pond and Arroyo Pond within Shadow Cliffs Regional Recreation Area

Common Name (Species)	Island Pond		Arroyo Pond		TOTAL[1]	
	Abundance	Average Length (in)[2] (range)	Abundance	Average Length (in)[2] (range)	Abundance	Average Length (in)[2] (range)
Bluegill *Lepomis macrochirus*	2	6.4 (5.6-7.2)	0	--[3]	**2**	**6.4 (5.6-7.2)**
Common carp *Cyprinus carpio*	4	27.8 (25.2-29.4)	3	30.7 (28.2-35.0)	**7**	**29.3 (25.2-35.0)**
Goldfish *Carassius auratus*	0	--[3]	2	17.9 (17.9-18.0)	**2**	**17.9 (17.9-18.0)**
Largemouth Bass *Micropterus salmoides*	78	7.2 (2.1-20.5)	42	8.3 (2.0-21.4)	**120**	**7.6 (2.0-21.4)**
TOTAL	**84**		**47**		**131**	

[1] Survey conducted October 29, 2012
[2] Total length (TL) = from the tip of the snout to the end of the tail
[3] No individuals recorded

A.7 Discussion

A.7.1 Overview of Conditions within the Study Area

A.7.1.1 Geomorphic and Steelhead Habitat Assessment

The overall condition of each reach was determined by assessing the relative condition of spawning and rearing habitat, assessing water temperature, and identifying potential stressors. Condition of spawning and rearing habitat was assessed as suitable, marginal, poor, or not present. Suitable habitat met or surpassed targets detailed in Section A.5.2 (e.g., spawning substrate <20 percent embedded, pools >2ft deep, cover complexity >100), marginal habitat did not meet targets but was likely still usable by steelhead, and poor habitat did not meet targets and was likely not usable by steelhead. Water temperature was assessed as potentially suitable, stressful, or lethal if MWATs were < 22°C (suitable), 22-25°C (stressful), >25°C (potentially lethal). Other potential limits on steelhead usage of the reach were barriers to migration, predation, or water quality.

Based on the habitat assessment, suitable spawning and marginal rearing habitat for steelhead in the Study Area occurred in Reaches 4b, 4c, and 10a, with marginal spawning and rearing habitat in Reaches 4a, 7f, and 10b (Table A-9). Reaches 7a-d did not contain suitable habitat. Pool tails dominated by gravel were observed in Arroyo del Valle in Reaches 4a-c, and 7f, and in Reach 10b of Arroyo de la Laguna (Table A-5). The remaining reaches either had pool tails dominated by sand or silt, or in the cases of Reaches 7c and 7d, were long, ponded reaches comprised of a single habitat unit without pool tails or spawning habitat. Based upon the embeddedness of pool-tails (< 20 percent), Reaches 4b, 4c, and 10a appeared to have suitable spawning habitat, with Reaches 4a, 7f, and 10b supporting marginal habitat.

Most reaches in Arroyo del Valle and Arroyo de la Laguna contained pools >2 ft depth, and although the average pool depth in Reaches 4a and 7b in Arroyo del Valle was <2 ft, the reaches did contain several pools >2 ft deep (Table A-5). Only one reach (7b) exceeded a cover complexity value of 100 within the Study Area; all other reaches were below this value, ranging from 28 to 48, indicating a potential lack of hydraulic and escape cover for rearing (Table A-5). Reaches 7a and 7b had the highest cover complexity, but had relatively few pools (Table A-5). The cover complexity was due to dense overgrown sections of willows and pads of tule reeds and was likely not desirable habitat for juvenile steelhead.

Table A-9 Steelhead Habitat Conditions in Study Reaches

Waterway	Study Reach	Spawning	Rearing	Temperature	Other Potential Limits on Steelhead Usage
Arroyo del Valle	4a	Marginal	Marginal	Potentially Lethal	Barriers (2)
Arroyo del Valle	4b	Suitable	Marginal	Stressful	None
Arroyo del Valle	4c	Suitable	Marginal	Stressful	Predators
Arroyo del Valle	7a	Poor	Poor	Stressful	Predators
Arroyo del Valle	7b	None	Poor	Stressful	Predators
Arroyo del Valle	7c	None	None	Potentially Lethal	Water Quality Predators
Arroyo del Valle	7d	None	None	n/a	Water Quality Predators
Arroyo del Valle	7e	Poor	Marginal	Potentially Lethal	Barriers (2)
Arroyo del Valle	7f	Marginal	Marginal	Potentially Lethal	Barriers (1)
Arroyo de la Laguna	10a	Suitable	Marginal	Potentially Lethal	None
Arroyo de la Laguna	10b	Marginal	Marginal	Potentially Lethal	None

A.7.1.2 Temperature

Water temperature within the Study Area appeared warm enough to potentially negatively affect steelhead. Water temperatures are coolest in the most upstream reaches (Reaches 4a-c, Table A-6), but still warm enough (>22°C) during portions of the summer to be potentially stressful to juvenile steelhead (Table A-2). Water temperatures increase downstream through Reaches 7a-d, and are highest in in Reach 7c. Water temperature data (Figure A-32) show that all reaches exceed 20°C during the summer period with downstream reaches (Reaches 7a-e, 10b) exceeding stressful and potentially lethal levels more often than upstream reaches. While MWATs were cooler in Reaches 7e-f, they were still high and potentially stressful (>22°C) through the summer rearing period. Water temperature in Reaches 10a and 10b were potentially stressful to lethal (Table A-6 and Figure A-32). Steelhead smoltification may be limited by temperature within Arroyo del Valle and Arroyo de la Laguna when water temperatures exceed 13°C during the latter half of the outmigration season (Figure A-32). Temperature did not appear to limit adult upstream migration. Temperatures remained below 24°C for most of the adult migration period in all reaches, although daily maximum temperatures did approach 24°C in Reaches 10 a and 10b in mid- to late April. Temperatures exceeded 12°C during the early part of the incubation period and exceeded 16°C in the latter part of the incubation period, suggesting reduced to very poor incubation survival (Figure A-32, Table A-2).

The conversion from lotic to lentic (i.e., actively flowing to still water) habitats associated with the presence of former gravel ponds in Reach 7c also appeared to have consequences for water temperature. The increase in channel width, and subsequent decrease in water velocity, creates slack-water. Slack-water has a longer transit time through the affected reach, and is exposed to sunlight for long periods of time, likely causing an increase in water temperature (Norman et al. 1998). The wider channel also increases the surface area of exposed water and decreases the influence of adjacent, overhanging vegetation on providing overhead canopy and shade. Water temperature data indicate temperature increases of 2-5°C through Reach 7c during the summer with average temperatures of 23-26°C (Figure A-32, Table A-5).

A.7.1.3 Migration Barriers

Upstream migration of adult steelhead appears limited by physical barriers within the Study Area. There is at least one previously identified barrier on Arroyo de la Laguna that was severely damaged in December 2012 and removed by Zone 7 in October 2013, improving passage conditions into Arroyo del Valle (just upstream of Castlewood Drive; Figure A-35e). Several other barriers, which are only passable in higher flows were noted (Figures A-19, A-35e, and A-35f). Along Arroyo del Valle there are several potential barriers within Reaches 7e-f, potentially limiting migration to upstream reaches under some flow conditions (Figures A-35a–d) and two potential low flow barriers in Reach 4a (Figure A-21).

A.7.1.4 Water Quality

Low DO concentrations (<3 mg/L) occur below 10-15 ft depth in the ponds in Reach 7c, but the remainder of the water column appeared to maintain higher DO concentration (Table A-7, Figure A-37). The reduction in water velocity and increase in water temperature associated with the presence of gravel ponds may also encourage algal blooms and a resulting decrease in dissolved oxygen (DO) concentration. Lower DO concentrations may limit growth rate and food conversion efficiency of native salmonids, which can tolerate concentrations below 5 mg/L, but face increasing stress and mortality down to 2 mg/L (Bjornn and Reiser 1991). These conditions likely persist into Reach 7d due to similarities in geomorphic conditions that affect water circulation and water quality conditions.

A.7.1.5 Predators

The gravel ponds within Reach 7c support predatory fish populations (Table A-8). The gravel ponds create ideal conditions for predatory warm-water fish, such as largemouth bass: they are relatively deep (20-30 ft) compared to its surface area, and the ponds are not well mixed in summer, supporting extremely high temperatures and low DO concentrations. Additionally, abundant aquatic vegetation provides cover for predatory fish (Smith 2007). In the Sacramento-San Joaquin system, largemouth and smallmouth bass, have been observed to consume up to 1.6 juvenile salmon per day (EA 1992, as cited in Kondolf et al. 2008). The unfavorable conditions and geographic range of predatory fish likely extends downstream into Reach 7d, which is also wide and deep, and upstream through Reaches 7a and 7b, which were both dominated by long runs with dense tule mats and low water velocities. Crews also observed several largemouth bass within a deep (4-5 ft) pool in Sycamore Grove Park in Reach 4c during reconnaissance surveys in mid-September 2012, indicating predator distribution upstream to at least this reach. Downstream migration of steelhead smolts may also be limited by predation within Arroyo del Valle. Out-migrating juvenile salmonids use velocity and current as directional cues and can become disoriented in slack-water reaches likely decreasing their ability to avoid predators (Norman et al 1998).

A.7.2 Additional Stressors on Steelhead Habitat

The current condition of the Study Area reflects responses to a number of different stressors that affect geomorphic processes, in turn effecting the distribution and quality of aquatic habitat. The stressors range from changes in base- and peak flows, to gravel mining (both in-channel and adjacent), to channel excavation and straightening related to flood protection. Surrounding land uses also affect the magnitude and timing of runoff, the extent of riparian cover, and water quality. Urbanization and residential development of over half of the valley with its associated changes in runoff, water quality, shading and channel configuration and incision have also effected aquatic habitat in Arroyo del Valle and Arroyo de la Laguna.

A.7.2.1 Streamflow

Some studies suggest that Del Valle Dam has substantially decreased peak flows (Section A.2.1), and that the dam may also reduce the transport of sediment from upstream sources to the valley floor, potentially leading to incision and bank erosion as the channel transports available sediment from the bed and banks. Increases in base flow during the summer (Section A.2.1, Figures A-8 through A-11), also potentially exacerbate channel incision, creating higher terrace and floodplain surfaces that are flooded less often, leading to reduced channel and floodplain complexity.

A.7.2.2 Channel Form

Historical in-channel gravel mining within Arroyo del Valle in Reaches 7c-d, and potentially in Reaches 7a-b, has caused physical and water quality changes that have substantially altered aquatic habitat. In particular, gravel ponds within Shadow Cliffs Regional Recreation Area increase channel width, and decrease channel gradient (Figures A-16 through A-18) and water velocity (Kondolf et al. 2002). These changes reduce stream power and the capacity of the stream or river to transport sediment to downstream reaches. Impoundments, such as Del Valle Dam, trap fine and coarse sediment that would normally be transported downstream, potentially causing a sediment deficiency in downstream reaches, which can have adverse habitat effects such as loss of spawning gravel and bed coarsening, potentially rendering substrate ecologically unsuitable to native aquatic species. The abrupt change in gradient between the slack-water reach and upstream reaches can also create a channel knickpoint that causes channel incision as the stream works to establish a new equilibrium gradient (Norman et al. 1998, Kondolf et al. 2008). The incision can propagate upstream and destabilize the bed and banks, degrading the channel, and reducing the extent of riparian vegetation, resulting in less shade and nutrients to stream ecosystems. The water source for riparian vegetation can also be reduced or eliminated as incision lowers the fluvial base-level, consequently lowering the groundwater table (Norman et al. 1998).

A.7.2.3 Large Woody Debris

Logs, stumps, and branches that enter and are transported by rivers and streams are important influences on channel morphology and aquatic ecology. Large woody debris (LWD), generally defined as wood ≥ 10 cm diameter and ≥ 1 m length, obstructs streamflow, stores and distributes sediment, and creates channel features, such as pools, riffles, and waterfalls. Wood intercepts organic matter traveling downstream, allowing this material to be processed by instream organisms. Macroinvertebrates and fish occupy and use pools and riffles as habitat, and sediment deposition provides sites for riparian forest regeneration. The abundance and frequency of LWD in the Study Area has likely been reduced through land use, which can alter the extent of the forest, reducing the amount of potential wood available and the age, which influences the size of LWD. The size of LWD is a significant influence on geomorphic function (Ralph et al. 1994). Channel modification that reduces the occurrence of bank erosion, further prevents the recruitment of wood. Channel confinement that prevents channel migration may also reduce the formation of gravel bars and floodplains that are sites of LWD deposition. Fluvial transport from upstream reaches can also be a significant source of wood to lower reaches where it deposits within the channel, on gravel bars, or along the banks. We observed few pieces of LWD within the Study Area. This may have been caused by a lack of recruitment due to channel confinement that reduces recruitment, rapid flushing downstream, or a reduction in the riparian forest. Another factor that may contribute to the lack of woody debris is maintenance activities along the channel where landowners remove downed trees and dispose of the wood.

A.7.2.4 Alterations to Food Web

The most important food source for juvenile salmonids is usually invertebrate drift from riffles. Benthic macroinvertebrate production is concentrated in highly oxygenated riffle habitats. Juvenile steelhead can minimize energy expended in feeding by establishing feeding stations where riffles enter pools or where they can hold near boulders, large wood, or other flow obstructions while remaining adjacent to higher velocity water with higher food delivery rates. Invertebrate production in riffles may be reduced by decreased surface flows; changes in channel geomorphology that reduce available habitat for benthic macroinvertebrates; and poor water quality that may reduce primary and secondary production or result in direct mortality of invertebrates. Wood obstructions also potentially store large amounts of externally derived organic matter that is a source of energy for aquatic food webs, and reduction in the amount of LWD limits organic matter retention and increases transport downstream. Introduction of non-native species can result in higher predation of steelhead and competition for food and habitat. Changes to flow, channel form, and the presence of predators have all occurred in the Study Area, and LWD was generally absent, likely affecting invertebrate production and food sources for steelhead.

In addition, major changes occurred in Arroyo de la Laguna affecting food production when the Pleasanton Marsh complex was drained and the riparian corridor was cleared causing the channel to incise. Mining activity in Arroyo de Valle brought similar changes, adversely affecting food producing habitat in the Livermore Valley.

A.8 Conclusions

Reaches 4b-c contained relatively abundant and unembedded spawning substrate, a relatively high number of pools >2ft deep, and the coolest observed summer water temperatures. However, pools generally lacked cover complexity, suggesting that while potentially suitable, they likely provided little escape cover, or thermal and hydraulic refuge, and were low quality summer and winter rearing habitat. Although relatively cool summer water temperatures in Reaches 4b-c were observed, they are still high enough (>22°C during some periods) to cause stress to juvenile steelhead. Crews observed either poor or no usable spawning habitat within Reaches 7a-d (Table A-5). Although the presence of relatively deep pools were recorded, the pools in Reaches 7c-d were former gravel ponds or sites of in-channel gravel excavation, too deep and warm to support steelhead rearing (Table A-5). Further, the physical conditions within Reaches 7a-d likely support warm water species that prey on juvenile steelhead. Reaches 7e-f flow through an urbanized section of Arroyo del Valle, surrounded by levees and occasional rip-rap (Figures A-28 and A-29). Crews observed marginal spawning habitat in Reach 7f and relatively deep pools (>2.5 ft, Table A-5) to potentially support rearing. As in Reaches 4a-c, the pools lacked complex cover, suggesting marginal summer and winter juvenile steelhead rearing habitat. Reaches 10a and 10b of the Arroyo de la Laguna also contained usable spawning habitat (suitable in Reach 10a and marginal in Reach 10b), and likely a greater amount than any reach in Arroyo del Valle owing to a wider channel with substantial gravel bar area. Similarly to Arroyo del Valle, pools within Arroyo de la Laguna, while adequately deep, lacked complex cover, limiting their utility as steelhead summer and winter rearing habitat.

The greatest opportunities for steelhead in the Study Area occur in Reaches 4b-c in Arroyo del Valle and Reach 10a in Arroyo de la Laguna. Reaches 4b-c occur upstream of the influence of gravel mining (both current and historical) and flood protection that affect Reaches 7a-f. Survey results indicate Reaches 4b-c contain suitable spawning habitat, but rearing habitat may be limited by high summer temperatures (summer rearing) and lack of hydraulic refuge (cover complexity, winter rearing). The opportunities in Reaches 4b-c are likely constrained by the poor quality habitat and multiple barriers occurring downstream. Reaches 7a-f are affected by current and historical gravel mining activities that create marginal to poor spawning and rearing habitat, sustain high summer temperatures, and support populations of non-native predatory fish. Reach 10a in Arroyo de la Laguna potentially supports spawning, but is likely limited by temperature and lack of complex cover to support summer rearing.

This study found available steelhead spawning and rearing habitat, but spawning habitat was limited by quantity and quality, and pool habitat was limited by a lack of complex cover. Summer rearing was also likely limited by high water temperatures. There were also limitations to upstream migration (barriers) that limit access to available habitat, and limitations to downstream migration (temperature and predation) that may supersede habitat availability or quality. Further, a number of ongoing stressors (changes in peak and base flows, changes in channel form, and lack of LWD) could affect geomorphic processes and the quantity and quality of aquatic habitat. Hanson et al. (2004) found unsuitable and potentially lethal water temperatures within Shadow Cliffs Regional Recreation Area, but suitable (for steelhead summer rearing) temperatures within Sycamore Grove Park. Hanson et al. (2004) identified areas from Del Valle Dam downstream through Sycamore Grove Park as potentially suitable for steelhead rearing, if passage for adults and juveniles were re-established. Gunther et al. (2000) concluded that the lowermost sections of Arroyo del Valle contain some suitable spawning gravel, but the portion downstream of Lake Del Valle contains little potential spawning and rearing habitat. Gunther et al. (2000) cited elevated water temperatures, channelization, and loss of natural channel features and habitat conditions that are controlled by releases from the dam, likely result in erratic habitat conditions. They found the majority of Arroyo de la Laguna unusable for steelhead except as a migration corridor because the available substrate, pool habitat, and warm summer temperatures did not support steelhead spawning or rearing conditions.

The challenges to restoring steelhead within the Study Area are related to passage, overall habitat quality, and water temperature. Fish passage barriers exist on Arroyo del Valle and Arroyo de la Laguna, potentially blocking access to higher quality habitats at the upstream end of the Study Area (Reaches 4b-c). Even with barrier removal, or restoration of fish passage, the habitats within Reaches 4b-c may not currently support robust steelhead populations without modification to improve spawning and rearing conditions. As these reaches are upstream of the ponds at Shadow Cliffs, which are sources for predators, downstream passage success of juveniles would likely be limited. Without improvements to adult upstream migration (through barrier modification) and juvenile downstream migration (through predator control) habitat gains in Reaches 4b-c would not likely support substantial steelhead populations. Reaches downstream of the influence of gravel mining may offer some opportunity for steelhead habitat, but habitat quality in these reaches was still poor to marginal, with potentially stressful water temperatures.

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Arroyo del Valle and Arroyo de la Laguna Steelhead Habitat Assessment

FIGURES

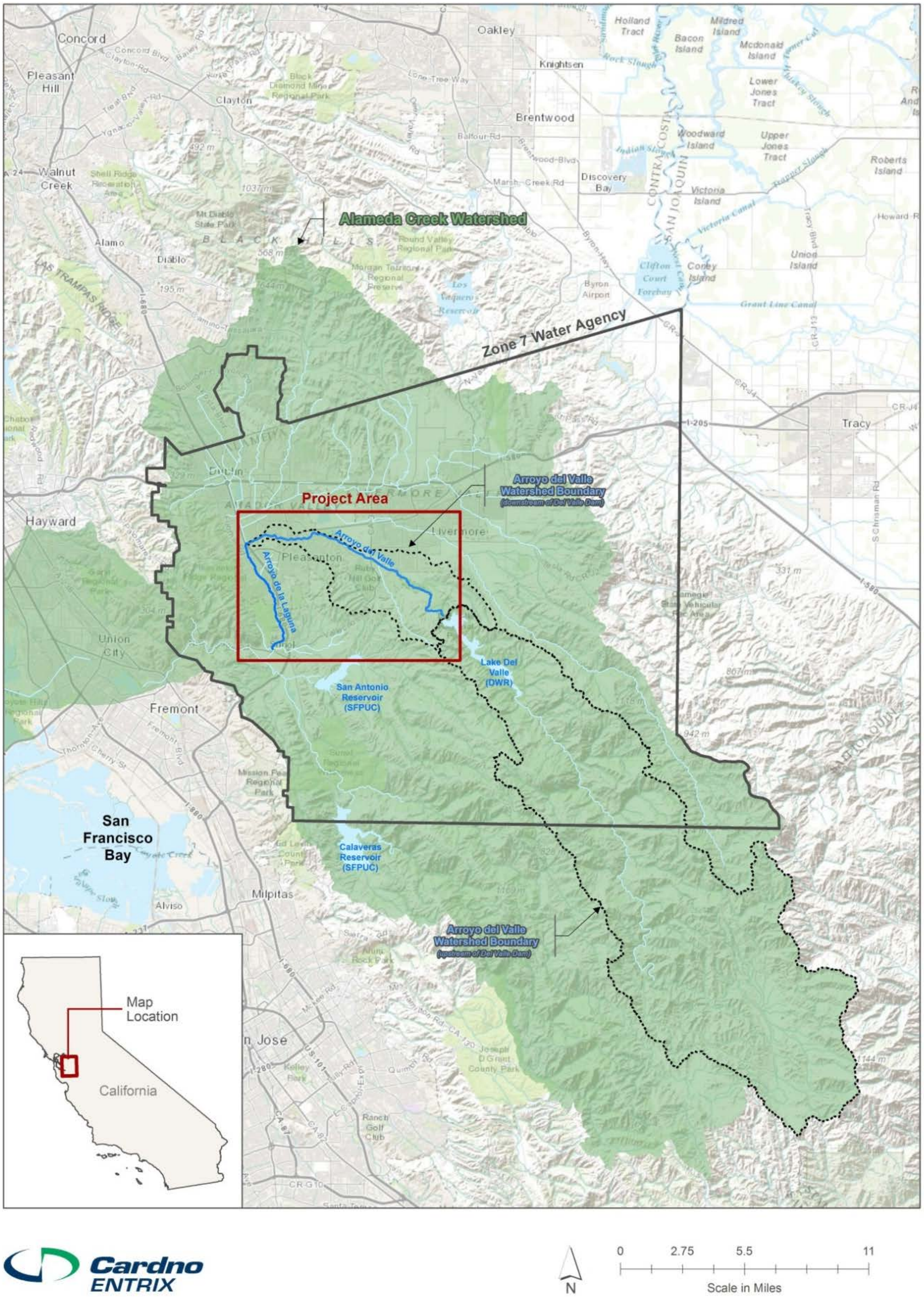

Figure A-1 Location of Arroyo del Valle and Arroyo de la Laguna within Alameda Creek Watershed

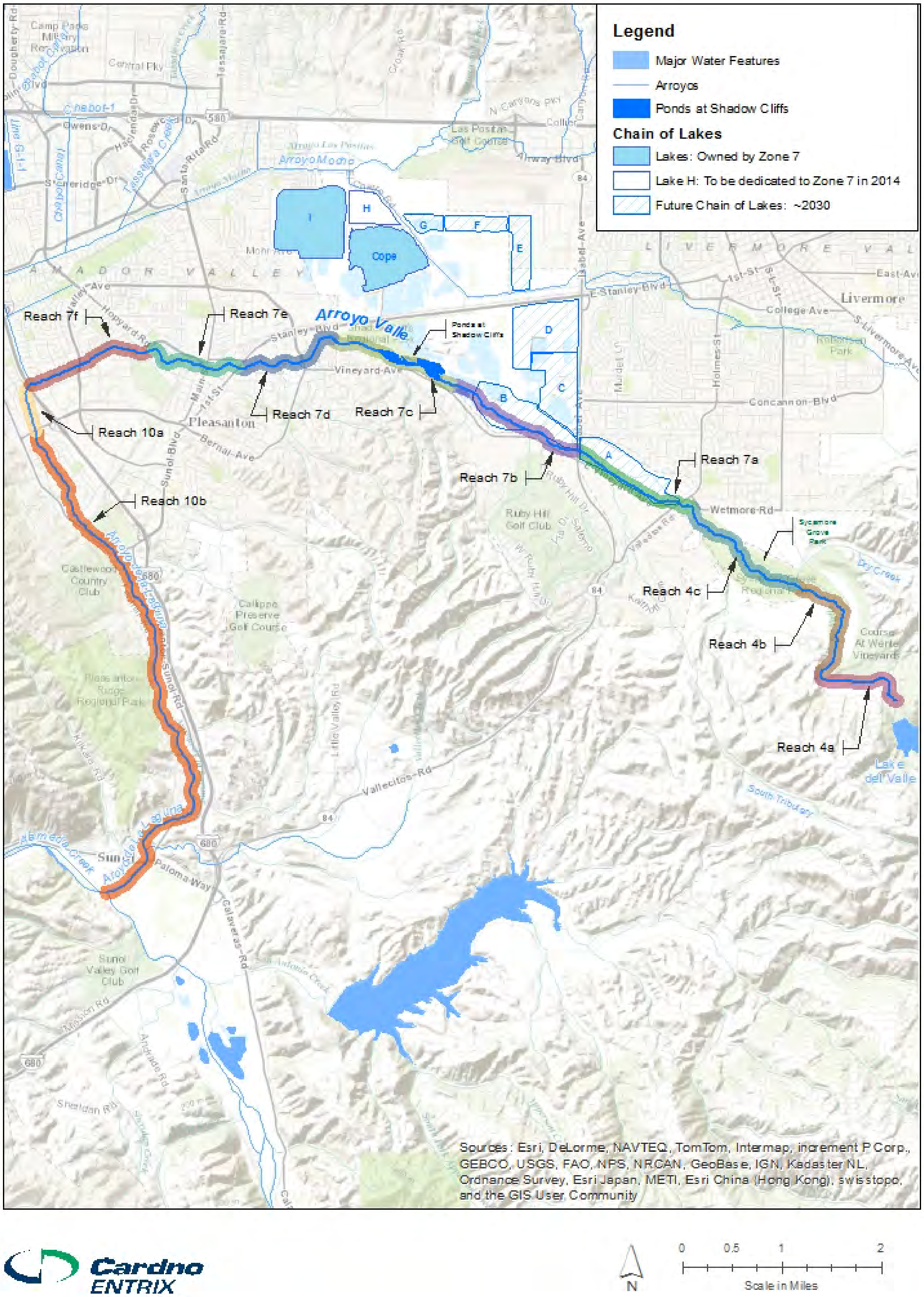

Figure A-2 Location of Study Reaches along Arroyo de Valle and Arroyo de la Laguna

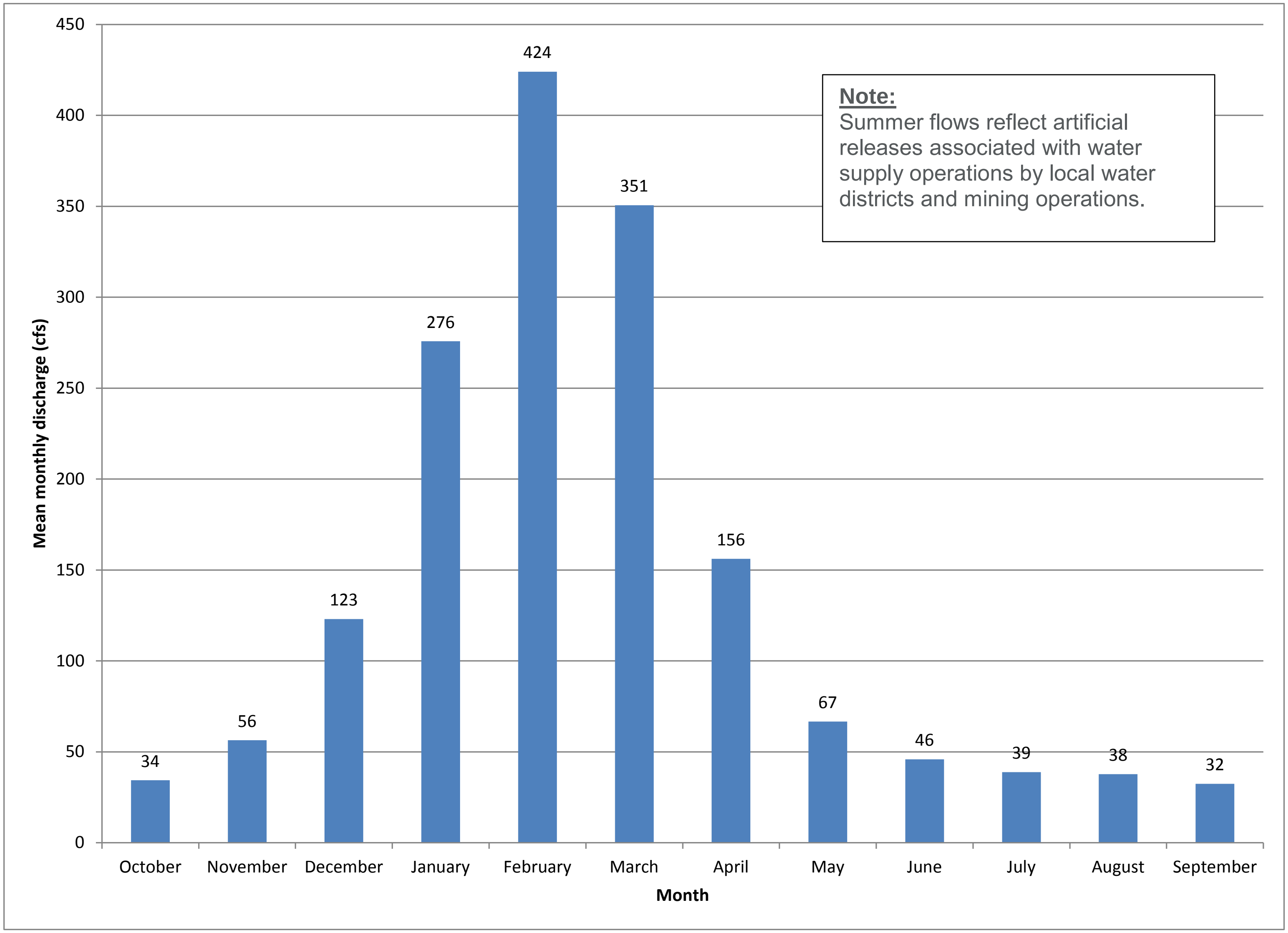

Figure A-3 Mean Monthly Flow for Alameda Creek at Niles Canyon, USGS Gauge # 11179000 (1969-2011)

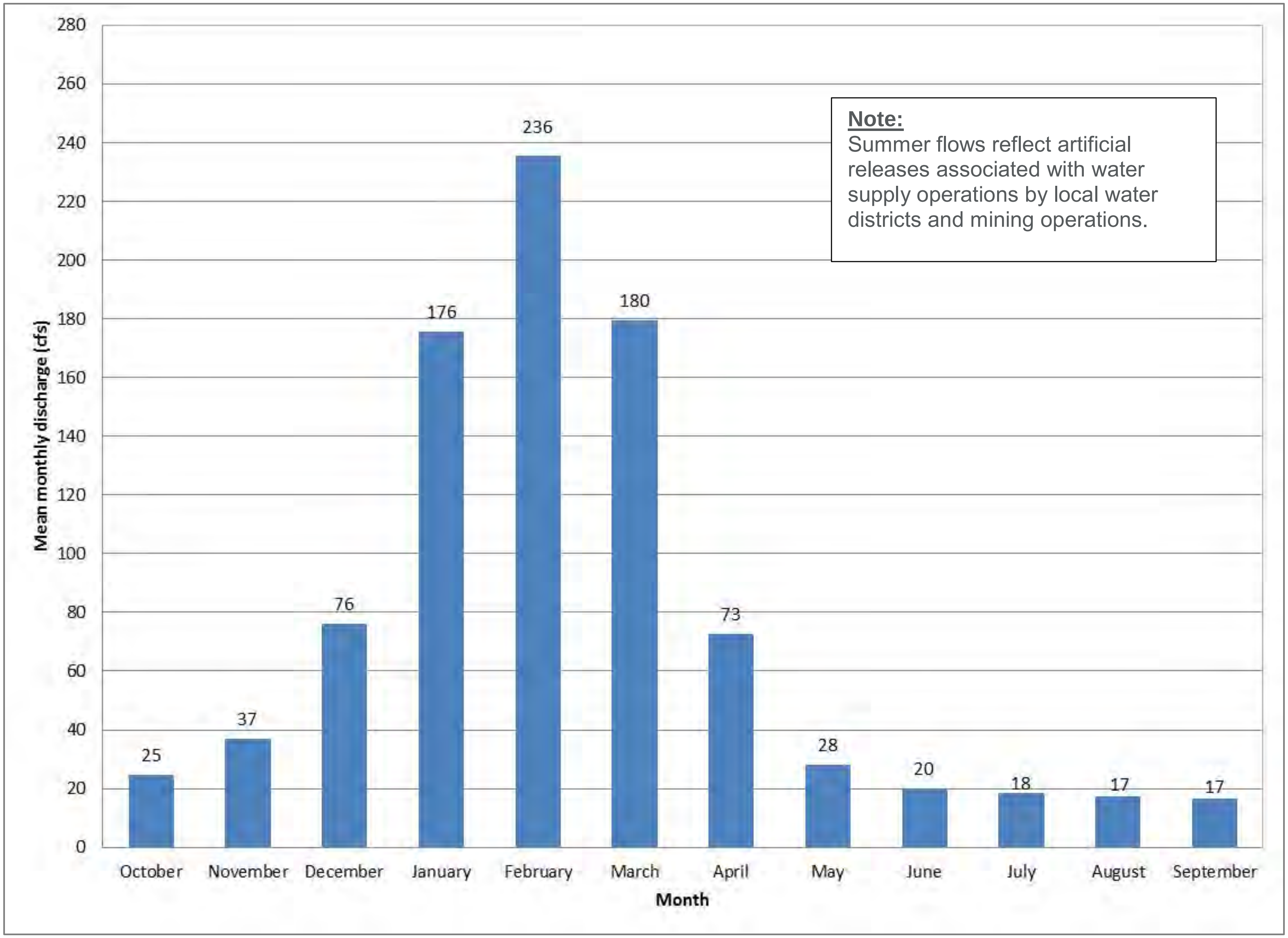

Figure A-4 Mean Monthly Flow for Arroyo de la Laguna at Verona, USGS Gauge # 11176900 (1969-2011)

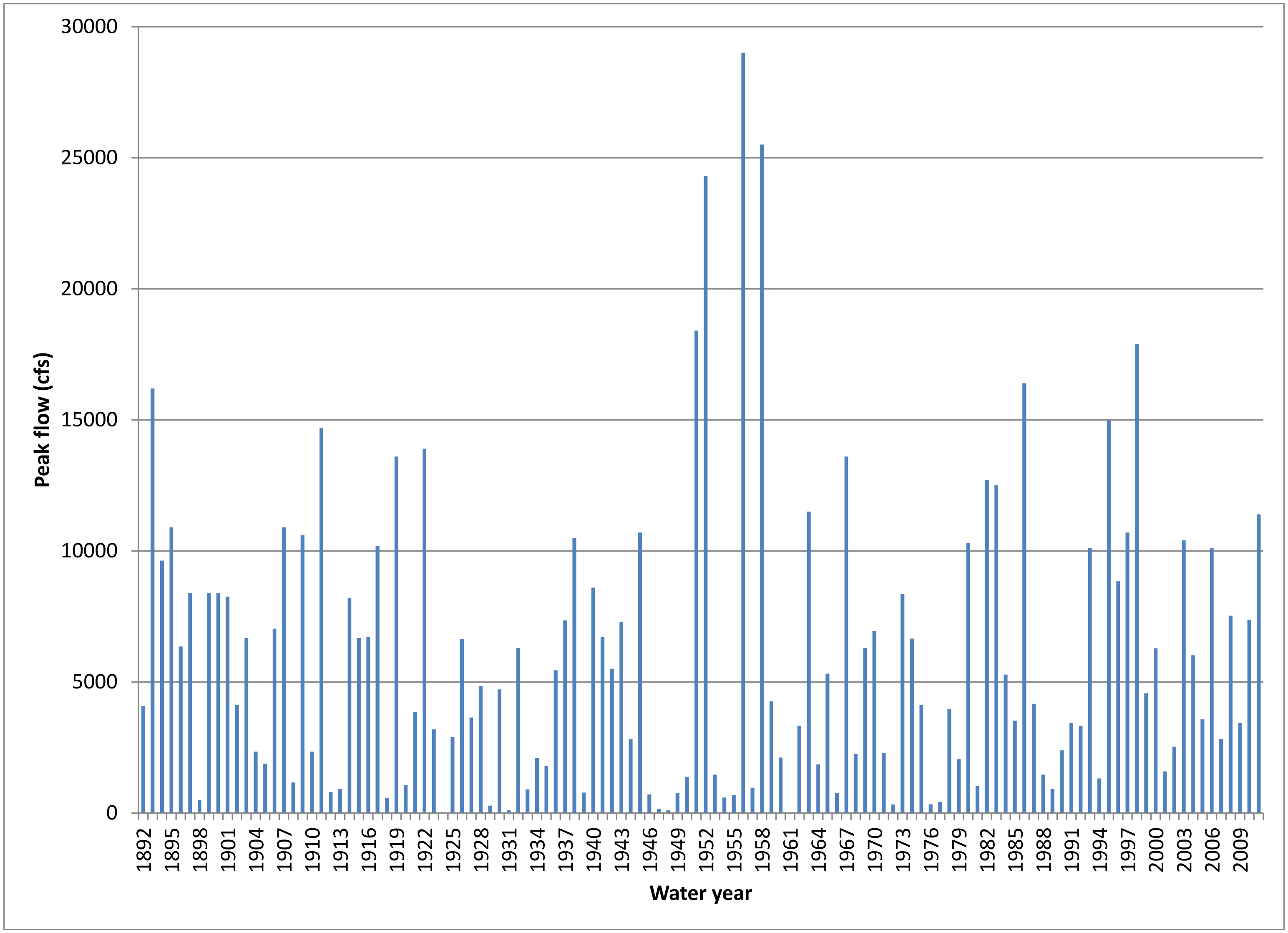

Figure A-5 Peak Flows for Alameda Creek at Niles Canyon, USGS Gauge # 11179000 (1892-2011)

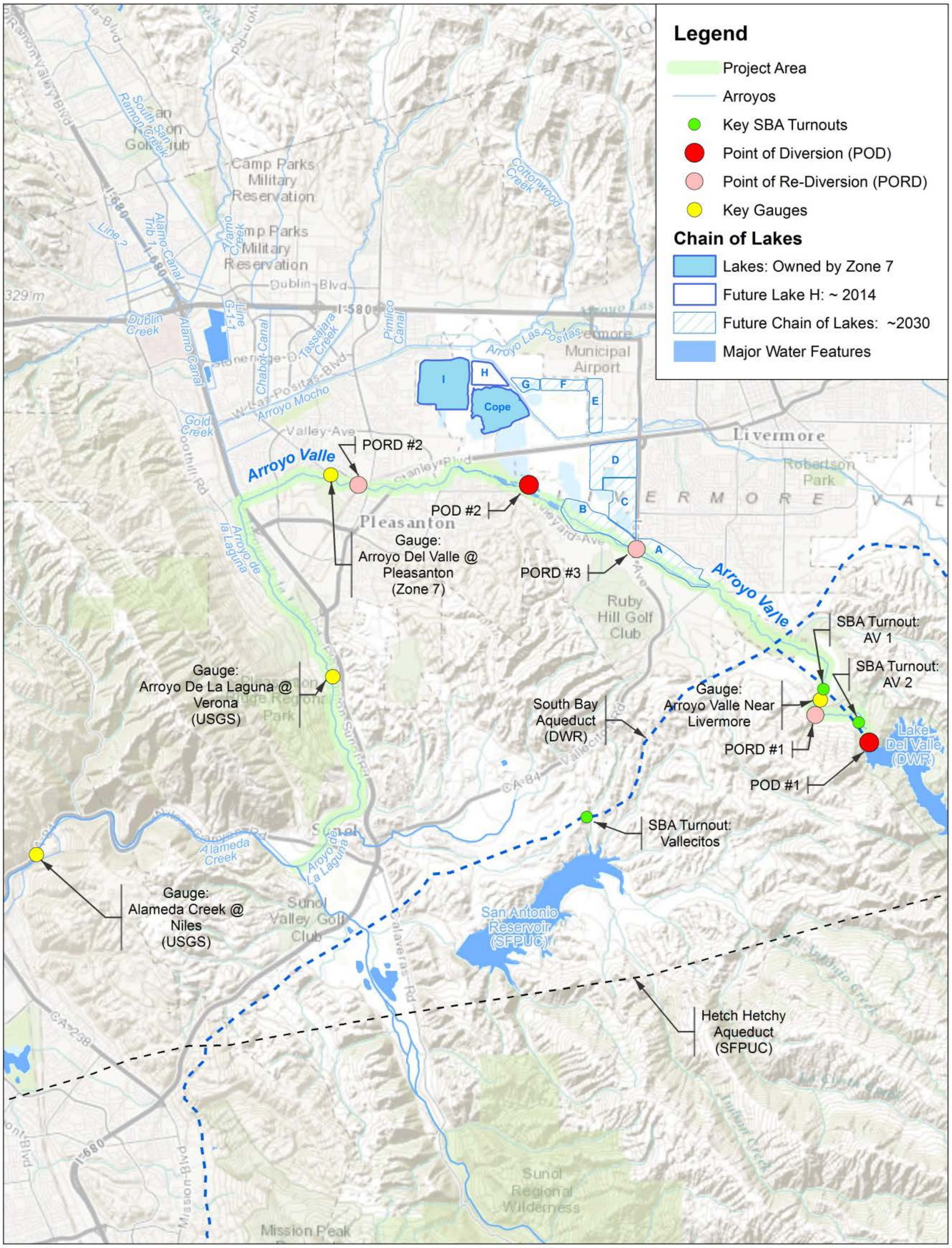

Figure A-6 **Location of Diversion Points and Stream Gauges along Arroyo del Valle and Arroyo de la Laguna**

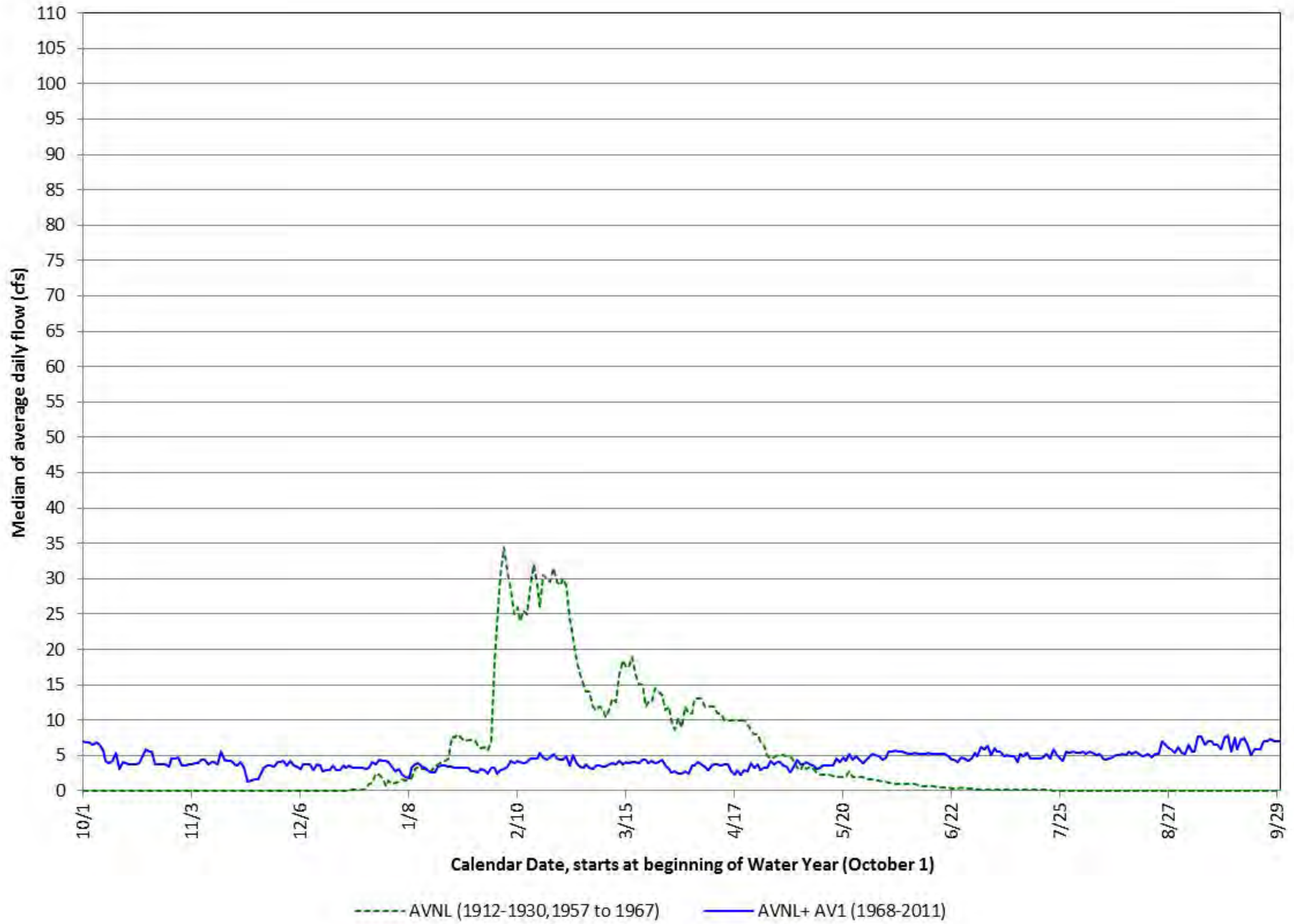

Figure A-7 Median Average Daily Flow for Arroyo del Valle near Livermore before and after Del Valle Dam

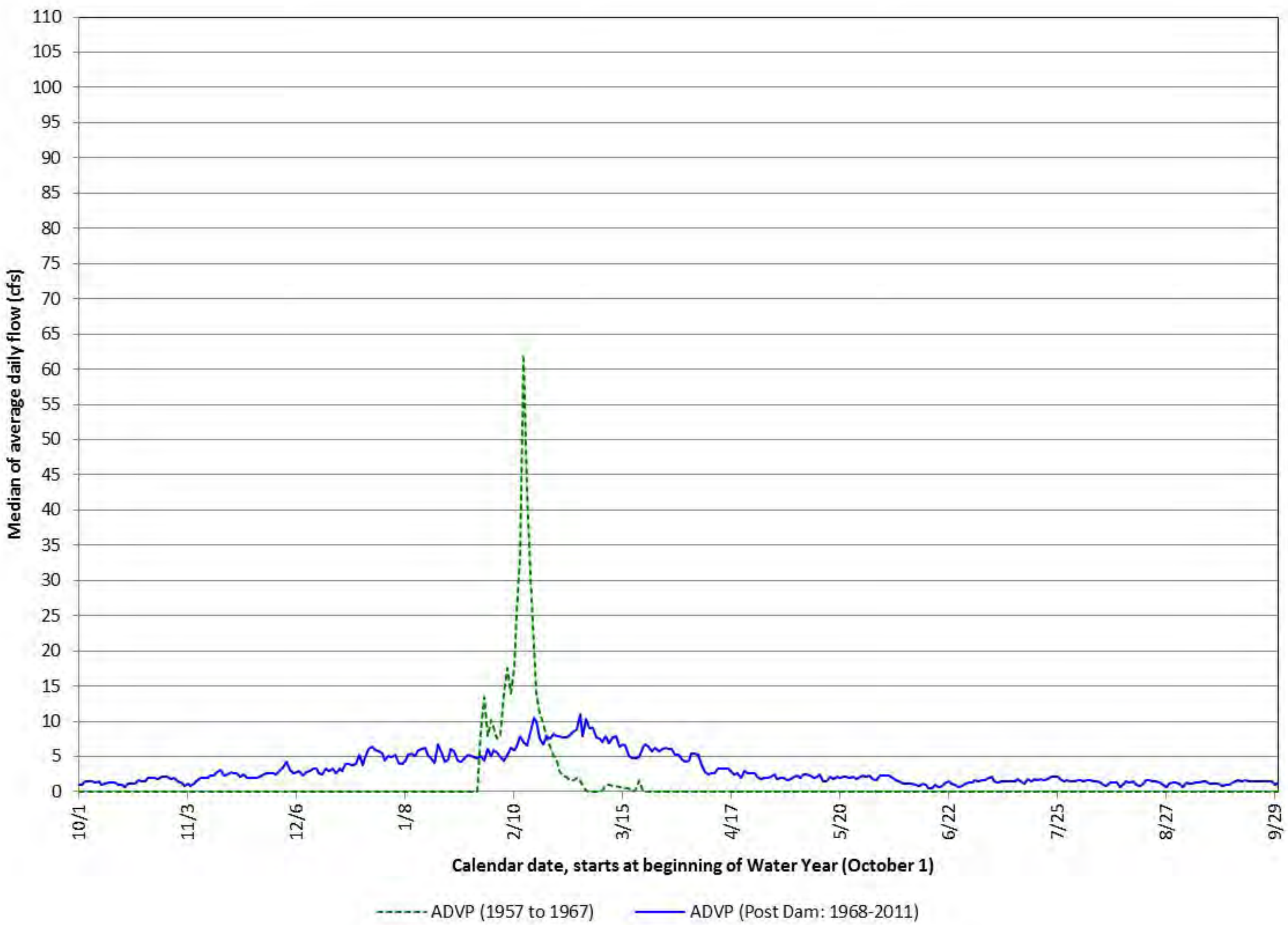

Figure A-8 Median Average Daily Flow for Arroyo del Valle near Pleasanton before and after Del Valle Dam

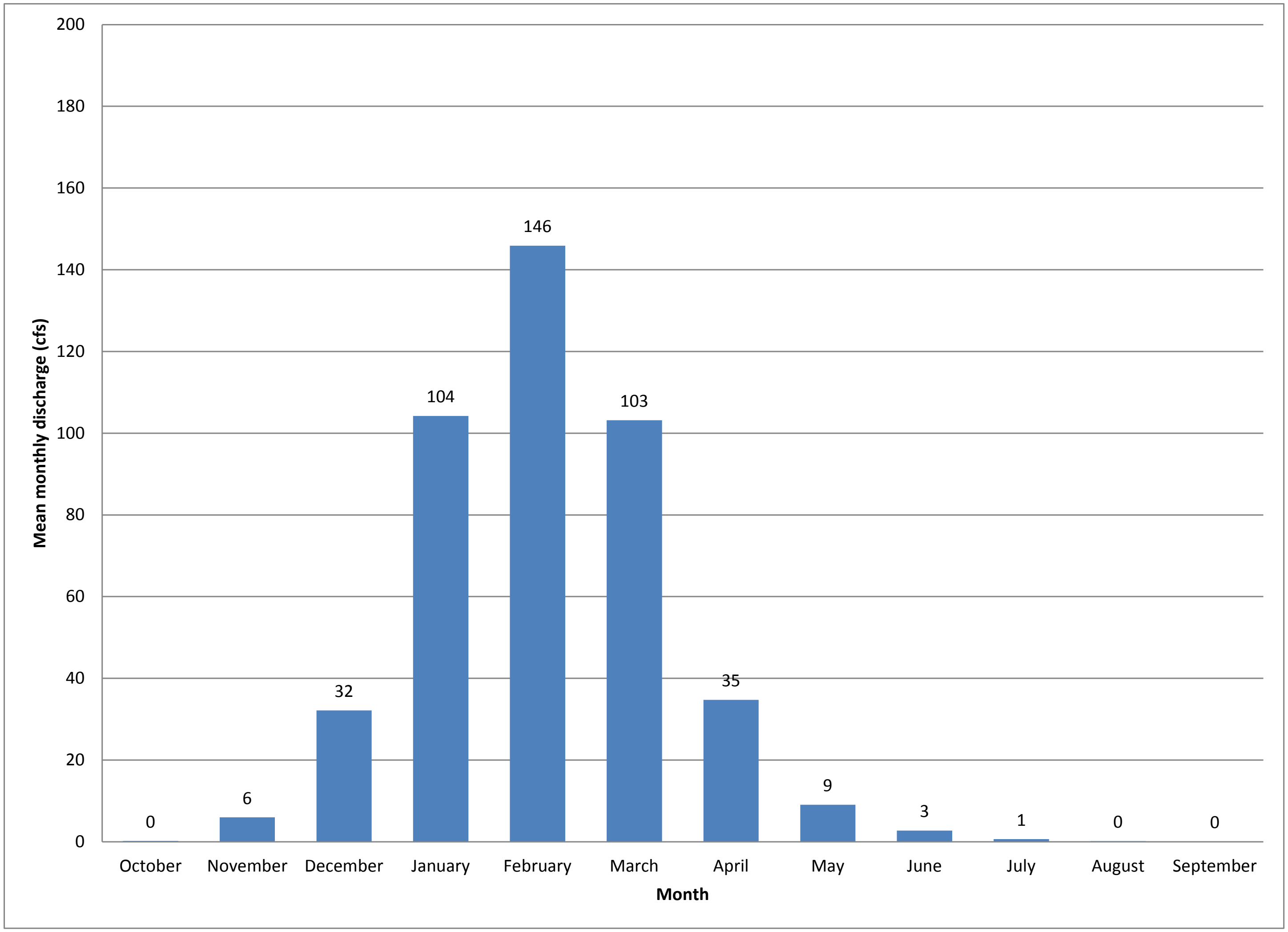

Figure A-9 Mean Monthly Flow for Arroyo del Valle below Lang Canyon, USGS Gauge # 11176400 (1969-2011) above Lake Del Valle

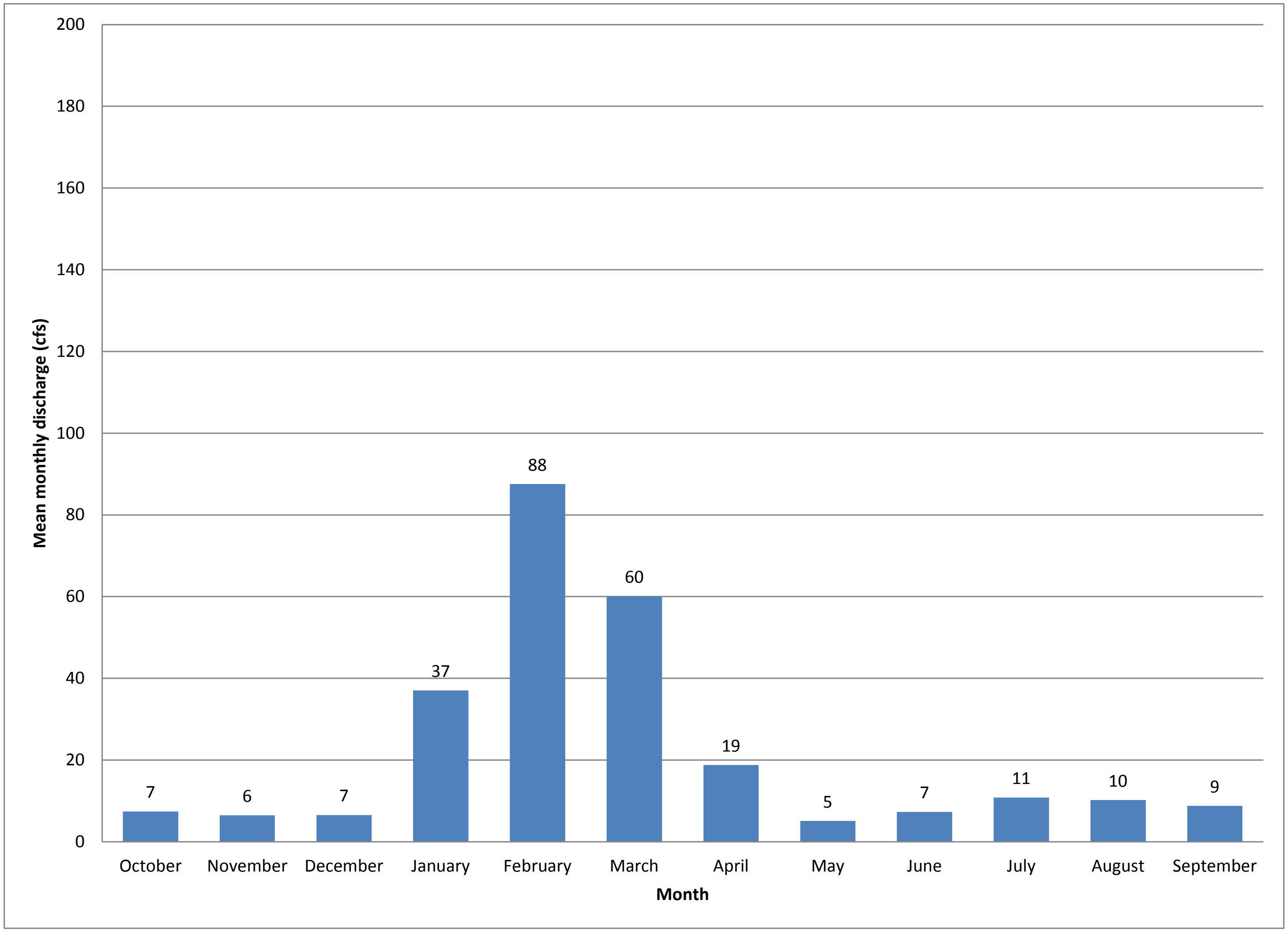

Figure A-10 Mean Monthly Flow for Arroyo del Valle at Livermore, USGS Gauge #11176500 (1969-2011) below Lake Del Valle

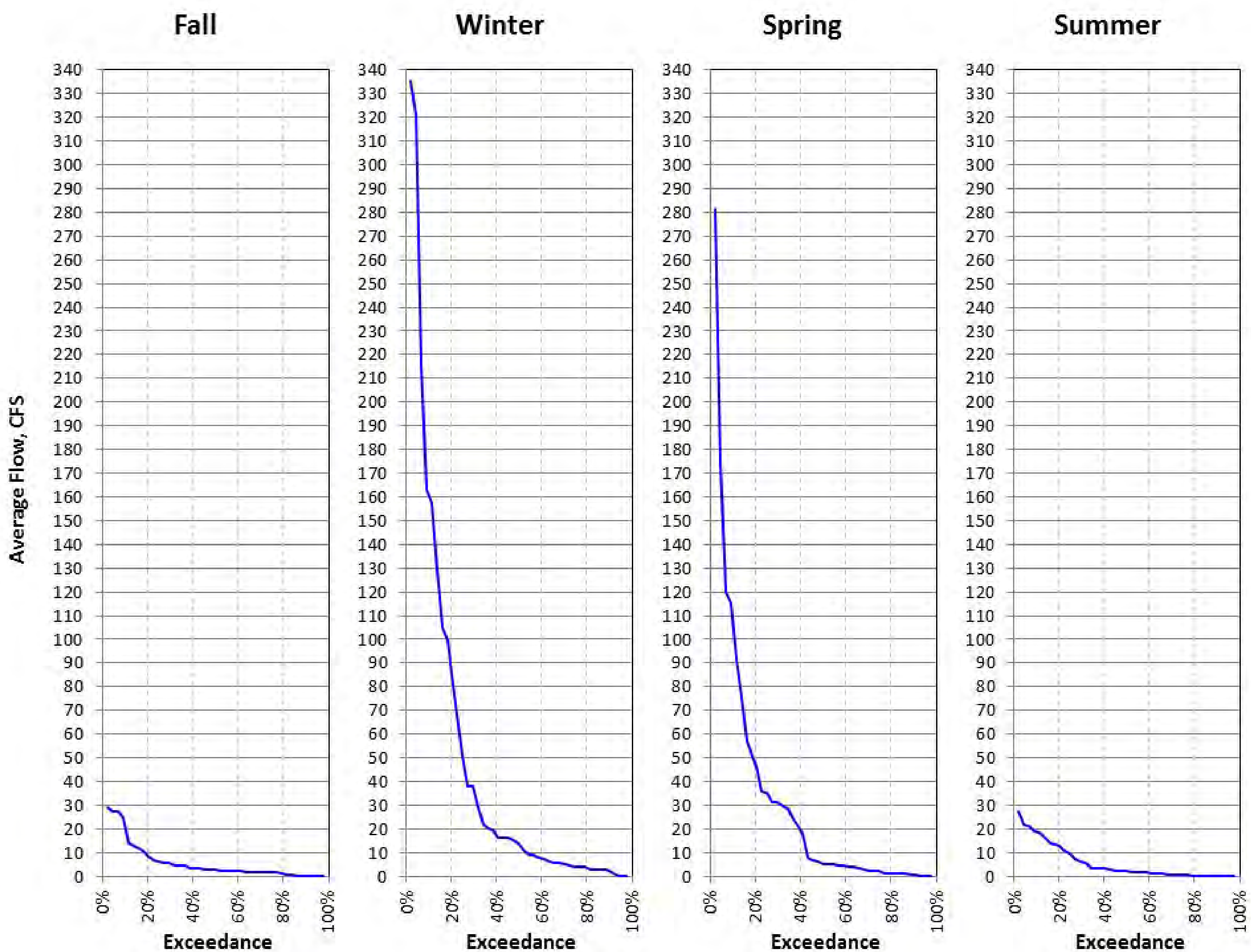

Figure A-11 Seasonal Exceedence Flow for Arroyo del Valle near Pleasanton (1968-2011)

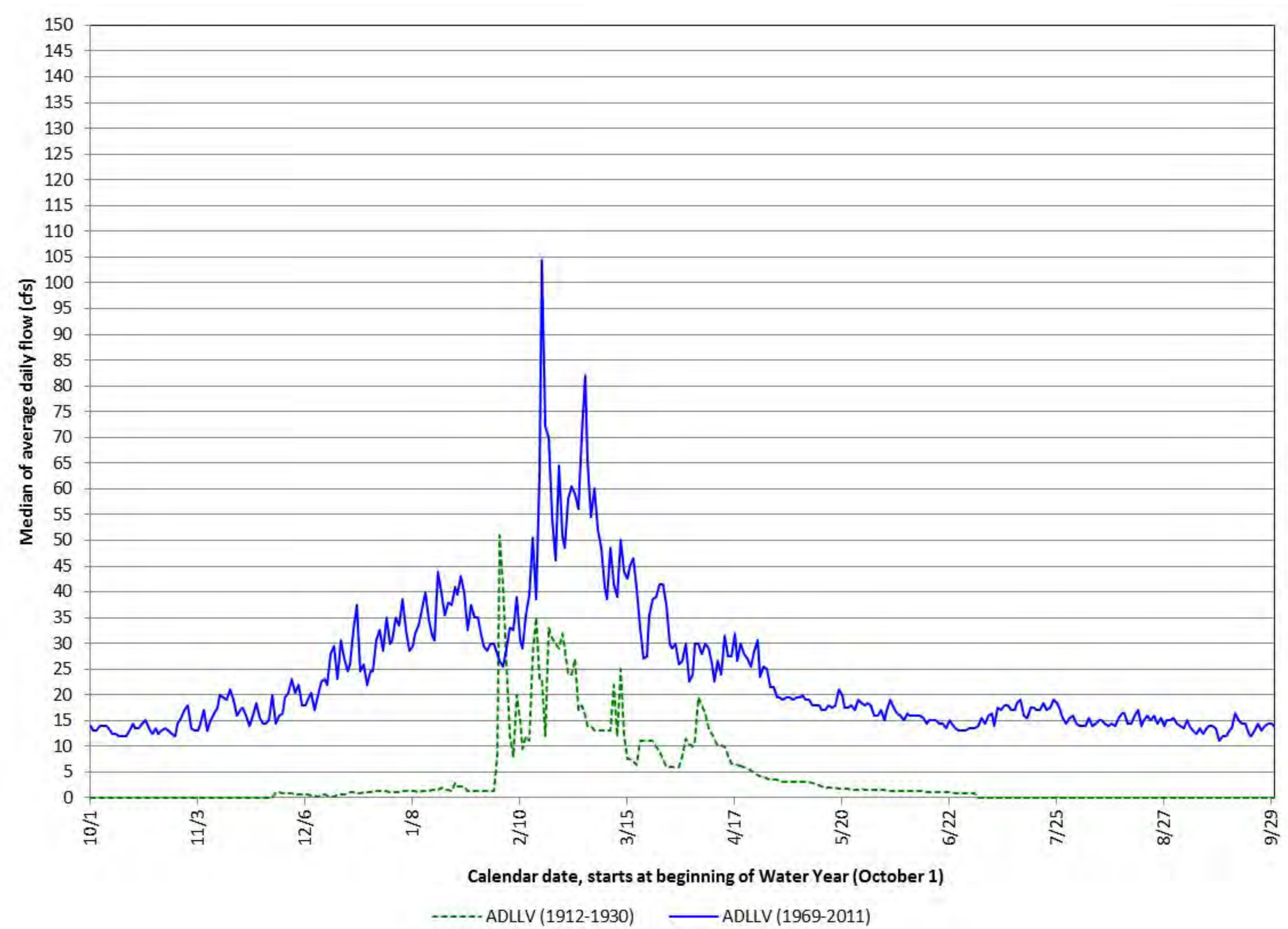

Figure A-12 Median Average Daily Flow for Arroyo de la Laguna at Verona before and after Water System Development and Flood Protection

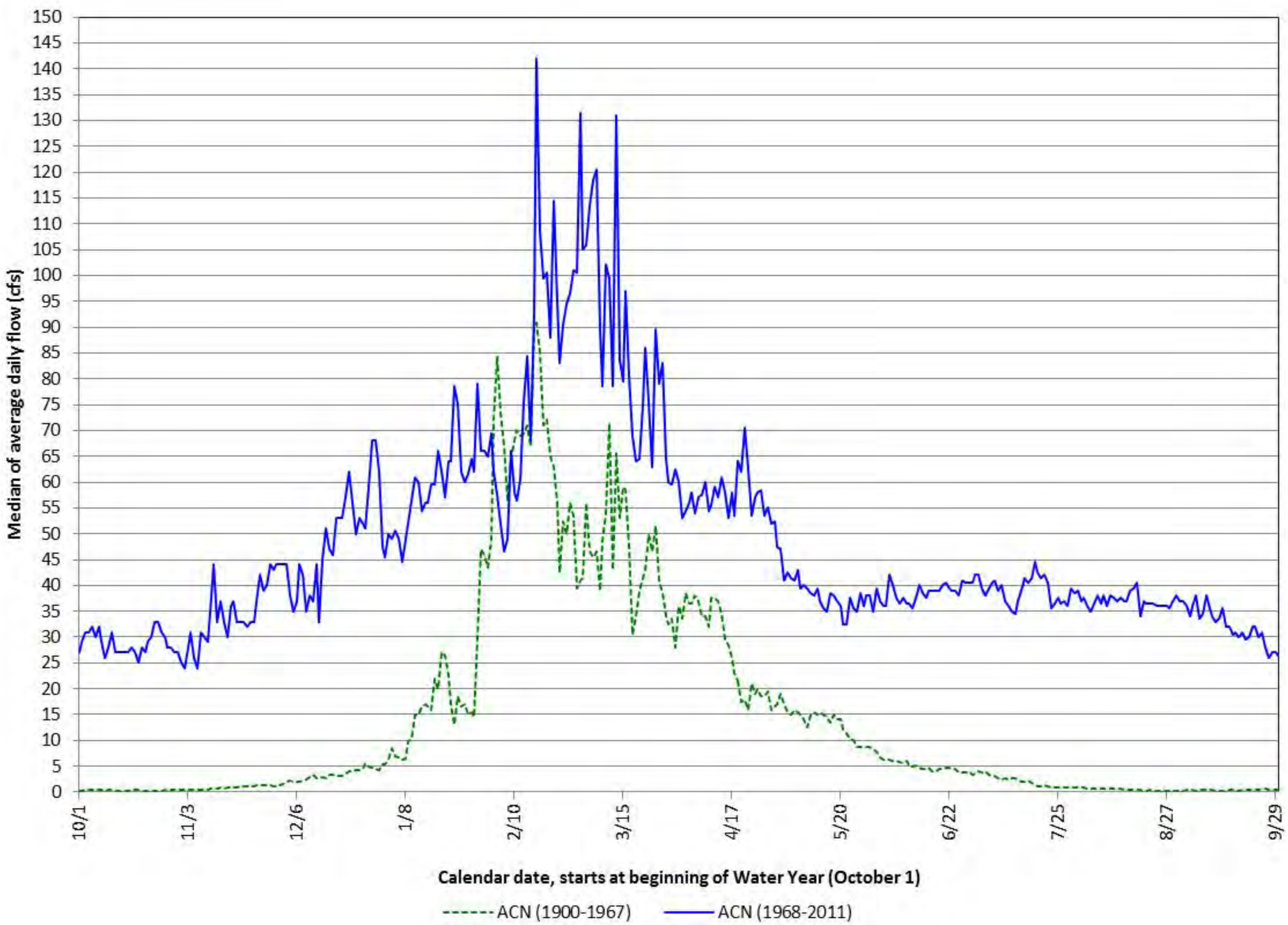

Figure A-13 Median Average Daily Flow for Alameda Creek at Niles before and after Water System Development and Flood Protection

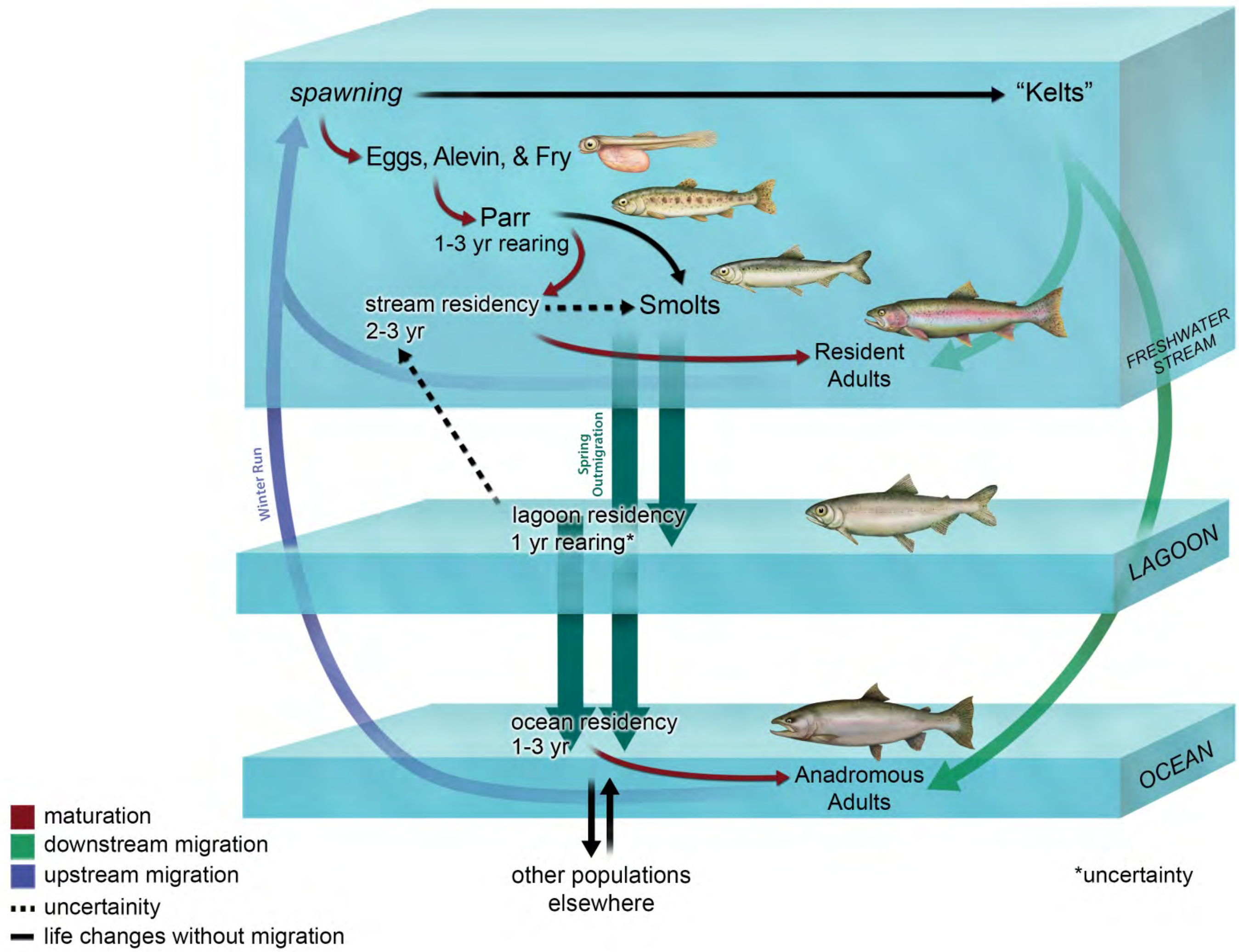

Figure A-14 Generalized Steelhead Life Cycle

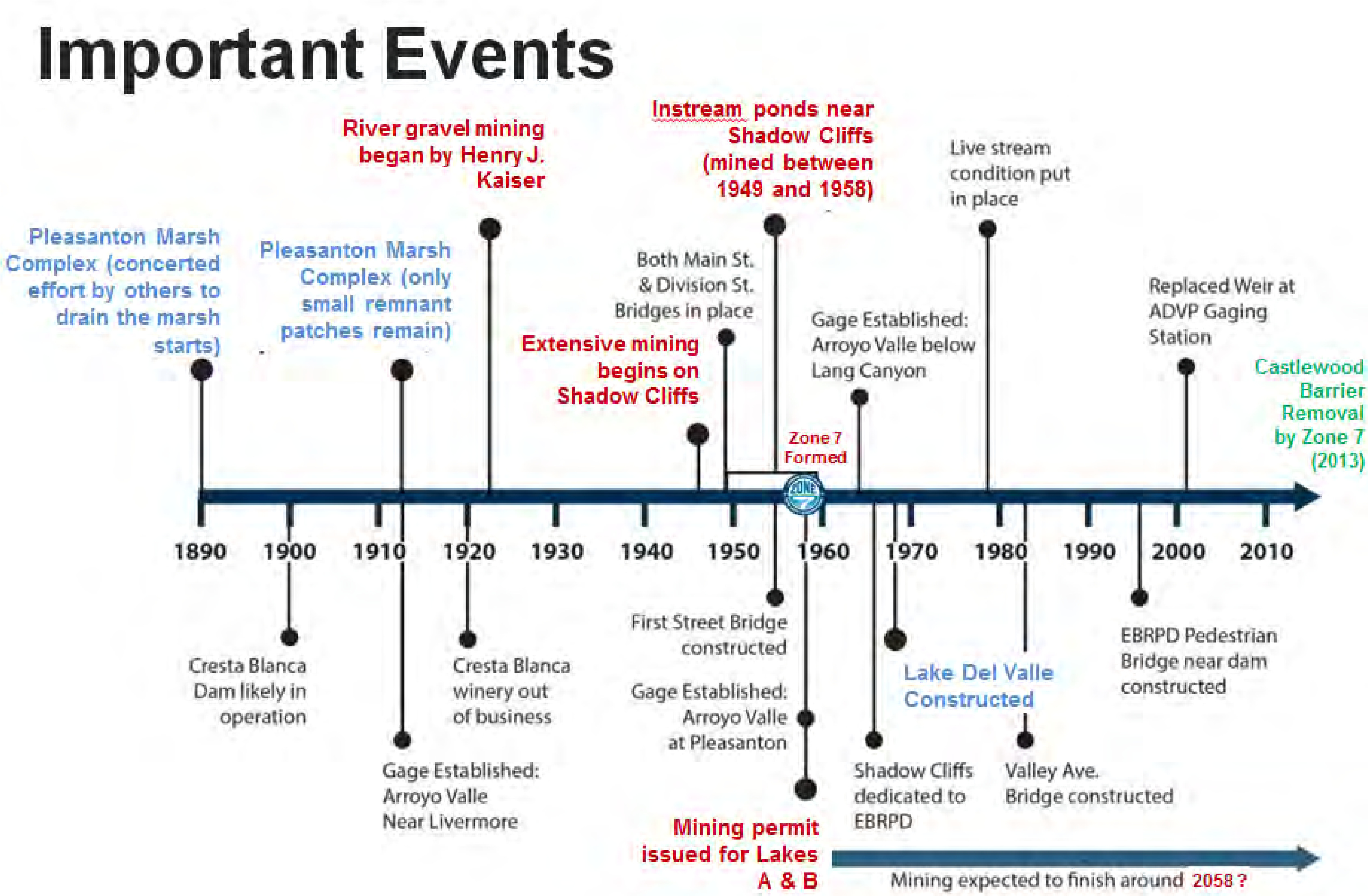

Figure A-15 Arroyo del Valle Historical Timeline of Geomorphic and Hydrologic Changes

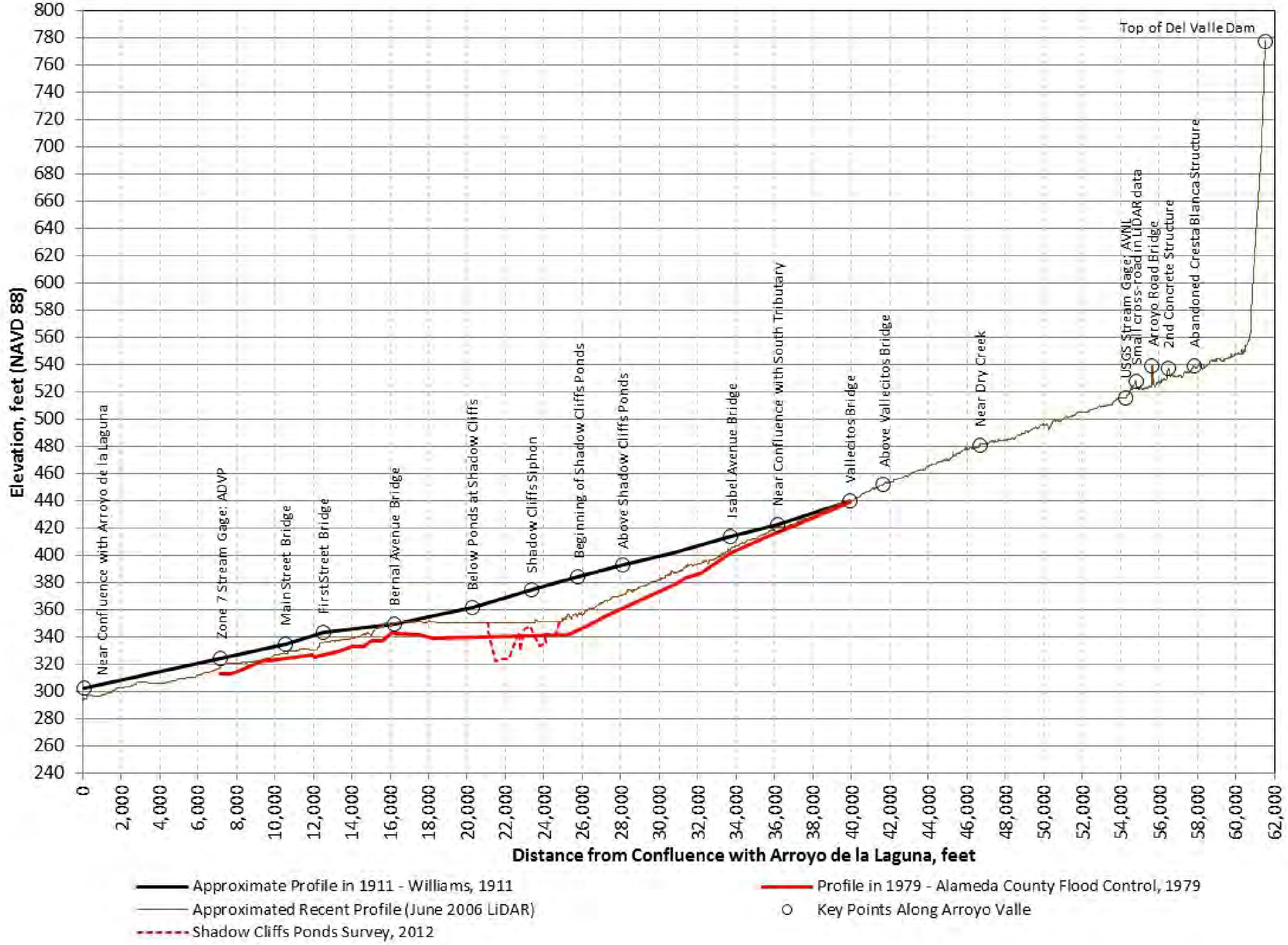

Figure A-16 Historical and Recent Longitudinal Profiles along Arroyo del Valle

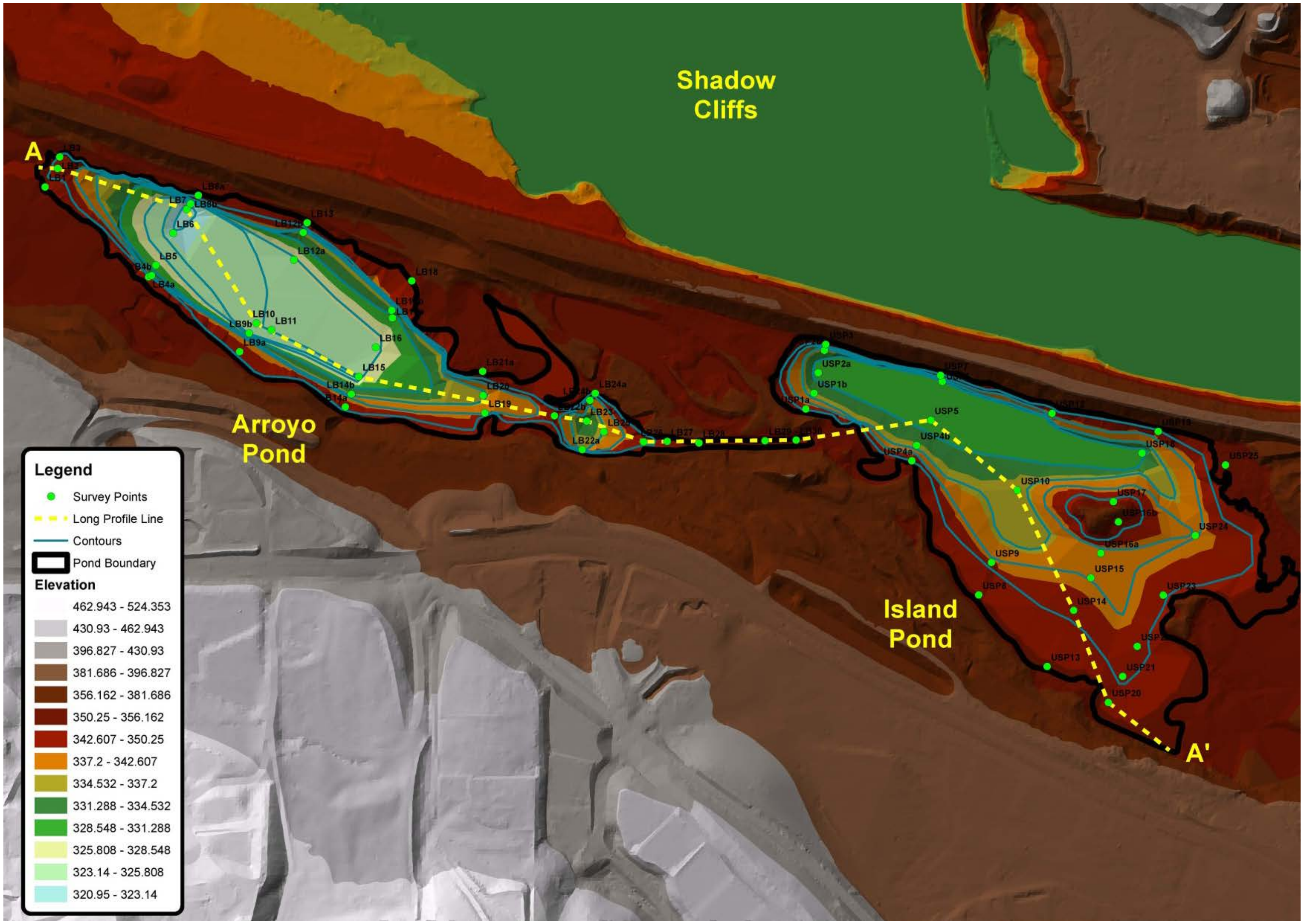

Figure A-17 Recent Bathymetric Data of Shadow Cliff Ponds

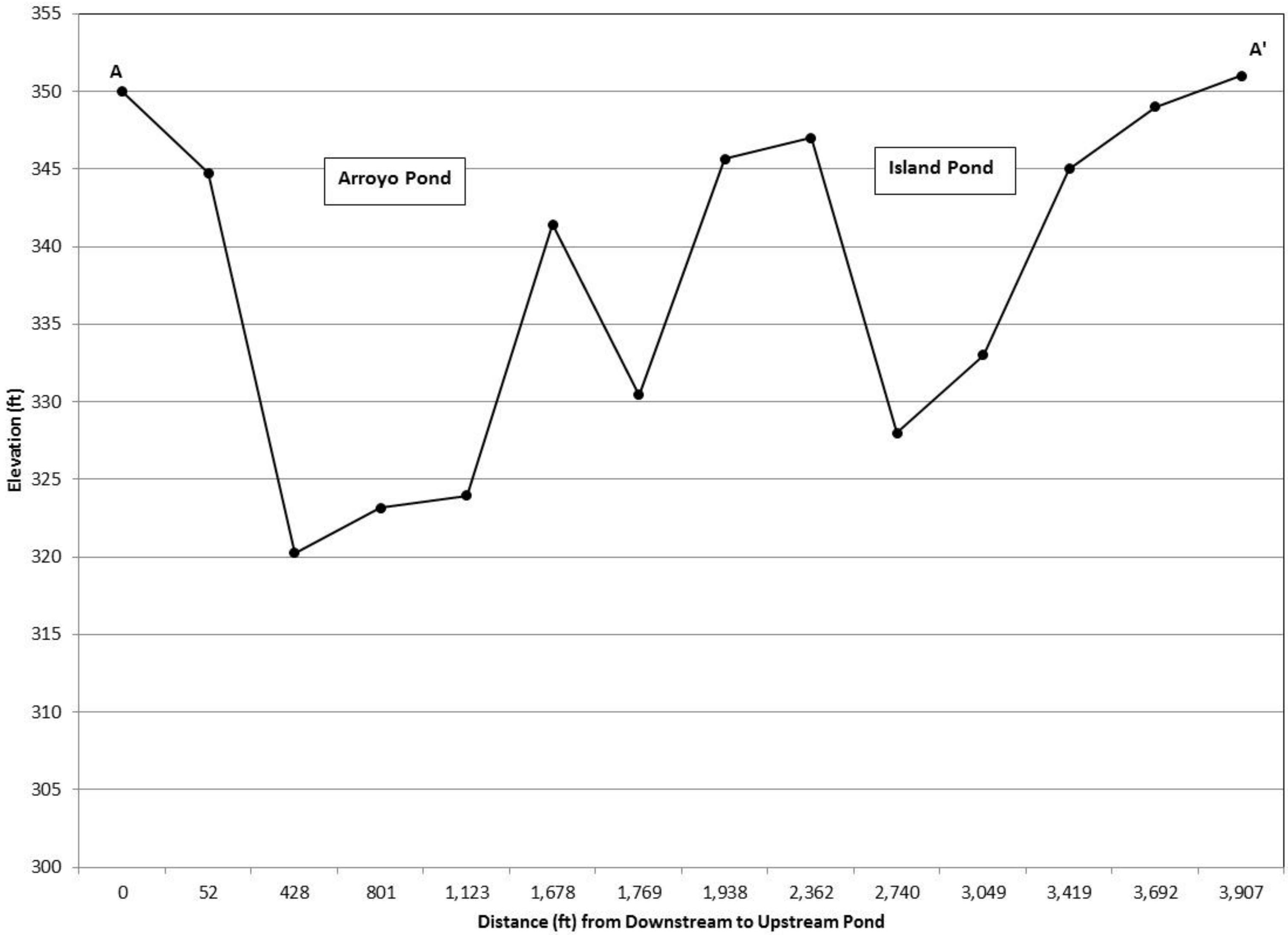

Figure A-18 Longitudinal Profile through Shadow Cliff Ponds along the center line

Figure A-19 Location of Study Reaches, Temperature Dataloggers, and Potential Barriers along Arroyo del Valle and Arroyo de la Laguna

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Figure A-20 Reach 4a

Figure A-21 Instream Structures on Arroyo del Valle in Reach 4a

Note: See Figure 3 for locations.

Figure A-22 Reach 4b

Figure A-23 Reach 4c

Figure A-24 Reach 7a

Figure A-25 Reach 7b

Figure A-26 Reach 7c

Figure A-27 Reach 7d

Figure A-28 Reach 7e


Figure A-29 Reach 7f


Figure A-30 Reach 10a


Figure A-31 Reach 10b

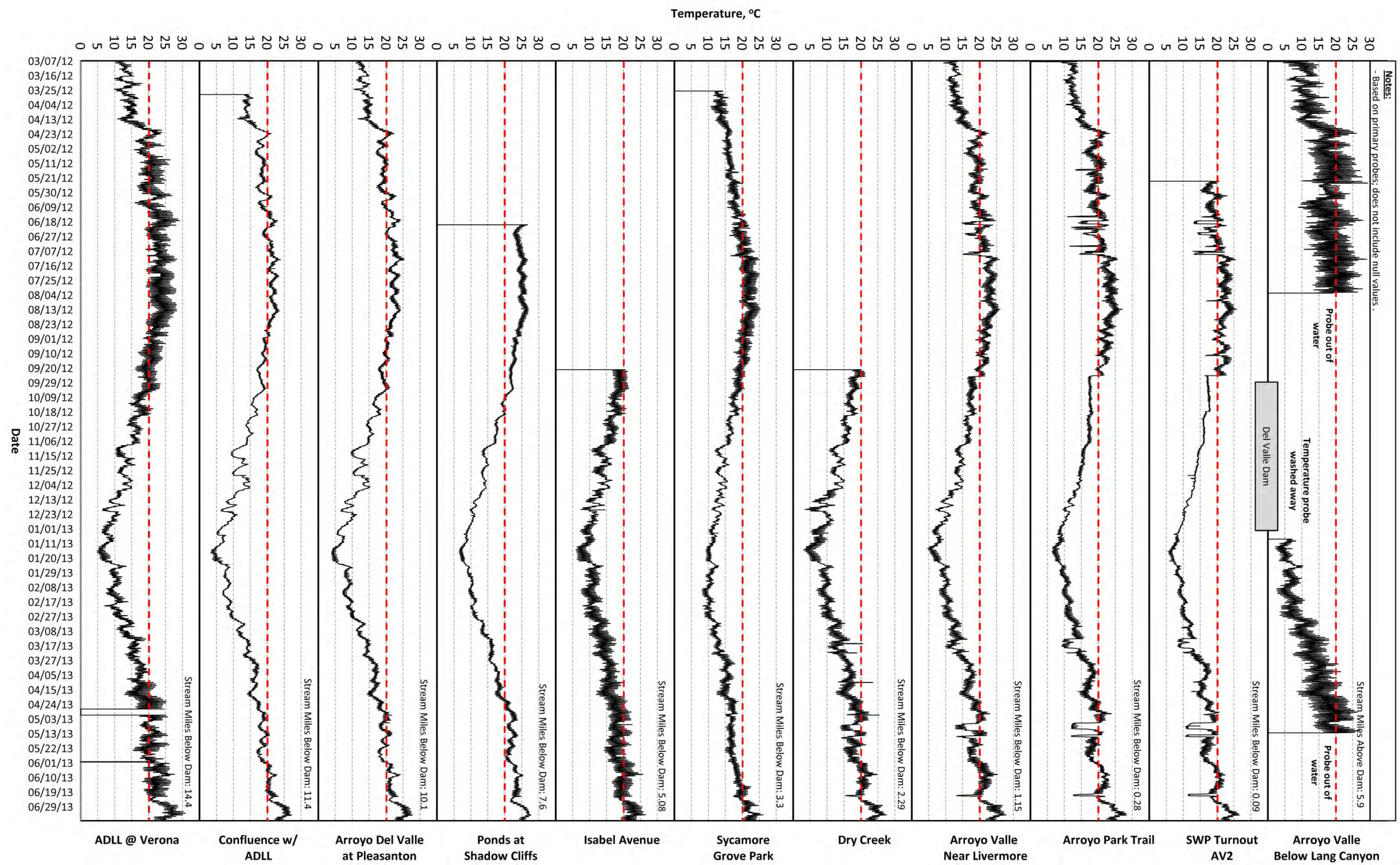

Figure A-32 Instantaneous Temperatures along the Study Area, from upstream above Lake Del Valle to the Verona Bridge on Arroyo de la Laguna

Notes: See Figure 19 for probe locations.

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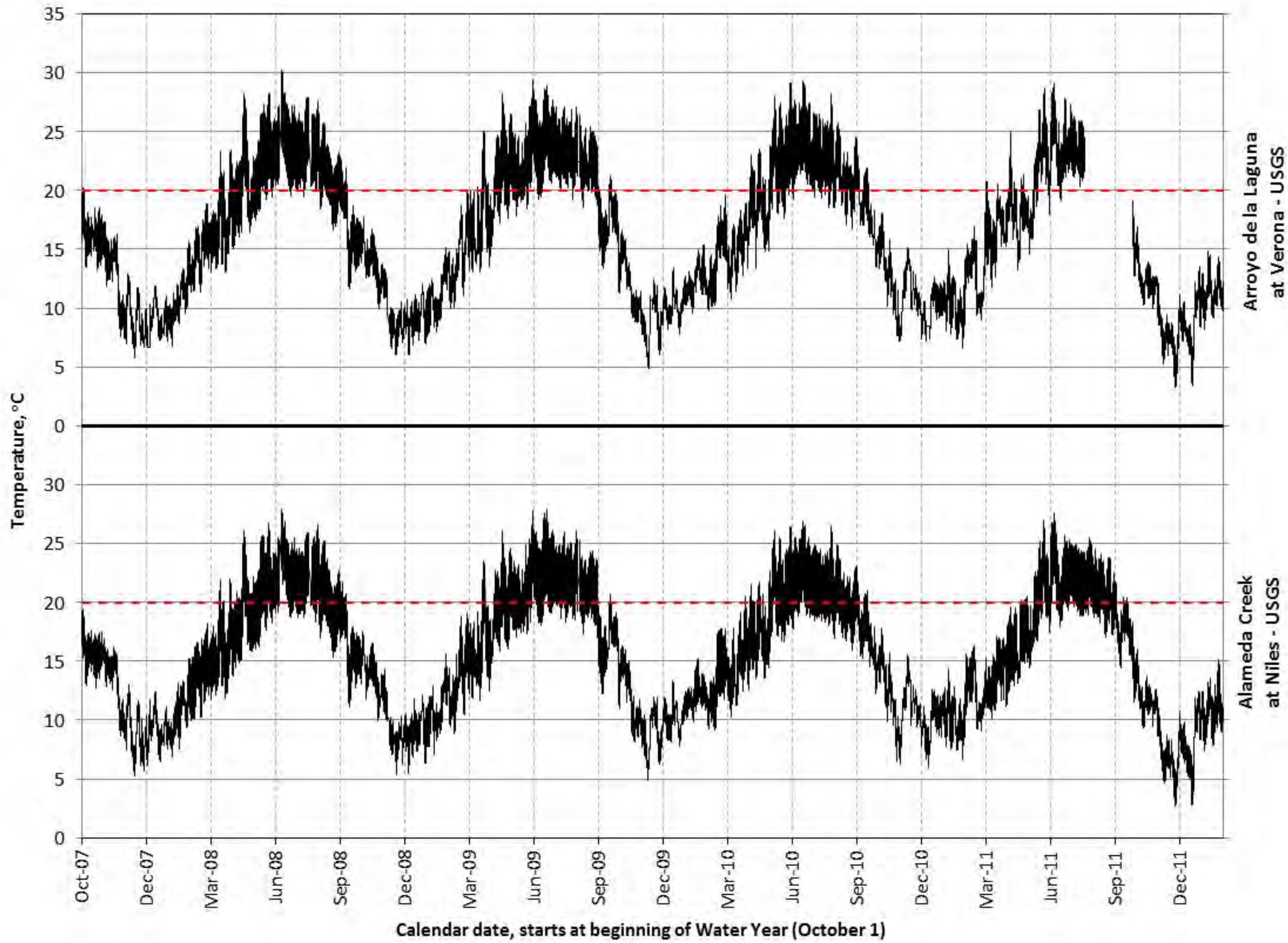

Figure A-33 Available Historical Instantaneous Water Temperatures from the USGS: 10/1/2007 to 3/1/2012

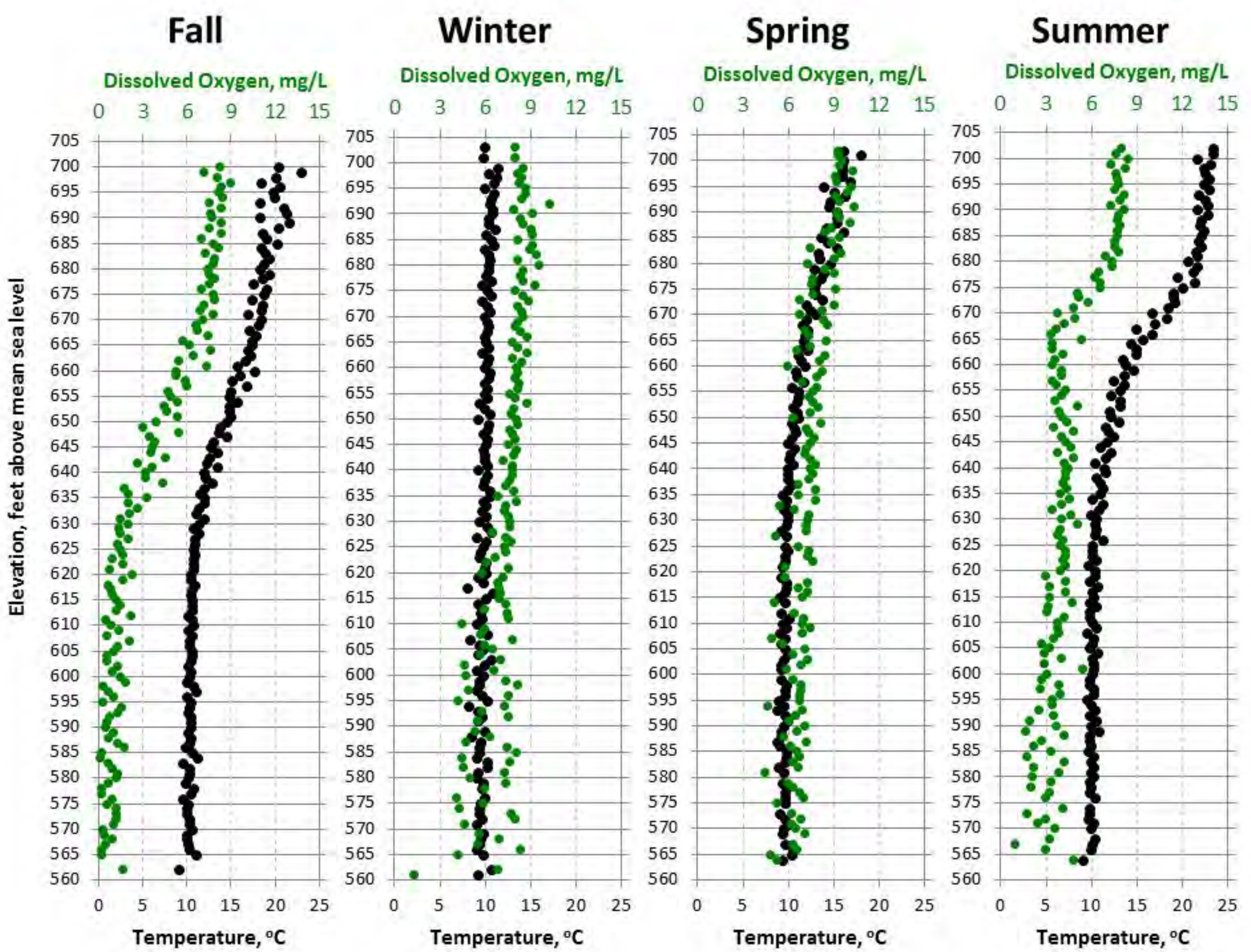

Figure A-34 Seasonal Water Temperature and Dissolved Oxygen profiles of Lake Del Valle (1988-2011) showing temperature at release points (630 and 650 ft above mean sea level)

Source: Department of Water Resources; results based on averaging the temperatures and dissolved oxygen for each depth and each season.

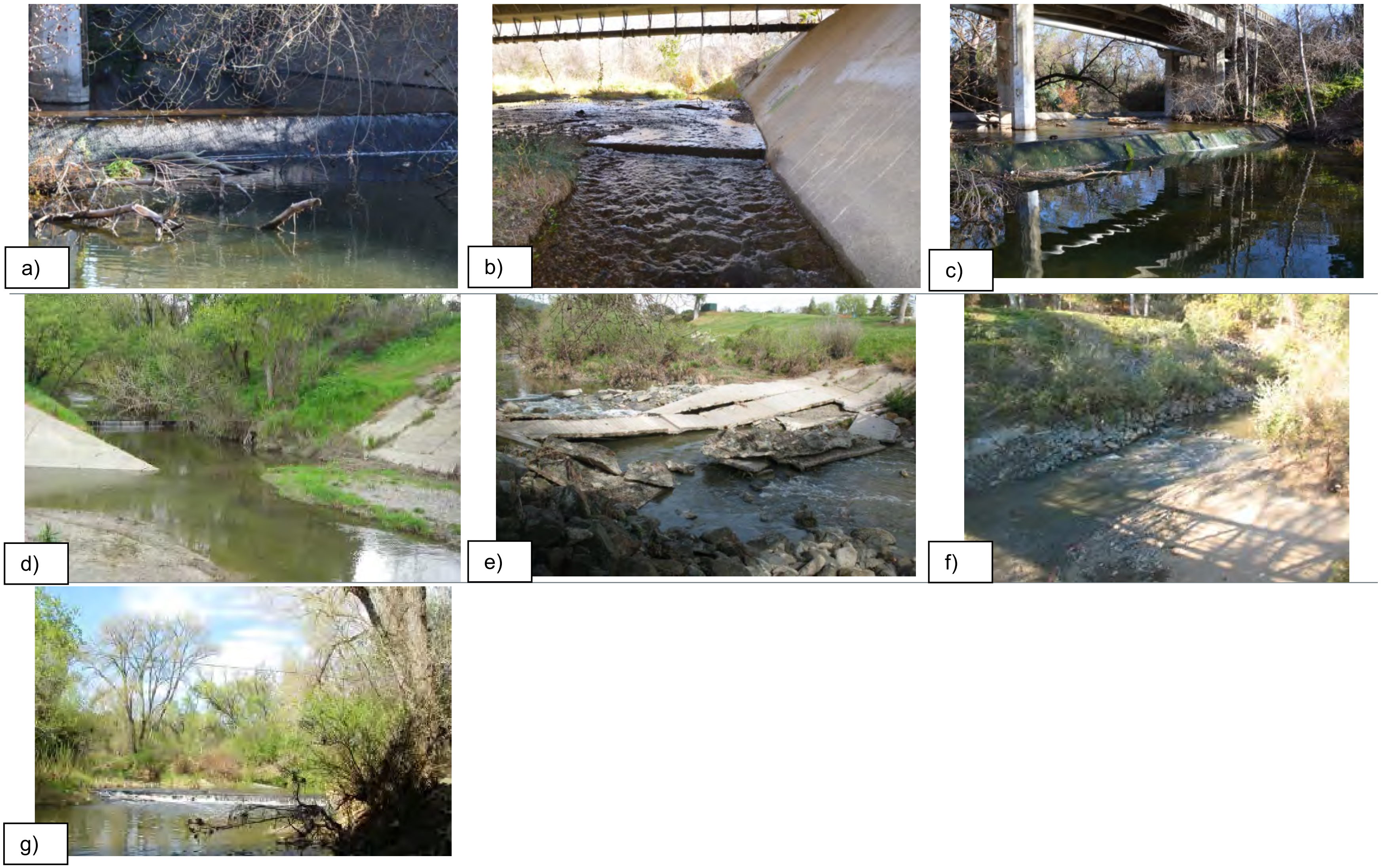

Figure A-35 **a) Main Street/Santa Rita Road b) Stanley Boulevard, c) Division Street Bridge, d) Arroyo del Valle/Arroyo de la Laguna Confluence, e) Castlewood Golf Course (before barrier removal), f) Castlewood Golf Course (after barrier removal), g) Highway 84 Pipeline Crossing**

Source: Photos taken from Valley and Mountain Associates 2007.

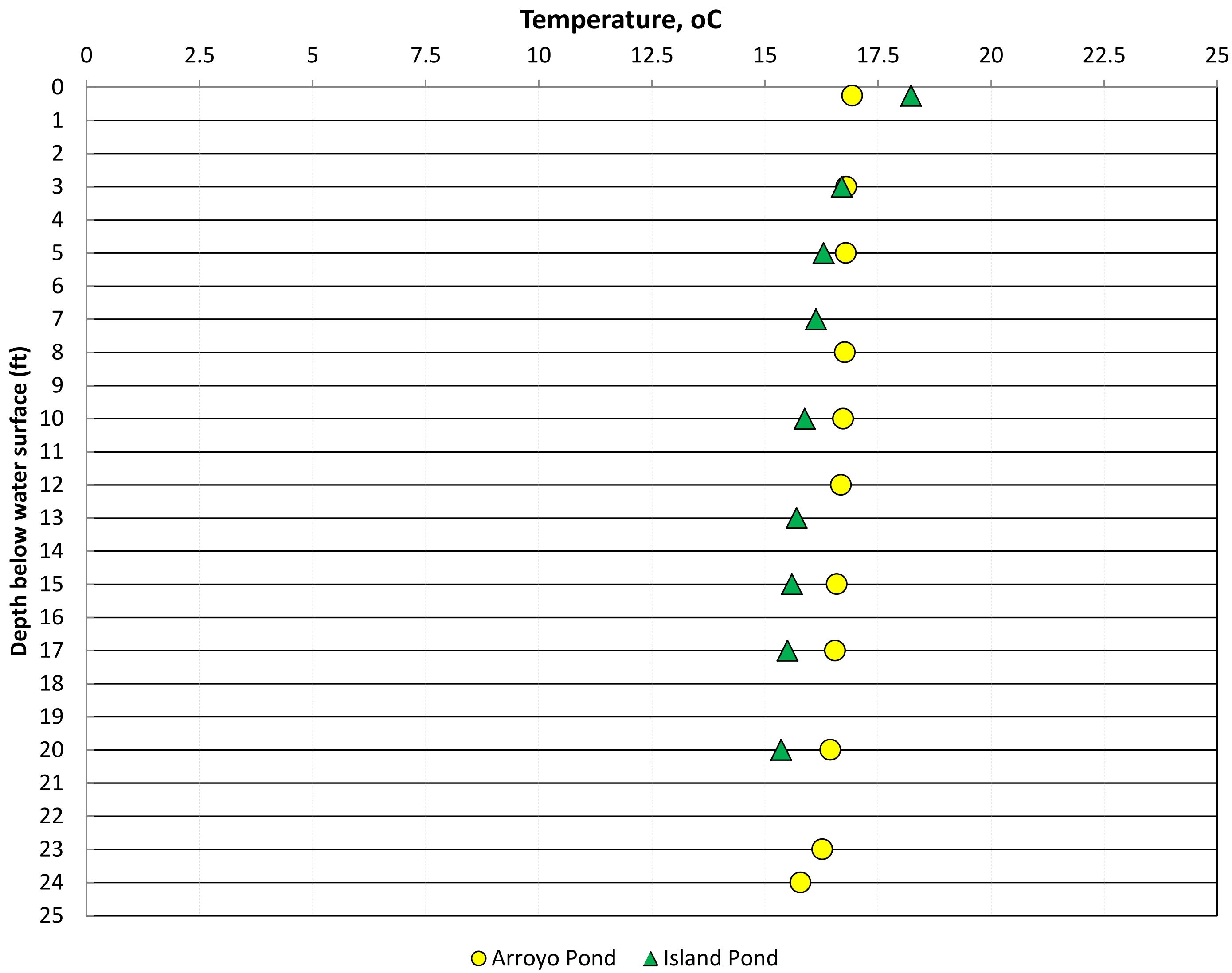

Figure A-36 Vertical Temperature Profile of Island and Arroyo Ponds in Shadow Cliffs Regional Recreation Area

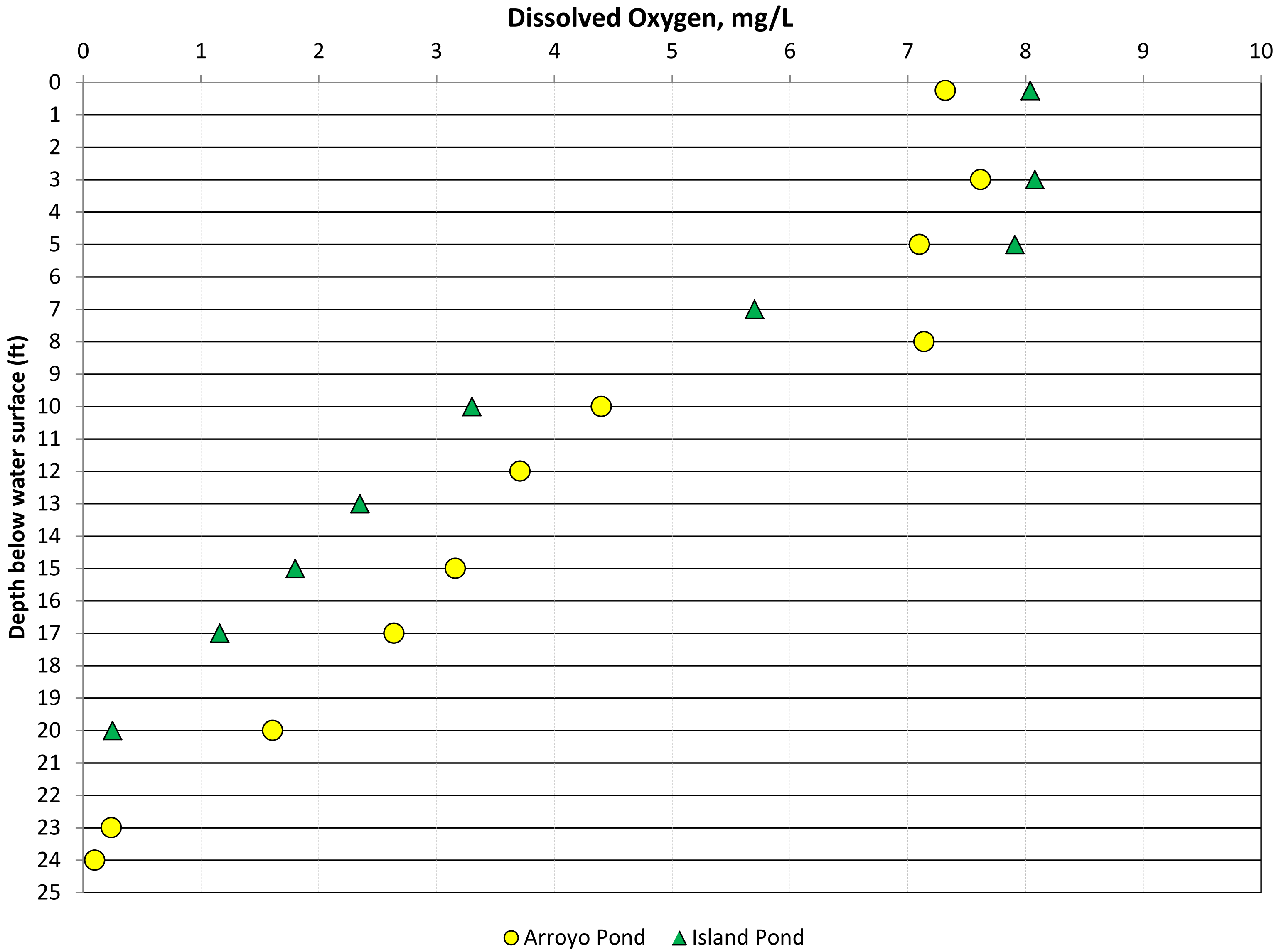

Figure A-37 **Vertical Profile of DO Concentration in Island and Arroyo Ponds in Shadow Cliffs Regional Recreation Area**

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Arroyo del Valle and Arroyo de la Laguna Steelhead Habitat Assessment

ATTACHMENT 1

SUMMARY OF WATER OPERATIONS ALONG ARROYO VALLE

Memorandum

Date: September 6, 2013

To: File

From: Brad Ledesma, Sal Segura, Jarnail Chahal

Subject: Summary of Water Operations along Arroyo Valle

Releases from Lake Del Valle or the SBA (SBA), along with natural runoff and gravel mining discharges, account for the majority of water in Arroyo Valle, downstream of Lake Del Valle. The purpose of this memorandum is to provide a brief description of water operations along Arroyo Valle to help facilitate review and discussion of the fisheries and amphibian habitat information collected along Arroyo Valle and Arroyo de la Laguna.

The following topics will be covered:

- Operation of Lake Del Valle
- Mining Discharges
- Operation of Shadow Cliffs

Figure 1 presents the location of key points along Arroyo Valle, Arroyo de la Laguna, and Alameda Creek discussed in this memorandum as they relate to water operations.

OPERATION OF LAKE DEL VALLE

Historical flooding along Arroyo Valle, Arroyo de la Laguna, and Alameda Creek, construction of the State Water Project in 1962, and the completion of the Del Valle dam in 1968, resulted in a reservoir built for flood control, recreation, and water supply purposes. The Department of Water Resources (DWR) owns and operates the lake,[1] while East Bay Regional Parks District (EBRPD) operates the recreational facilities.

Physical Description of Lake Del Valle and Release Points

Lake Del Valle has a 235-foot earthen dam, and can store 77,100 acre-feet (af) of water, but is normally operated so that it does not exceed storage levels above 40,000 af (see Attachment 1). DWR can make releases from Lake Del Valle, depending on need, through two outlets:

- Flood Control Gates (up to 7,000 cubic feet per second [cfs])
- Conservation Outlet Works (COW, up to 120 cfs)

All water released through the Flood Control Gates enters the Arroyo Valle at the flood outlet structure, while water released through the COW can be released via the Del Valle Branch Pipeline directly to the South Bay Aqueduct (SBA), or to the Arroyo Valle via to two smaller turnouts (AV #1 and #2). The Del Valle Branch Pipeline has a capacity of 120 cfs, while the capacity of AV #1 and #2 are 6 cfs and 120 cfs,

[1] DWR also owns and operates the SBA and Del Valle Branch pipeline.

respectively. DWR can also release State Water Project water from the SBA into the Arroyo Valle via AV #1, AV #2, and the COW.[2] Figure 2 illustrates the relationship between these release points.

DWR also has the ability to pump State Water Project water from the SBA into Lake Del Valle using the Del Valle Branch Pipeline and pump station, and if conditions require, can use the pump station to pump water out of the lake.

Flood Control Operations

A key function of Lake Del Valle is to provide flood protection to downstream communities; consequently, even though DWR owns and operates the lake, they must follow flood control regulations established by the Army Corps of Engineers (ACOE), as approved by the United States Congress.

Natural flows into Lake Del Valle are generated by runoff in areas of the Arroyo Valle watershed located upstream of the dam; this flow is currently recorded by a United States Geologic Survey (USGS) gaging station Arroyo Valle below Lang Canyon (AVBLC), #11176400. Flows recorded at AVBLC since Lake Del Valle was constructed have ranged from 0 cfs in the summer to well over 8,000 cfs in winter/spring; however, the largest flow in Arroyo Valle was estimated by the USGS to be approximately 18,200 cfs during the flood of 1955. This range of flow illustrates the flashiness of the watershed.

The lake is considered in flood stage when storage reaches 39,000 af between November through April, and 40,000 af during the remainder of the year. Once the lake is in flood stage, the quantity of water released by DWR for flood control purposes depends on inflow into the lake, water surface elevation in the lake, and flow at USGS gaging station Alameda Creek at Niles (ACN), #11179000. DWR typically lowers the lake to 25,000 af each year between September and December for both flood control and water supply purposes.

Recreation

Another function of Lake Del Valle is to serve as a recreational facility; consequently, EBRPD operates an extensive array of trails, camping sites, bathrooms, drinking water fountains, fishing, boating, and other recreational amenities. EBRPD also uses water from Lake Del Valle to feed its small water treatment plant located onsite; this treated water is used to provide potable water for its facilities. However, storage in Lake Del Valle needs to remain relatively high (above 35,000 af) during the summer months to support recreational use of the lake (e.g., boating and fishing); consequently, DWR does not normally release water from the lake during the summer unless absolutely necessary.

Water Supply - State Water Project

Lake Del Valle is also part of the State Water Project, and provides off-stream regulatory and emergency storage, as well as blending water to improve water quality, for the SBA, which serves three State Water Contractors (listed upstream to downstream): Zone 7 Water Agency (Zone 7), Alameda County Water District (ACWD), and Santa Clara Valley Water District. These three contractors are also known as the SBA Contractors. Each year, after the summer recreational season is over, DWR typically releases water from Lake Del Valle between September and December to meet the water supply needs of SBA

[2] Note that AV #1 is located downstream of USGS Gage Arroyo Valle near Livermore; however, AV #2, located adjacent to the dam, was recently upgraded, and therefore, AV #1 will likely serve a much more minor role in State Water Project operations.

Contractors; thereby, reducing energy usage through reduced pumping. These releases also make room in the lake for flood control and water supply purposes. Additionally, at times when water quality in the SBA is not optimum, the SBA Contractors will also request that DWR blend water from Lake Del Valle with water from the SBA to improve water quality (e.g., help reduce taste and odor issues).

Lake Del Valle also provides emergency storage for the SBA contractors in the event water from the South Bay Pumping Plant is cut off during a catastrophic event (e.g., levee failure in the Sacramento-San Joaquin Delta) or unscheduled maintenance.

Water Supply - Local Water Rights

Zone 7 and ACWD have water right permits on Arroyo Valle. Permit 11319 allows Zone 7 to replenish the Livermore-Amador Valley Groundwater Basin, manage salt loading, improve water quality, and maintain water supply reliability. Permit 11320 allows ACWD to replenish the Niles Cone Groundwater Basin, repel seawater intrusion that threatens a drinking water supply for residents in southern Alameda County, and to supply water to its customers. Consequently, Lake Del Valle captures local runoff under both permits in addition to storing State Water Project water.

Key Stream Gaging Stations along Arroyo Valle and Arroyo de la Laguna

Shortly after filing their initial applications, Zone 7 and ACWD established or re-established several stream gaging stations along Arroyo Valle. The gaging stations included:

- *Arroyo Valle below Lang Canyon (USGS 11176400)*: located upstream of Lake Del Valle, and operated by USGS
- *Arroyo Valle near Livermore (USGS 11176500)*: located just downstream of Lake Del Valle, and operated by USGS
- *Arroyo Valle at Pleasanton*: located where Arroyo Valle crosses Division Street in Pleasanton, California, and operated by Zone 7
- *Arroyo de la Laguna at Verona (USGS 11176900 and 11177000)*: located downstream of the confluence with Arroyo Valle, and operated by USGS

Live Stream Requirement

Beginning in 1978, Permits 11319 and 11320 were modified to include a new condition requiring both Zone 7 and ACWD to maintain a live stream in Arroyo Valle from Lake Del Valle to the Arroyo Valle at Pleasanton gaging station as long as either water agency had water stored under Permits 11319 and 11320 in Lake Del Valle. No flow or other specification is tied to the live stream requirement. Typically, Zone 7 and ACWD request that DWR release a combined flow of 8 to 10 cfs during the summer, when there is no natural flow, and only 0 to 2 cfs during the winter to supplement natural runoff downstream of the dam, which can be flashy, and range from 0 to hundreds of cfs.

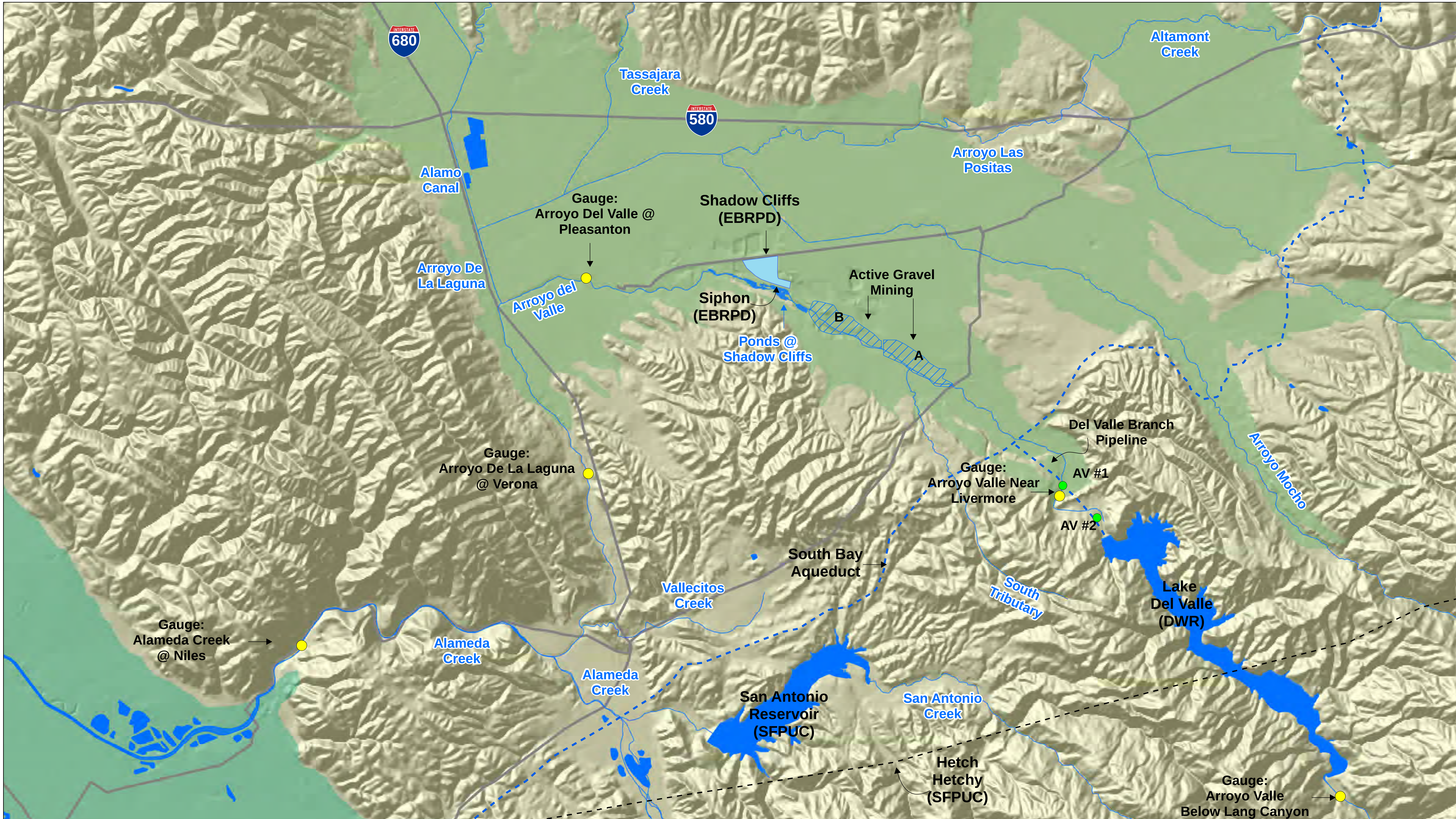
Although Zone 7 and ACWD can request that DWR release water to the Arroyo Valle, State Water Project operations dictate whether the source of the water is from Lake Del Valle, the SBA, or both. DWR could release no water at all if the water supply or SBA conveyance capacity is unavailable.

MINING DISCHARGES

Arroyo Valle has historical and existing gravel mining operations adjacent to its watercourse. Depending on the depth of mining, or hydrologic conditions, the companies operating these gravel-mining operations may discharge water directly into the Arroyo Valle from time to time under their existing National Pollution Discharge Elimination System (NPDES) permit. No gravel mining discharges have occurred in the Arroyo Valle since 2004; however, this could change in the future. Mining discharges can range from 0 to 20 cfs.

OPERATION OF SHADOW CLIFFS

Shadow Cliffs Regional Recreation Area, located about 7 miles downstream of Del Valle Dam, is owned and operated by East Bay Regional Parks District (EBRPD) and historically received mining discharge water directly into Shadow Cliffs to help maintain water levels in most years. However, at times, these discharges could be interrupted, and actually ceased in September 2002 when one of the mining companies completed their mining activities. Consequently, at the request of EBRPD and contingent upon availability, Zone 7 will request that DWR release State Water Project water for EBRPD to collect using a siphon located within the Arroyo Valle, adjacent to Shadow Cliffs Regional Recreation area. The siphon is owned and operated by EBRPD, and EBRPD typically requests and siphons 1 to 2 cfs from May to October.



LEGEND

- Key SBA Turnouts
- Key Gauges
- South Bay Aqueduct
- Hetch-Hetchy Aqueduct
- Lake A
- Lake B
- Shadow Cliffs
- Major Water Features
- Major Streams and Arroyos
- MajorHighways
- Livermore Valley Groundwater Basin
- Niles Cone Groundwater Basin

N

0 0.5 1 2

Scale in Miles

DRAFT

ZONE 7 WATER AGENCY

Figure 1

Summary of Water Operations

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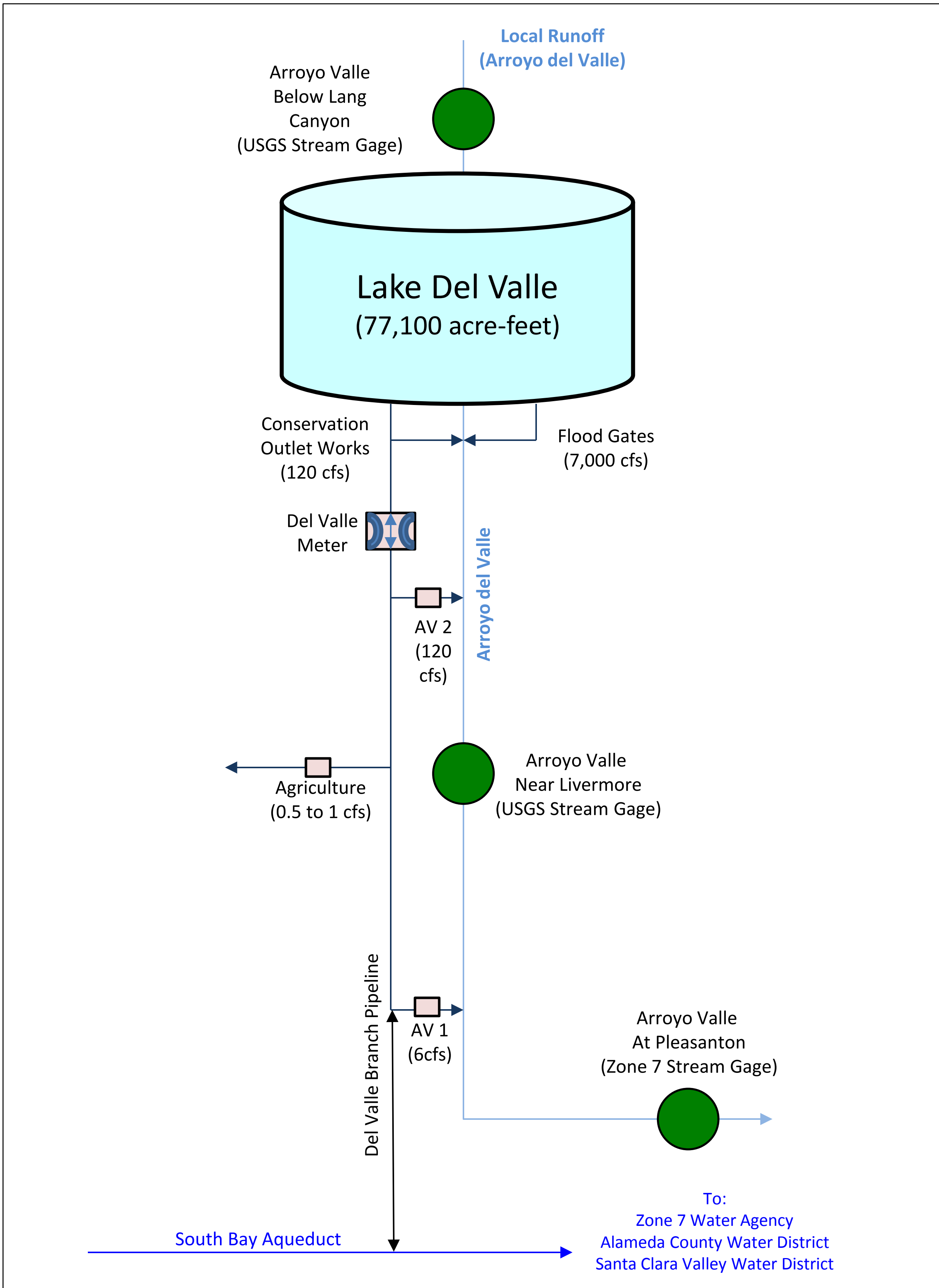

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ZONE 7 WATER AGENCY

Figure 2

Lake Del Valle Release Points

Department of Water Resources' Mission...

To manage the water of California, in cooperation with other agencies, to benefit the state's people and protect, restore and enhance the natural and human environments.

South Bay Aqueduct

(Bethany Reservoir and Lake Del Valle)

GRAY DAVIS
Governor
State of California

MARY D. NICHOLS
Secretary for Resources
The Resources Agency

THOMAS M. HANNIGAN
Director
Department of Water Resources

4/01

Windsurfing is also allowed at Bethany Reservoir.

Bethany Reservoir

Bethany Reservoir is located 1-1/2 miles down the California Aqueduct from Banks Pumping Plant about 10 miles northwest of Tracy in Alameda County. Completed in 1967, Bethany Reservoir serves as a forebay for South Bay Pumping Plant and a conveyance facility in this reach of the California Aqueduct.

History

The Indians who lived in the Bethany Reservoir area were probably Northern Valley Yokuts. Because the reservoir area is on higher ground outside the Delta and lacks trees, the Indians apparently spent little time there. Evidence of native habitation found during project construction includes an obsidian knife, a chert core tool, and the remains of a human skeleton found near the South Bay Pumping Plant.

Recreation

Operated by the California Department of Parks and Recreation, the recreation area provides opportunities for picnicking, fishing, boating, windsurfing, hiking, and bicycling. However, overnight camping and hunting are not allowed at Bethany Reservoir.

Lake Del Valle

Lake Del Valle was created in 1968 to provide recreation and fish and wildlife enhancement, flood control for Alameda Creek, and regulatory storage for a portion of the water delivered through the South Bay Aqueduct.

History

A band of Ohlone Indians roamed the Del Valle area long before the Spanish missionaries and explorers set foot in California. Arrowheads and grinding stones recovered at Lake Del Valle reveal the existence of Ohlone settlements in the shadow of the Diablo Range.

Lake Del Valle State Recreation Area occupies part of the 1839 Mexican land grants to the families of Agustin Bernal and Antonio Sunol (the present-day city bears his name).

During the late 1800s and early 1900s, Europeans moved in and took over the lands of the original Mexican and Spanish grant holders. Foundations and rock piles from buildings from that period still stand along the old trails. Many of the early building sites are beneath the waters of Lake Del Valle.

Del Valle Dam

The 235-foot-high Del Valle Dam impounds a reservoir with a total capacity of 77,100 acre-feet. To provide a flood control reserve, it normally stores from 25,000 to 40,000 acre-feet. (An acre-foot is 325,900 gallons, enough water to cover one acre of land one foot deep.)

Del Valle Dam is the only flood control dam in the Livermore Valley.

Recreation

Operated by the East Bay Regional Park District, Lake Del Valle's 5,200-acre recreation area offers picnicking, swimming, boating, fishing, biking, hiking, windsurfing, camping, and horseback riding. For a map with Lake Del Valle's recreational opportunities or other Lake Del Valle information, call East Bay Regional Park District at (925) 373-0332.

Fishing is best during the winter, with the California Department of Fish and Game regularly planting trout from October through May. Planting of trophy-sized trout is supported by the East Bay Regional Park District's fishing permit program. A state fishing license with appropriate stamps and a Park District daily fishing access permit are required for anglers age 16 and older.

Boating and swimming are permitted in designated areas only. Alcohol is prohibited and children should be accompanied by adults at all times.

About 150 family campsites and three group sites (each accommodates 150 people) are available year-round. Picnic sites with barbecue units are provided in many park areas. No ground fires are permitted, except in personal cooking units. Picnic areas for large groups may be reserved at least two weeks in advance by calling (510) 636-1684.

Information

To reach the park, take Highway 580 to the North Livermore Avenue exit in Livermore. Drive south through Livermore. Livermore Avenue becomes Tesla Road. Turn on Mines Road to Del Valle Road (the right fork) and follow to the park entrance. For information, call (925) 373-0332.

For more information about the State Water Project and accessibility, call the California Department of Water Resources' Office of Water Education at 1-800-272-8869.

Visit DWR's Web site at
http://wwwdwr.water.ca.gov/

For TTY phone service, call (916) 653-6226.

If you need this publication in an alternate form, contact the Office of Water Education at 1-800-272-8869.

Lake Del Valle is a popular Bay area recreation spot.

Lake Del Valle and Dam Statistics

Max. Normal Storage	40,000 acre-feet
Lake Gross Capacity	77,100 acre-feet
Surface Area	708 acres
Elevation	703 feet MSL
Shoreline	16 miles max. flood control storage
Maximum Depth (normal)	153 feet
Water Surface Elevation	703 feet MSL (normal maximum)
Dam Structural Height	235 feet
Crest Elevation	773 feet
Crest Length	880 feet
Volume	4,150,000 cubic yards of earthfill

Bethany Lake and Forebay Dam Statistics

Lake Gross Capacity	4,804 acre-feet
Surface Area	161 acres
Shoreline	6 miles
Maximum Depth	30 feet
Surface Elevation	243 feet
Dam Structural Height	121 feet*
Crest Elevation	250 feet
Crest Length	3,940 feet
Volume	1,400,000 cubic yards of earthfill

*Bethany Lake is impounded by five dams, but this statistic shows only the Forebay Dam feet.

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The State Water Project

Planned, designed, constructed, operated and maintained by the California Department of Water Resources (DWR), the State Water Project (SWP) is the largest state-built, multipurpose water project in the United States.

The SWP, spanning more than 600 miles from Northern California to Southern California, includes 32 storage facilities, 17 pumping plants, 3 pumping-generating plants, 5 hydroelectric power plants, and approximately 660 miles of canals, pipelines, and tunnels.

The main purpose of the SWP is water supply - that is, to divert and store water during wet periods and distribute it to areas of need in Northern California, the San Francisco Bay area, the San Joaquin Valley, the Central Coast, and Southern California. Other SWP purposes include flood control, power generation, recreation, fish and wildlife enhancement, and water quality improvement in the Sacramento-San Joaquin Delta.

Public agencies that have long-term contracts for SWP water deliveries are repaying the cost, plus interest, of financing, building, operating and maintaining the SWP water storage and delivery system.

Bethany Reservoir allows fishing.

The South Bay Aqueduct

Construction on the South Bay Aqueduct began in 1960. The Aqueduct was the first delivery system completed under the SWP and has been conveying water to Alameda County since 1962 and to Santa Clara County since 1965.

The South Bay Aqueduct begins at Bethany Reservoir near Tracy, with the South Bay Pumping Plant lifting water 566 feet into the first reach of the Aqueduct.

The South Bay's Pumping Plant's nine pumping units, with a combined capacity of 330 cubic feet per second, discharge water through two parallel buried pipelines to the eastern ridge of the Diablo Range.

From there, water flows by gravity for nine miles to the 100 acre-foot Patterson Reservoir, where some water is released for delivery to Livermore Valley. Water flow then continues about nine miles to a junction point where a portion is diverted into a 1 1/2-mile branch line and pumped into Lake Del Valle.

Beyond the Del Valle junction, the water flows by pipeline to La Costa Tunnel, proceeds southwest past Sunol, through the Mission Tunnel, then south through the hills overlooking San Francisco Bay. South Bay Aqueduct terminates in a 160-foot diameter steel tank on a hillside five miles east of downtown San Jose.

Water agencies served by the South Bay Aqueduct — the Alameda County Flood Control and Water Conservation District (Zone 7), Alameda County Water District, and Santa Clara Valley Water District — can receive up to 188,000 acre-feet a year. Maximum annual entitlement for each contractor is: Zone 7, 46,000 acre-feet; Alameda County Water District, 42,000 acre-feet; and Santa Clara Valley Water District, 100,000 acre-feet.

Arroyo del Valle and Arroyo de la Laguna Steelhead Habitat Assessment

ATTACHMENT 2

ARROYO DEL VALLE AND ARROYO DE LAGUNA TEMPERATURE PROBE DATA

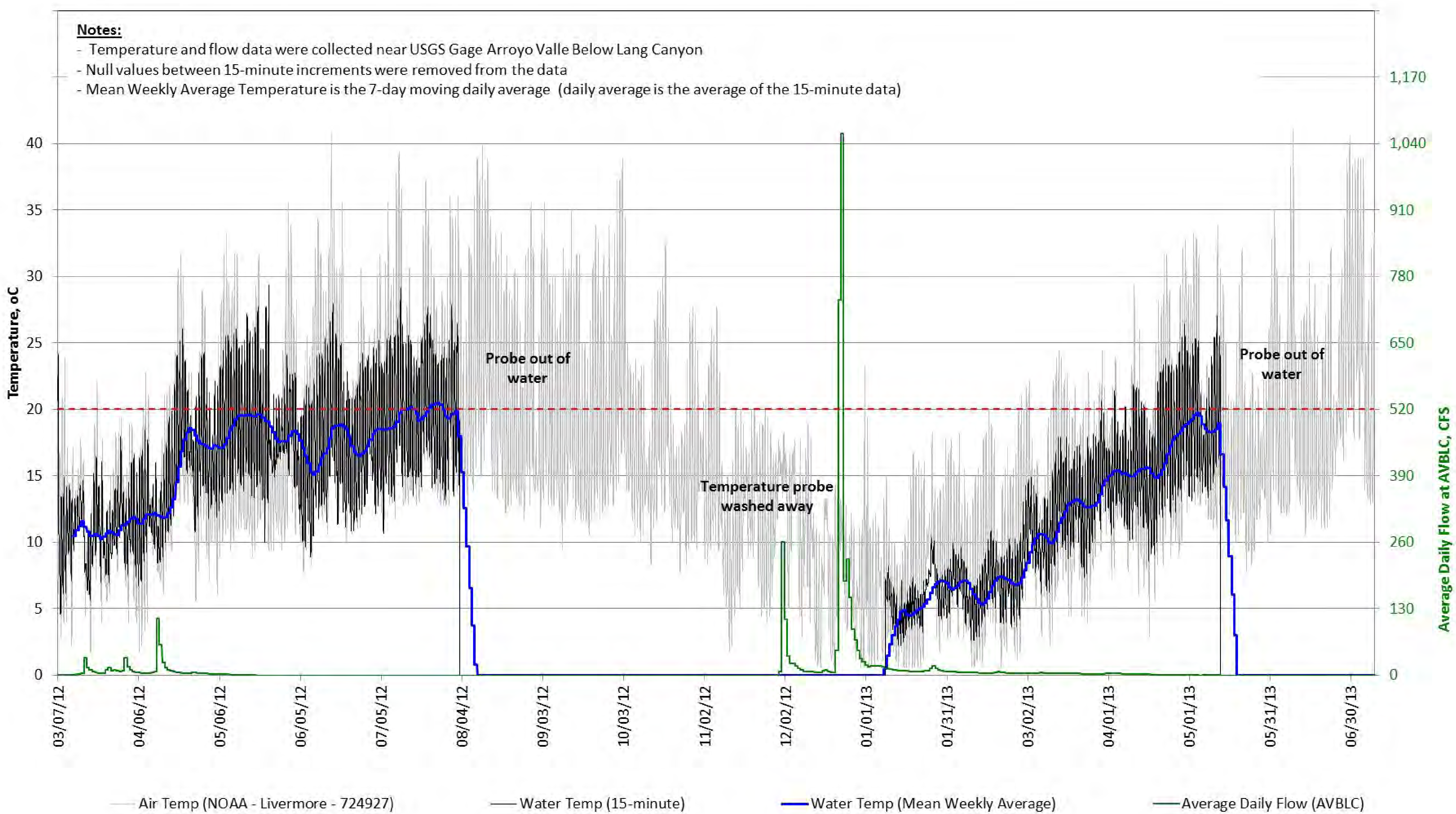

Figure 1 **Instantaneous Water Temperature on Arroyo del Valle at Below Lang Canyon (BLC-h)**

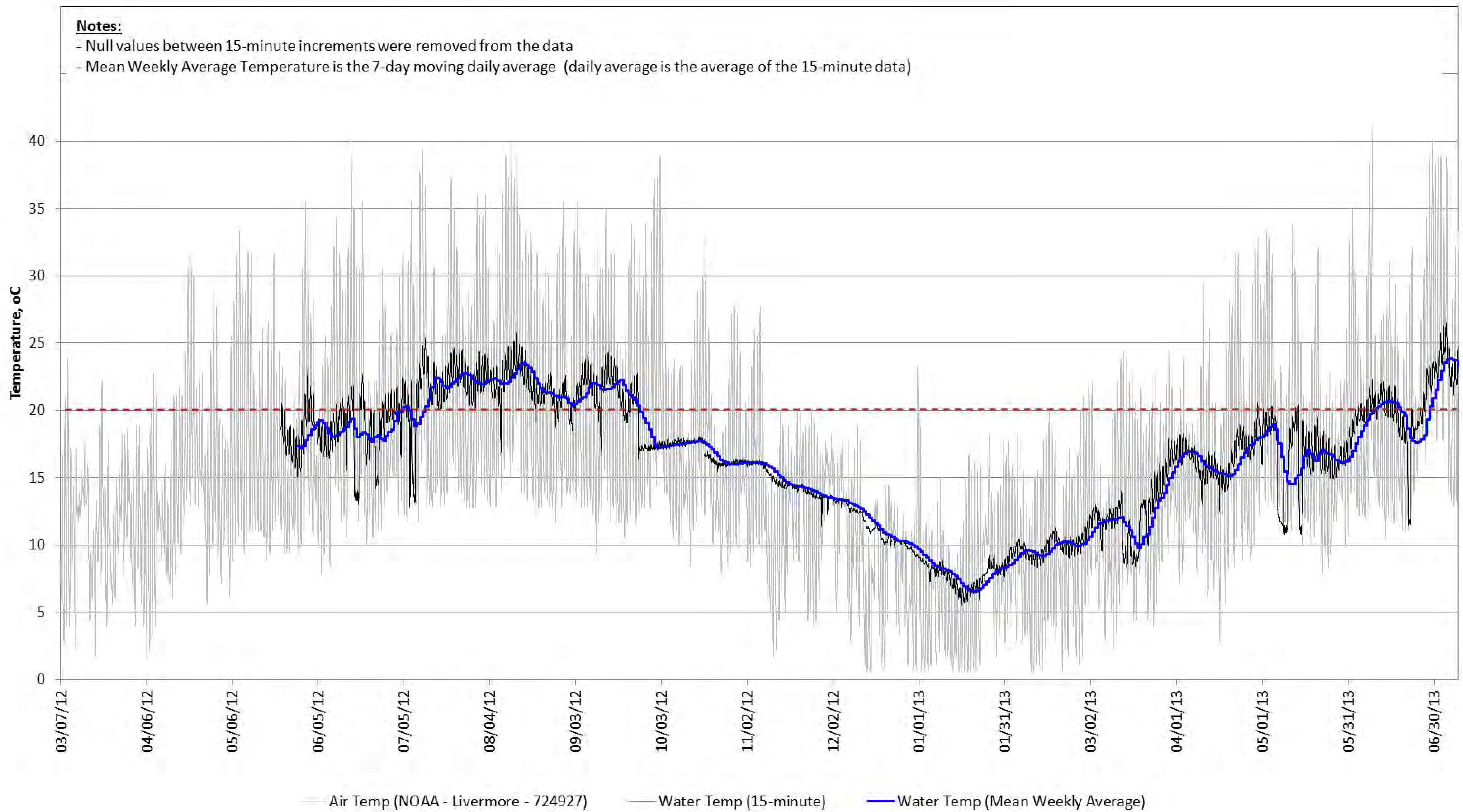

Figure 2 **Instantaneous Water Temperature on Arroyo del Valle at Arroyo Valle Turnout #2 (AV2-h)**

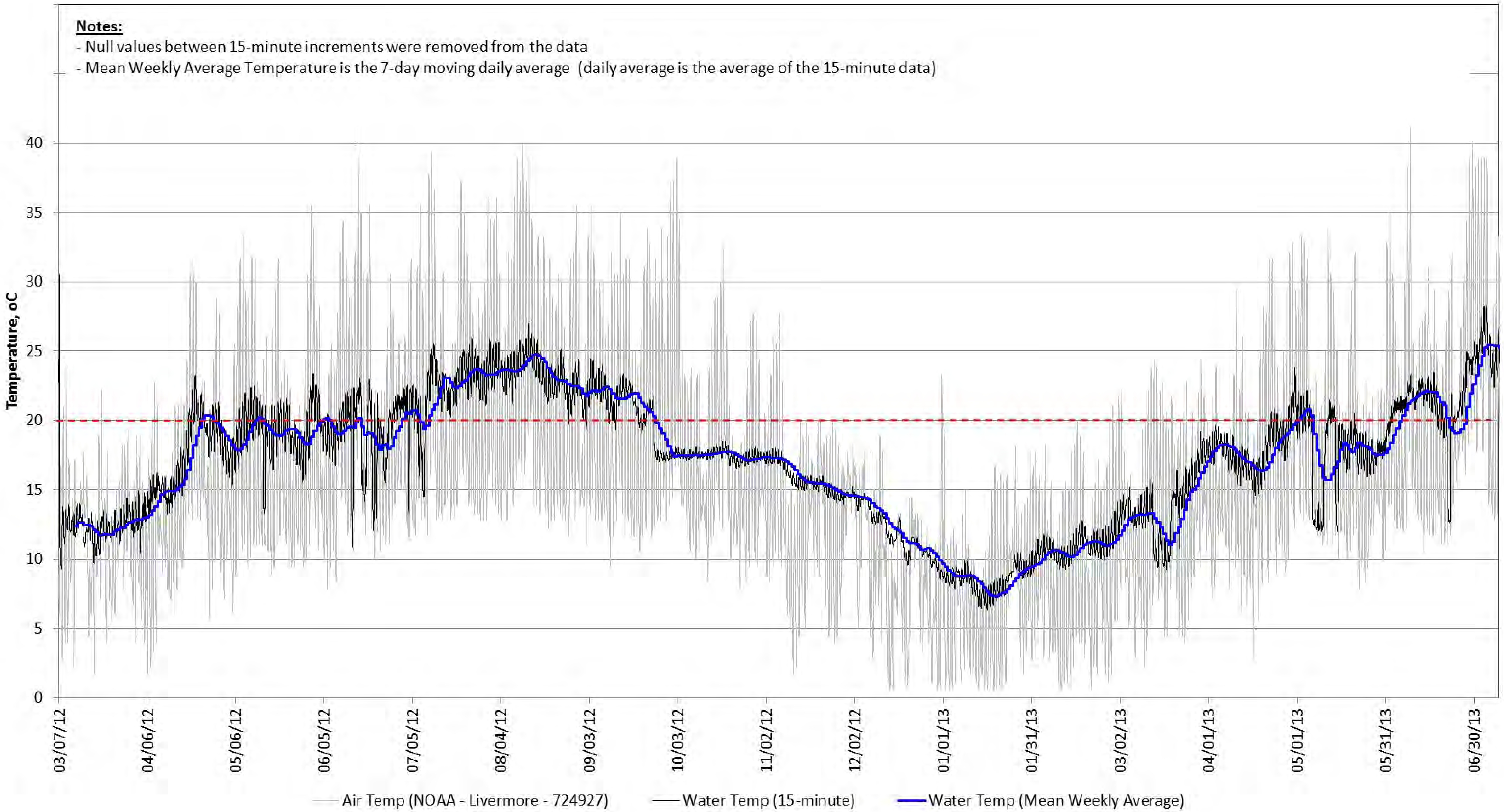

Figure 3 **Instantaneous Water Temperature on Arroyo del Valle near Arroyo Park Trail (APT-h)**

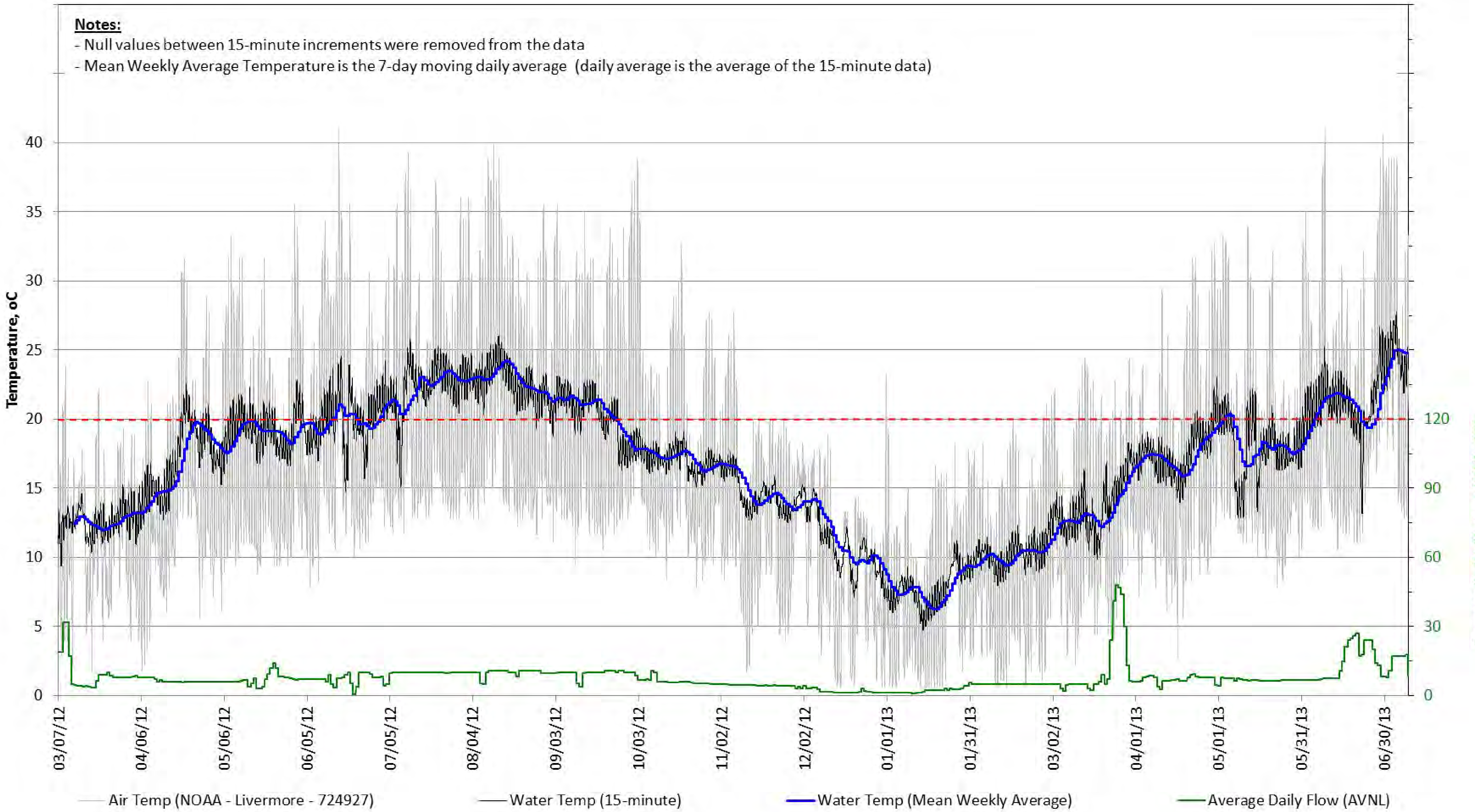

Figure 4 **Instantaneous Water Temperature on Arroyo del Valle near Livermore (AVL-h)**

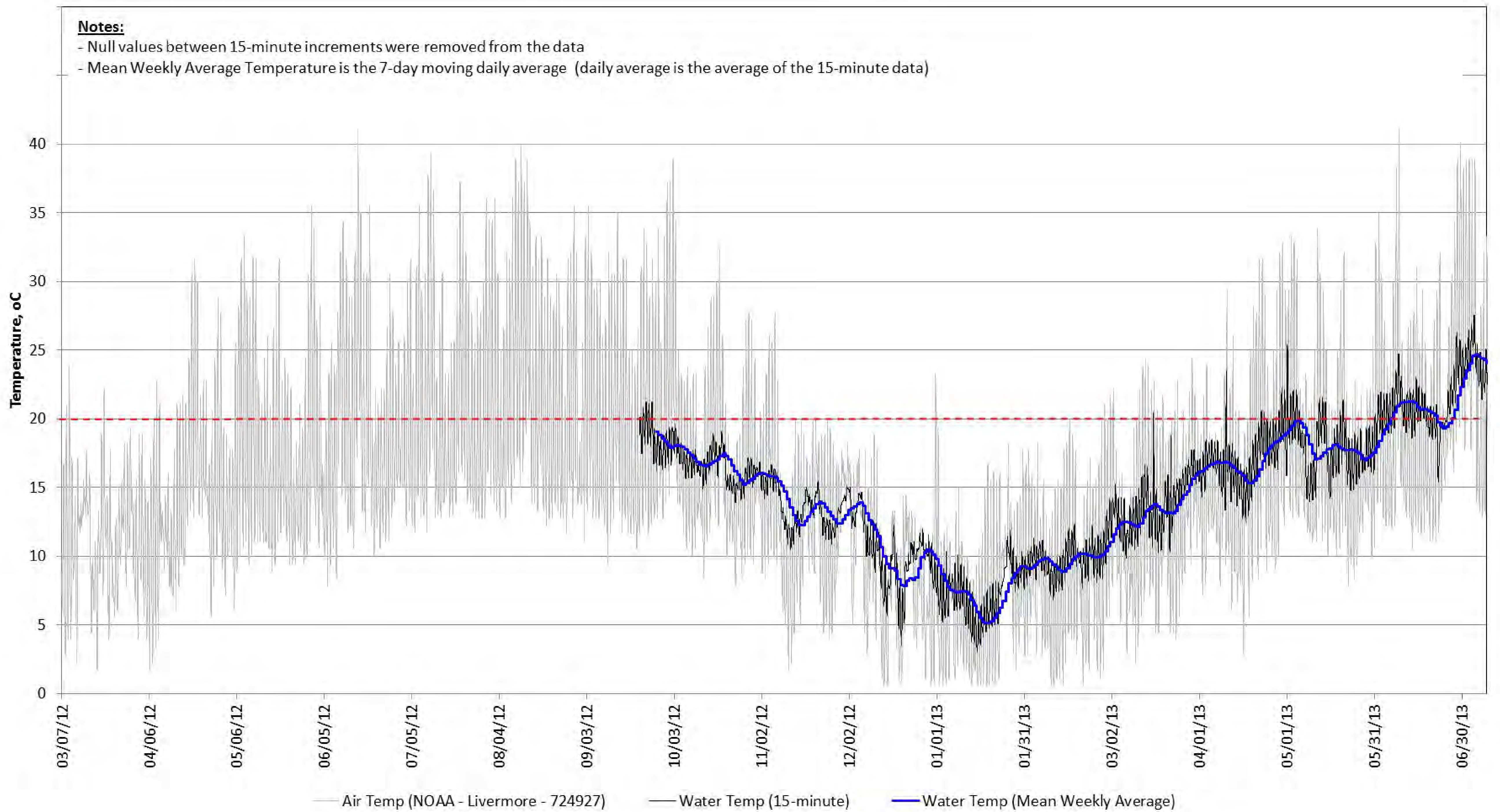

Figure 5 **Instantaneous Water Temperature at Dry Creek on Arroyo del Valle (DCC-h)**

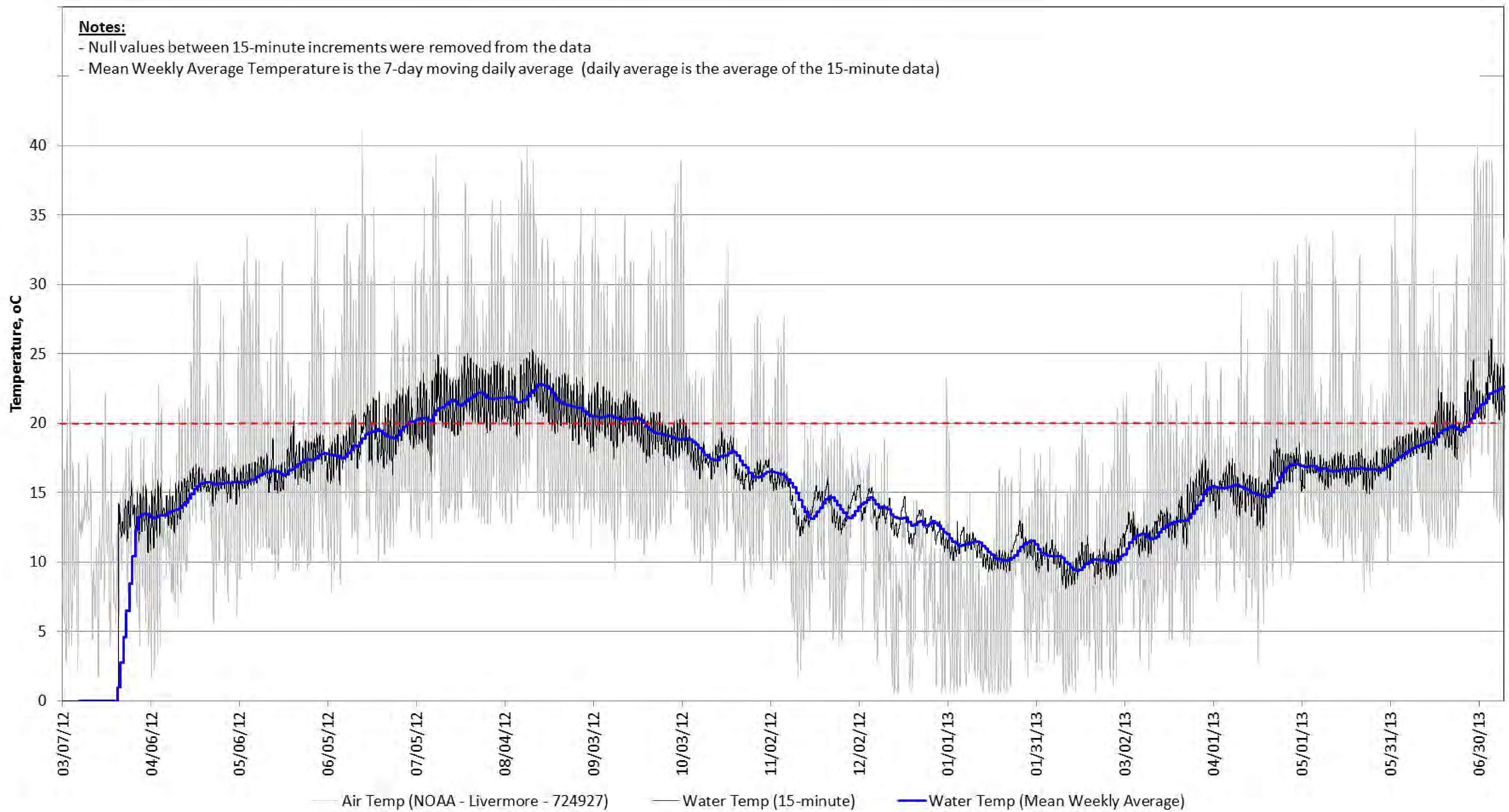

Figure 6 **Instantaneous Water Temperature at Sycamore Grove Park on Arroyo del Valle (SGP-h)**

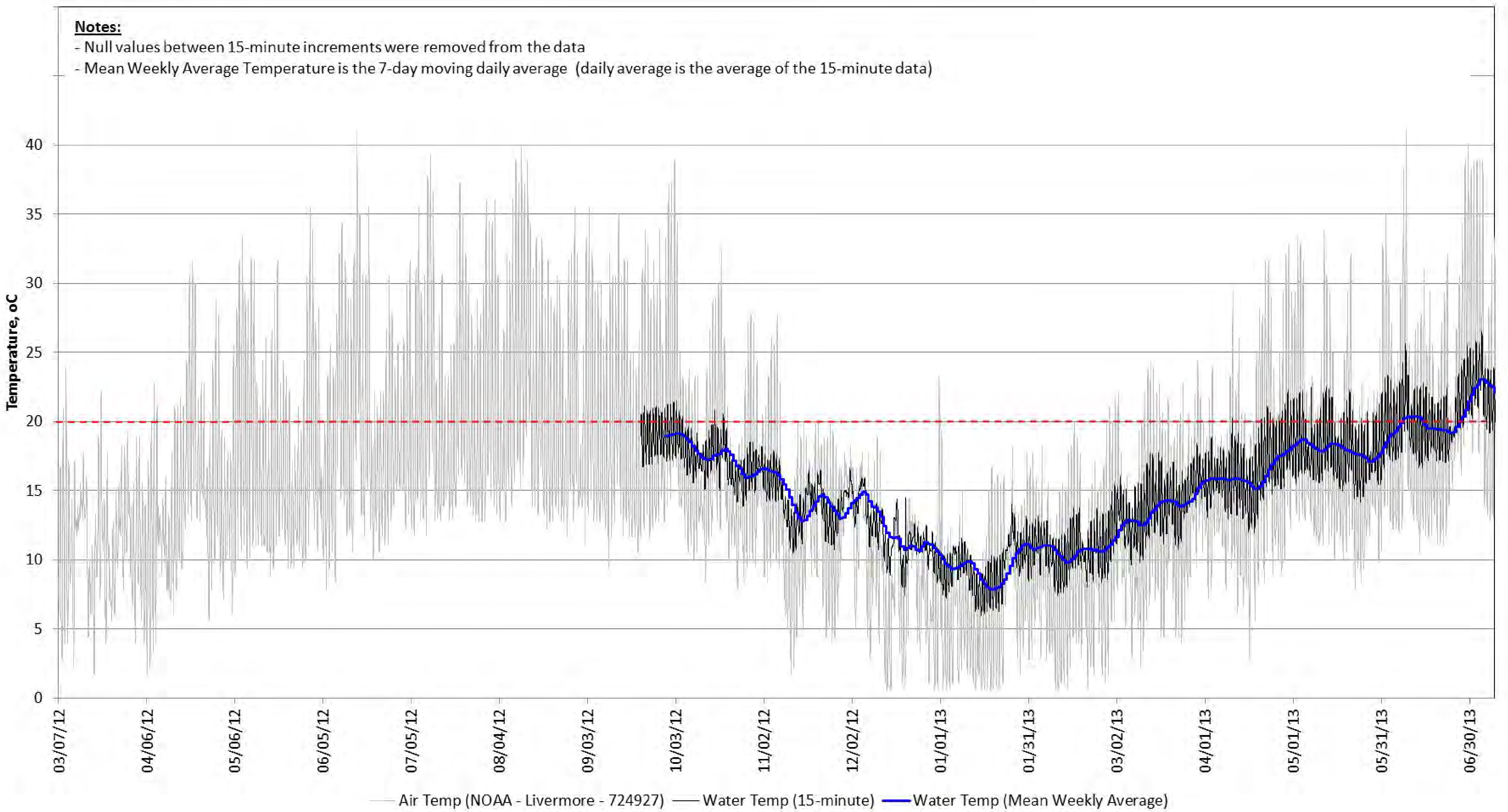

Figure 7 **Instantaneous Water Temperature at Isabel Avenue on Arroyo del Valle (ISA-h)**

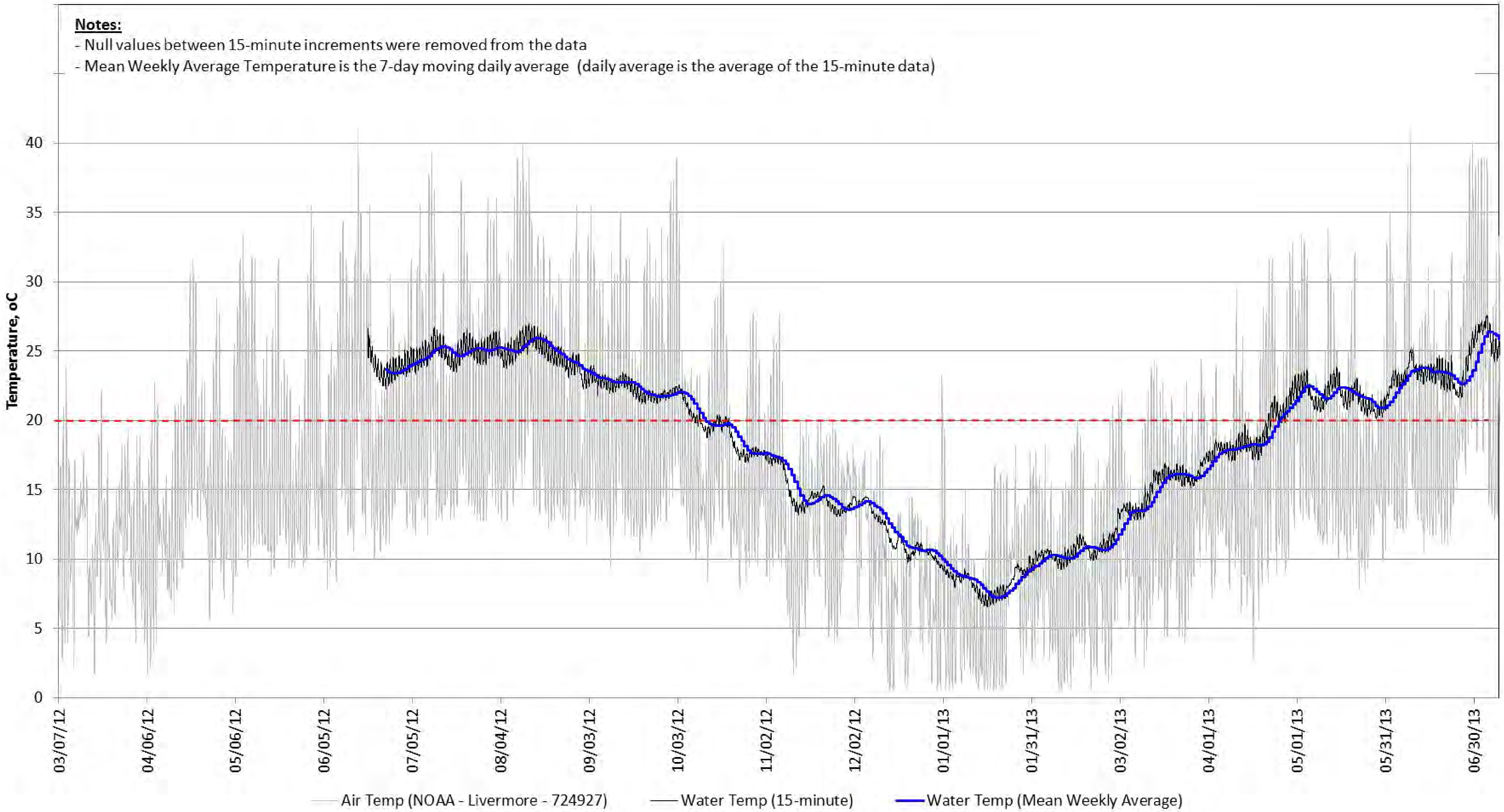

Figure 8 **Instantaneous Water Temperature at the Ponds at Shadow Cliffs Regional Recreation Area on Arroyo del Valle (PSC-h)**

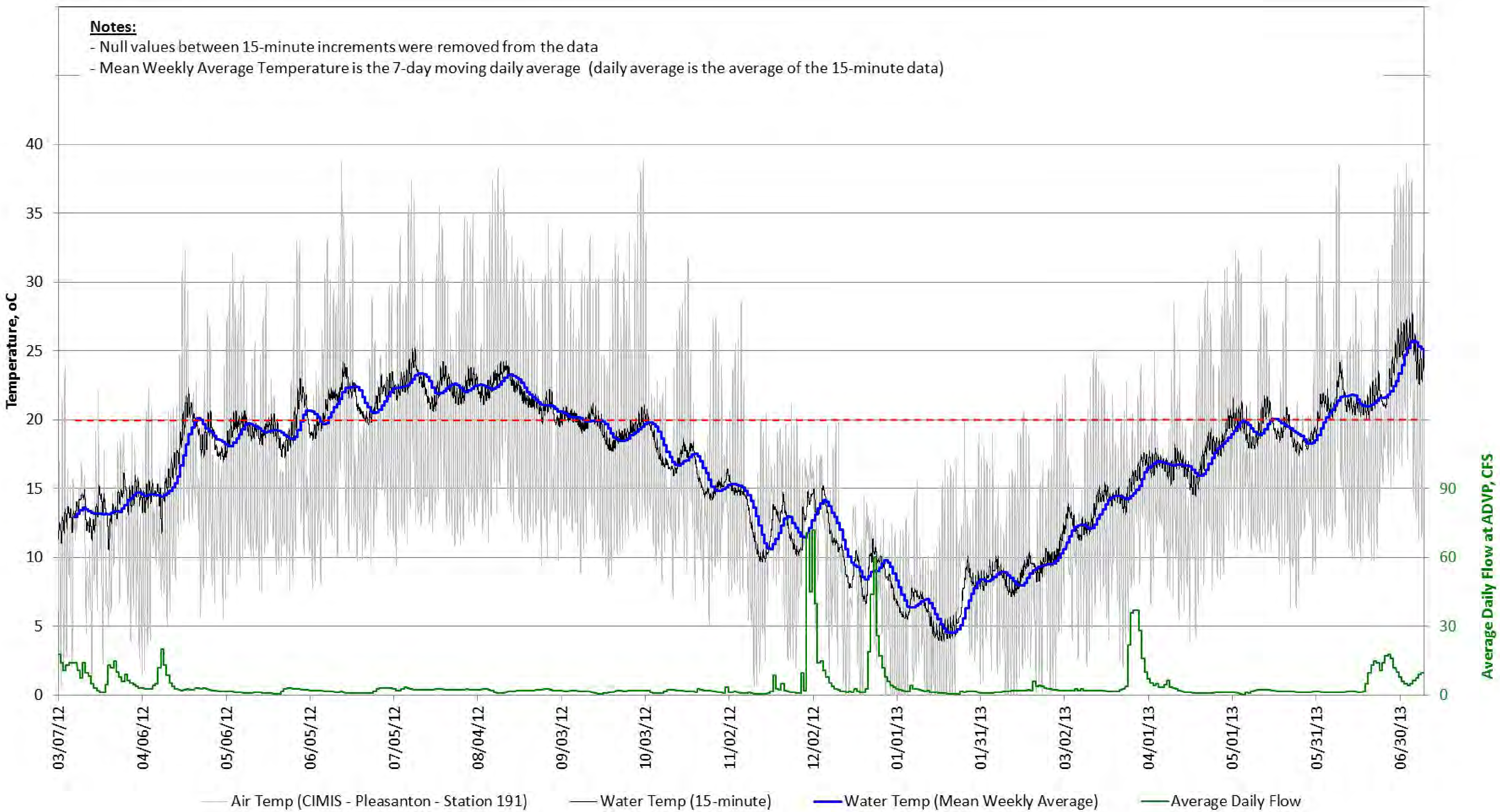

Figure 9 **Instantaneous Water Temperature at Arroyo del Valle at Pleasanton (AVP-h)**

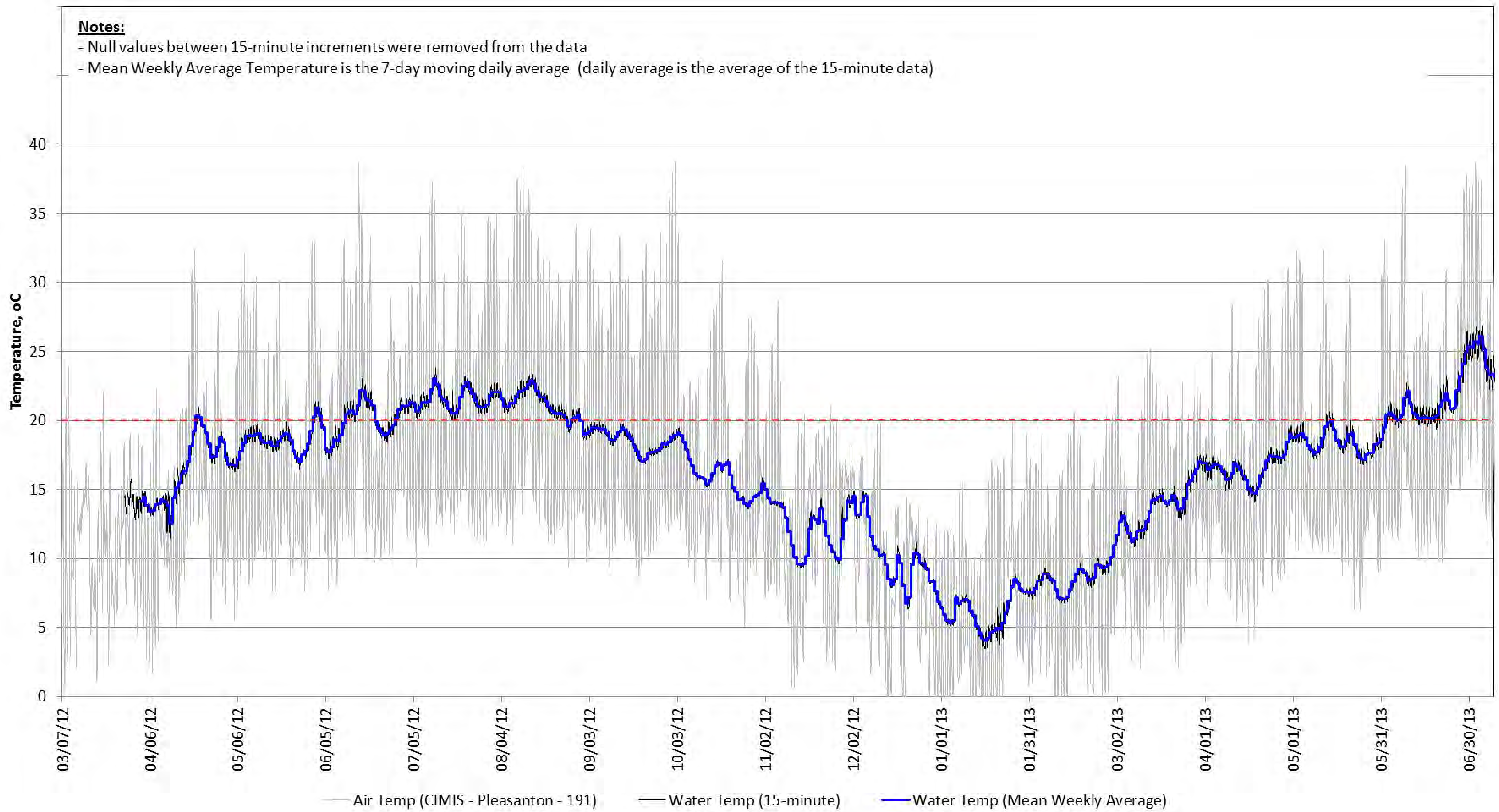

Figure 10 Instantaneous Water Temperature at the Arroyo del Valle and Arroyo de la Laguna Confluence (ALL-h)

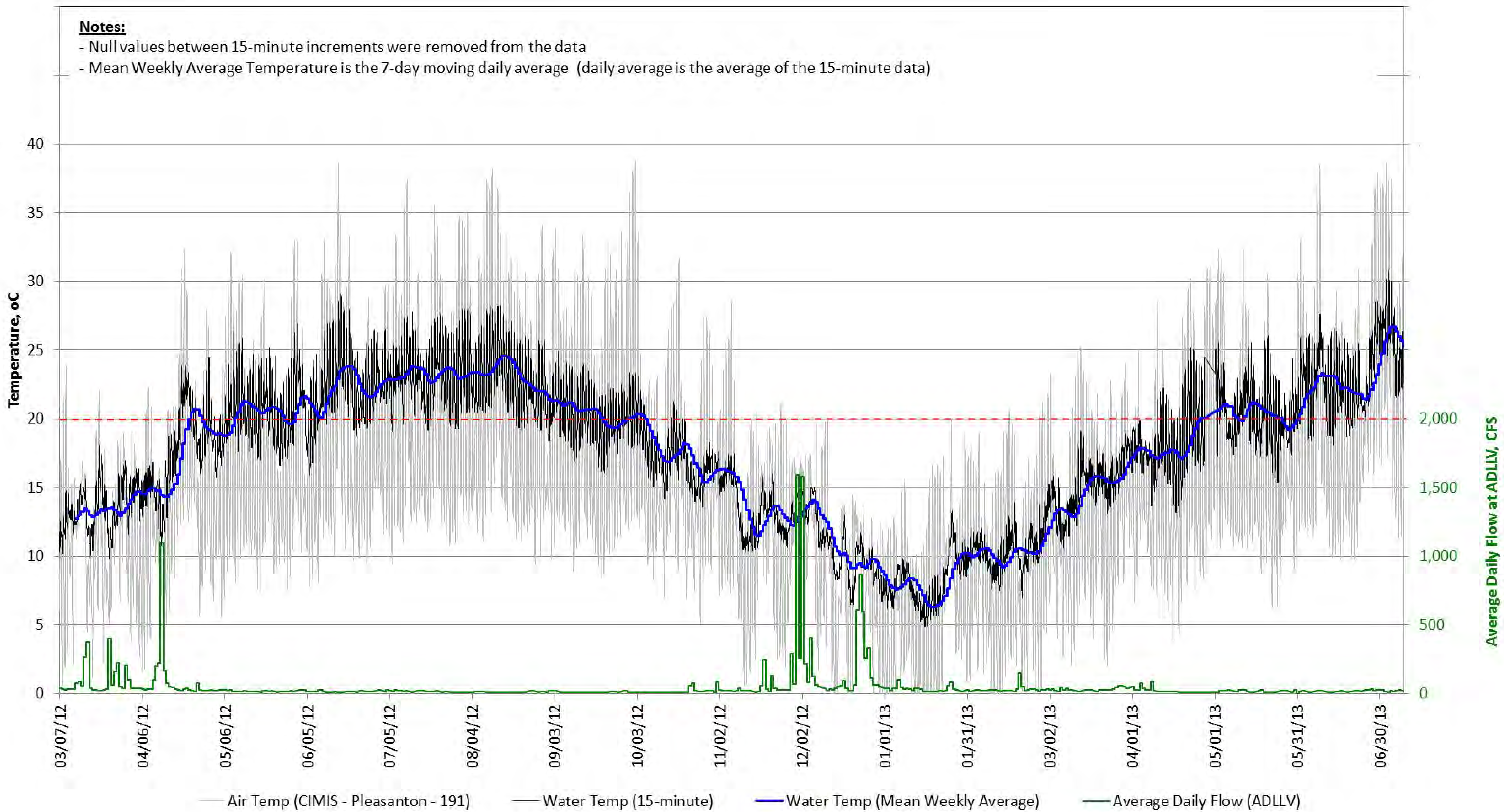

Figure 11 **Instantaneous Water Temperature at Arroyo de la Laguna at Verona (ADLL @ Verona)**