2.0 WATERSHED CHARACTERIZATION AND DESCRIPTION OF MERCURY SOURCES

Much of the information presented in the Conceptual Model assumes a fundamental understanding of the watershed characteristics (topography, geology, meterology, and hydrology) and historical mercury mining operations in the watershed. The reader familiar with this information may choose to skip this section. However, existing information on recent mercury measurements in the watershed, including the results of the recently completed Synoptic Survey (Tetra Tech, 2003d), and fish bioaccumulation data are also summarized in this section.

2.1 WATERSHED DESCRIPTION AND SYSTEM CHARACTERISTICS

Topography

The Guadalupe River headwaters are in the eastern Santa Cruz Mountains near the summit of Loma Prieta (elevation 3,790 feet). As seen in Figure 2-1, the upper portion of the watershed is mountainous with several ridges extending out into the alluvial valley. The Guadalupe River begins at the confluence of Alamitos and Guadalupe Creeks, below Almaden Lake, and flows 19 miles through heavily urbanized portions of San Jose, ultimately discharging into South San Francisco Bay through Alviso Slough (Figure 2-2). Three tributaries: (1) Ross, (2) Canoas, and (3) Los Gatos Creeks, join the river as it flows toward San Francisco Bay. Guadalupe River has a total drainage area of approximately 170 square miles south of Highway 237. The river then flows into a 5-mile tidally-influenced reach through Alviso Slough to San Francisco Bay.

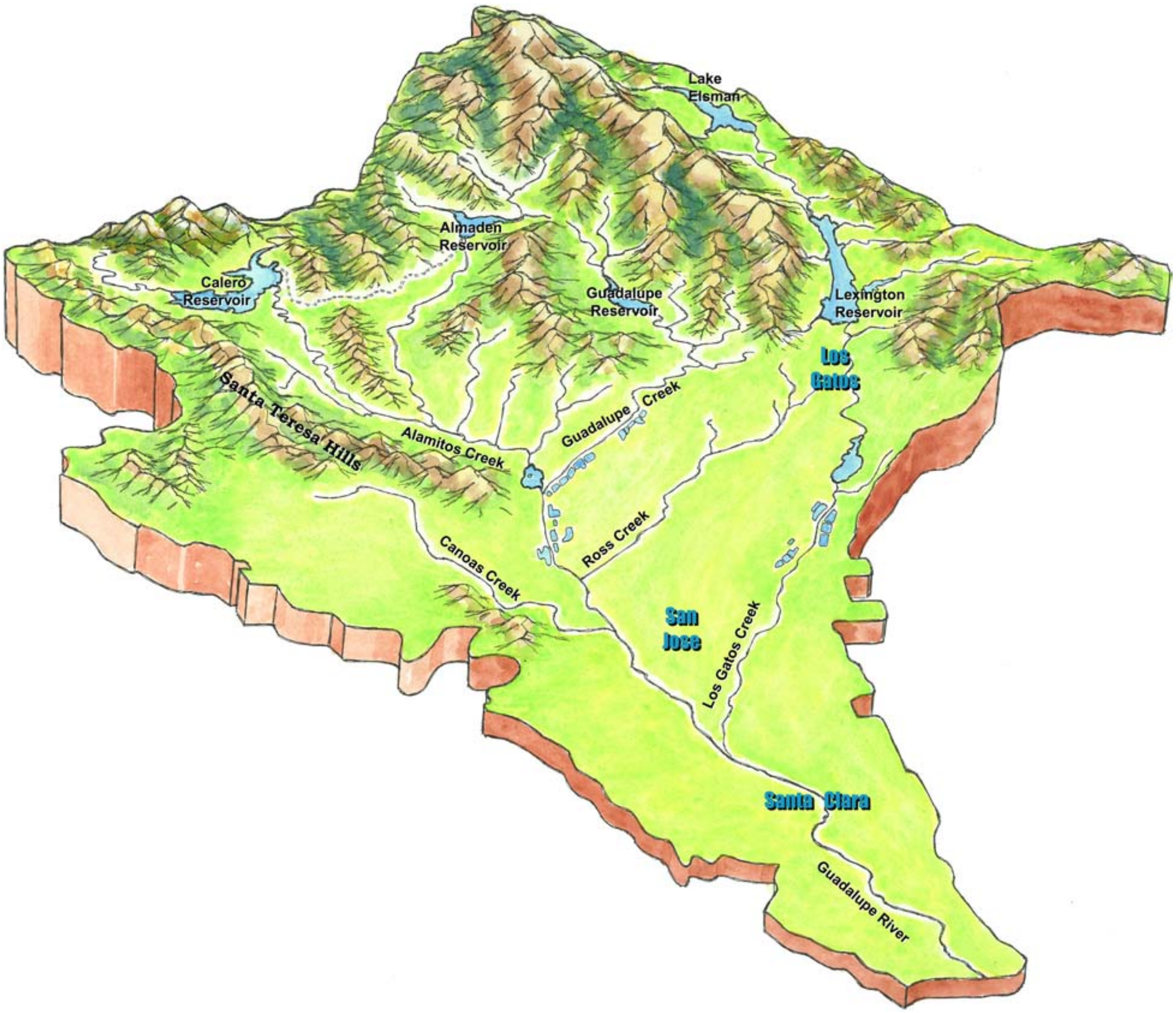


Figure 2-1. General topography of Guadalupe River watershed.

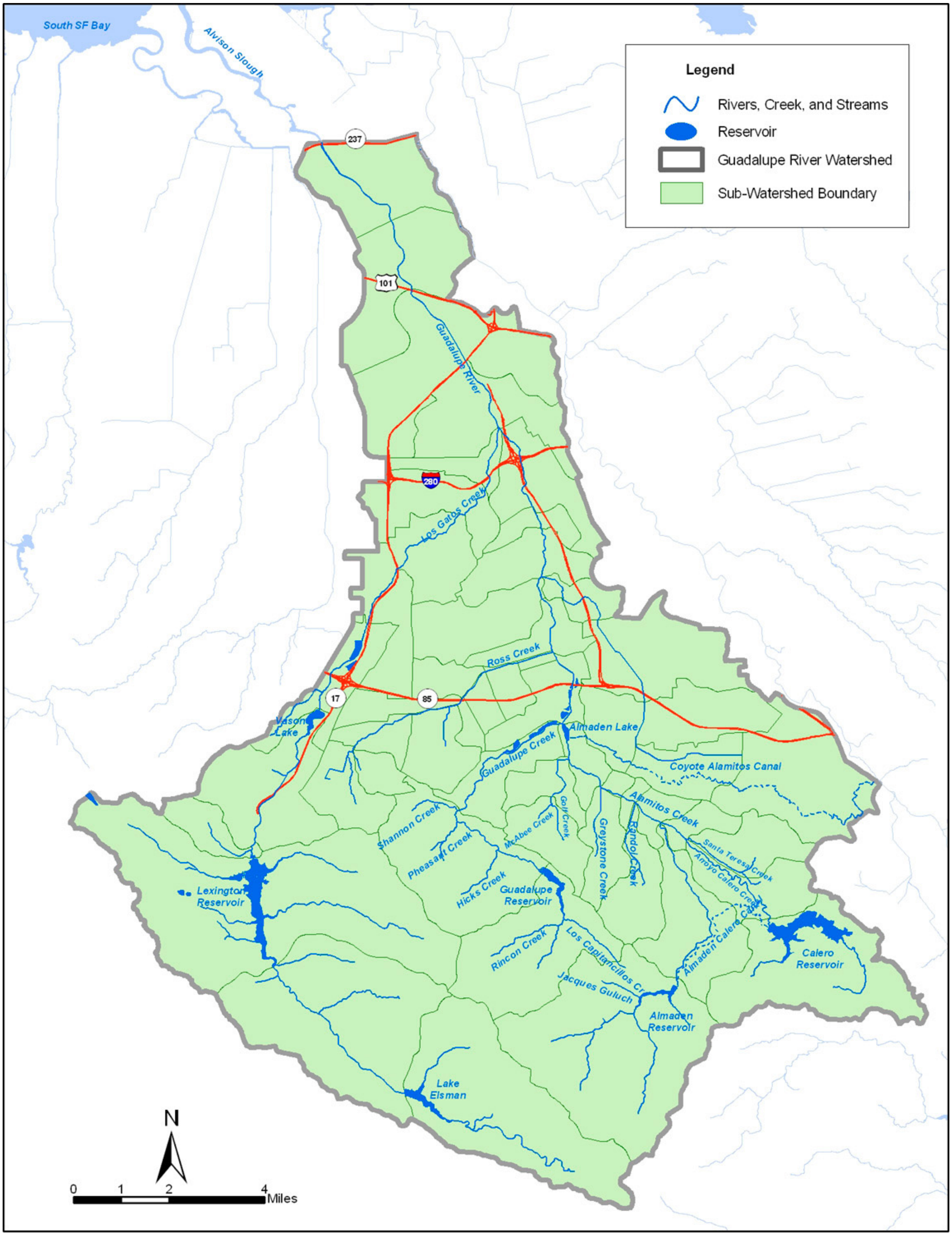


Figure 2-2. Major waterbodies and subwatersheds of Guadalupe River system.

Geology

The Guadalupe River watershed can be divided into three regions: 1) an upland region with bedrock outcrops, 2) an alluvial plain, and 3) a baylands region. The upland region is underlain by sedimentary and metamorphic formations, chiefly belonging to the Franciscan Formation. Common sedimentary rock types include sandstone, shale, graywacke, limestone, and conglomerates. Common metamorphic and volcanic rocks include chert, serpentinite, greenstone, basalt, and schist. The alluvial plain overlies a deep structural basin filled with up to 1,500 feet of Plio-Pleistocene and Quaternary unconsolidated alluvial materials. The alluvial deposits consist of well-graded, interbedded fine sands and silts with some gravels. Coarse gravel deposits are present in some reaches of the Guadalupe River where it flows across the ancestral channel, rather than in relocated channels. The portion of the watershed south of Highway 237 is underlain by Bay muds and river sediments.

Mercury mineralization in the South San Francisco Bay Region is chiefly associated with serpentine intrusions into the Franciscan Formation, where the serpentine has been hydrothermally-altered to silica carbonate (Bailey and Everhart, 1964). The naturally occurring mercury is principally in the form of the mineral cinnabar (mercury sulfide) in the silica carbonate. Because the rock types in the Franciscan Formation contain limestone and carbonates, soils derived from these deposits are alkaline, as is the runoff and mine seeps. The alkaline seeps are in contrast to other mining areas with acid-mine drainage where the ore was associated with pyrites and other sulfide minerals, such as the gold mines in the Sierra Nevada (Alpers and Hunerlach, 2000) and the New Idria Mine, where the mercury ore was due to hot springs solution deposits (Ganguli et al., 2000).

The Franciscan Formation and its related serpentine beds underlie the New Almaden Mining District of the upper Guadalupe River Watershed (see Plate 1 from the Bailey and Everhart, 1964 report). Silica carbonate bedrock is found in scattered areas of the New Almaden Mining District, the largest mercury mine in North America. The mines where silica carbonate outcrops were at the surface include the Mine Hill area with multiple mines and open-cuts, the Providencia Mine, and the Guadalupe and Senador Mines along the extension of Los Capitancillos Ridge. Smaller outcrops were associated with the Enriquita fault zone that cuts across the present location of Guadalupe Reservoir. This zone was exploited by three small mines: San Mateo, San Antonio, and Enriquita. There were other small outcrops along the eastern portion of Los Capitancillos Ridge. Much of the ore grade deposits containing cinnabar were removed by mining, particularly the original surface outcrops and a placer deposit in thick gravels in the lower portion of Deep Gulch Creek. However, dispersed cinnabar may be present in small silica carbonate outcrops and in the remaining unexplored subsurface veins. Other rock types that had some cinnabar in a few locations, as noted in the report on the New Almaden Mining District (Bailey and Everhart 1964) include graywacke and shale in the Harry area and altered greenstone or tuff in the nearby upper Cora Blanca and Los Angeles areas of the New Almaden Mining District (all near Mine Hill).

Silica carbonate bedrock is present in small areas of the Calero Reservoir watershed east of the reservoir, and in small areas near Cherry Creek on the west side of the reservoir.

The Santa Teresa Hills between Canoas and Calero Creeks also have silica carbonate bedrock. Mining operations here were limited as discussed in Section 2.5 on the Mining Operations.

Meterology

The watershed has a Mediterranean-type climate generally characterized by moist, mild winters and dry summers. The measurable precipitation is in the form of rainfall, 85 percent of which occurs between November and April. Mean annual precipitation ranges from 48 inches in the headwaters above the Guadalupe and Almaden Reservoirs to 14 inches at the Central San Jose rain gauge (station 131). Temperatures range from below freezing in the mountains for a few days in winter to nearly 100 °C in the hottest parts of the valley in the summer.

Limited information is available in the San Jose and greater San Francisco Bay Area on wet and dry deposition of mercury. The closest air monitoring station for mercury to the Guadalupe River Watershed is the one at Moffett Field in Sunnyvale. The annual rainfall at this monitoring station during a 1999-2000 pilot study was 14.33 in, and the volume-weighted average total mercury concentration in the rain was 9.7 ng/L (SFEI, 2001). The computed wet deposition flux was 3.5 $\mu g/m^2/yr$ in the South Bay. The total mercury concentration in ambient air at the South Bay station was 2.2 ng/m^3. The total mercury in the air was divided into 95 percent Hg^0, 2 percent RGM (Hg^{2+}), and 3 percent particulates based on literature values. An estimate of total deposition flux was made by multiplying the concentration of each species by the appropriate deposition velocity. The total dry deposition flux was estimated to be 19 $\mu g/m^2/yr$. Wet and dry deposition is expected to be higher in the upper parts of the watershed because of the higher rainfall (e.g., up to 48 in/yr) and higher dry deposition due to increased capture in the forested areas. Due to retention of deposition in the watershed, the portion of the total deposition flux that actually reaches surface water is less than the above estimates.

Methylmercury is found at low concentrations in wet deposition (e.g., 0.015-0.35 ng/L as summarized by St. Louis et al., 1995). No local data for methylmercury in rainfall are currently available.

Hydrology

The Guadalupe River plays an important role in flood control for the Santa Clara Basin and has been subject to modification since 1866. In the early 1960s, Canoas and Ross Creeks were rerouted to flow into Guadalupe River. More recently, it was modified as part of the 1975 Almaden Expressway construction project, where approximately 3,000 feet of channel was widened and moved eastward; the original channel was filled to allow construction of the northbound expressway. The riverine characteristics are as follows: concrete or rock-lined culverted (21 percent), natural modified (earthen channels, re-routed, or contained by levees) (38 percent), and natural, unmodified (40 percent) (Santa Clara Basin Watershed Management Initiative, 2000).

The Guadalupe River has different flow characteristics in the dry and wet seasons. The median flow in the Guadalupe River at the USGS gauge at St. Johns Street was 1 to 16 cfs between 1956 and 1998, which is dominated by the dry season (ALERT, 2003). In the wet season, flows increase substantially during storm events. Between 1930 and 1998, peak flows at the USGS gauge varied from 125 cfs in 1960 to 10,500 cfs on March 10, 1995. The large flows, such as in 1995 and 1998, resulted in flooding of the downtown area of San Jose. Flows rise quickly during winter storms with the peak occurring within 24 to 48 hours, and then return to normal flows over a period of a few days. The degree of flooding of the lower Guadalupe River is affected by the available capacity of the reservoirs at the time of a large storm event.

There are six water conservation and storage reservoirs in the watershed, which also provide varying amounts of flood control. These reservoirs are Calero Reservoir on Calero Creek, Guadalupe Reservoir on Guadalupe Creek, Almaden Reservoir on Alamitos Creek, Vasona Reservoir, Lexington Reservoir, and Lake Elsman on Los Gatos Creek above Lexington Reservoir. The storage capacity of the reservoirs is provided in Table 2-1. Water is transferred to Calero Reservoir from Almaden Reservoir via the Almaden-Calero Canal and from the Central Valley Project (CVP). The quantity of water transferred is highly variable from one year to the next. For example, the total water transferred from the CVP to Calero in 1999-2002 ranged from none to 4,209 acre-ft. Transfers from the canal were 1,690 acre-ft in 1998 and 3,950 acre-ft in 1999.

Table 2-1
Reservoir Capacity and Drainage Area of Reservoirs of Guadalupe River System (SCVWD/ACOE, 1999 and ALERT, 2003)

Reservoir (Creek)	Drainage Area Above Reservoir (sq miles)	Design Reservoir Capacity (acre-ft)
Almaden (Alamitos)	12	1,586
Guadalupe (Guadalupe Creek)	6	3,228
Calero (Calero Creek)	7	10,050
Lexington (Los Gatos Creek)	37.5	19,834
Vasona (Los Gatos)	44	400
Lake Elsman (Los Gatos Creek)	9.9	6,280

The Guadalupe River system has 15 subwatersheds, as shown in Figure 2-2. Guadalupe Creek and Alamitos Creek subwatersheds, which drain the former mining areas, comprise 26,206 acres, representing 24 percent of the entire Guadalupe River watershed (108,911 acres) (see Table 2-2). The area of these watersheds above the reservoirs is 16,000 acres or 14.7 percent of the total watershed. The relative proportion of typical flows during a large storm is shown in Figure 2-3. In large storms, flow above the Guadalupe River gauge at Almaden Expressway below Ross Creek has comprised between 37.5 and 99.4 percent of the total flow at the USGS gauge at St Johns Street downstream of Los Gatos Creek (SCVWD/ACOE, 1999). In the summer, flows are much less than as seen in Figure 2-4. Streamflow decreases downstream of the reservoirs due to percolation through the stream bottom and diversion to recharge facilities.

Table 2-2
Size of Subwatersheds
in Guadalupe River Watershed

Creek	Acres
Alamitos Creek	11,808
Calero Creek	6,762
Canoas Creek	11,899
East Ross Creek	1,311
Golf Creek	844
Greystone Creek	1,116
Guadalupe Creek	9,489
Guadalupe River	21,496
Lone Hill Creek	1,276
Los Gatos Creek	35,261
McAbee Creek	1,232
Randol Creek	1,416
Ross Creek	3,197
Santa Teresa Creek	1,285
Short Creek	519
Total Guadalupe Watershed	**108,911**

The effect of “flashy” wet weather flows during wet weather is that sediment transport is increased due to scouring of banks and the stream bottom. In such a system, the majority of the mercury load to the Bay would come from storm events, as was demonstrated by the recent sampling in December 2002 by SFEI. Sediment loading consists of two components: the suspended fraction and bedload. Estimates of suspended and bedload transport made using gauged flows, measured total suspended solids concentrations, and bedload estimates at the USGS gauge ranged from 36 to 74 M kg/yr (Porterfield, 1980). In the lower part of the Guadalupe River below the USGS gauge at St. Johns St., bedload is not be expected to be transported until the flow in the river reaches 115 cfs (ACE, 2002). The total annual bedload transport was estimated as 7.6 M kg/yr under pre-project conditions and 7.33 M kg/year for post-project conditions following completion of the new bypasses (ACE, 2002). An estimate of the sediment transported past Interstate I880 was 6.9 M kg/yr of sands and 33.3 M kg/yr of silts and clays; all but 0.12 M kg/yr of sands was estimated to be deposited upstream of the railroad bridge across Alviso Slough based on hydraulic modeling (NHC, 2000). Some information is available for Guadalupe Creek indicating that significant sediment transport to Alamitos Creek does not occur until flows reach 320 cfs, which has a 2-year recurrence interval, when about 140 tons/day of sediment could be transported (Jones and Stokes, 2000). At larger flows in Guadalupe Creek such as a flow with a 10-year recurrence interval, 1270 cfs, about 1000 tons of sediment/day could be transported downstream to Alamitos Creek. This sediment then enters the percolation pond system above a drop structure, so that all the sediment would not reach the Guadalupe River. Detailed sediment transport estimates for the other creeks have not been made.

The District removes sediment from the various drop structures and flood control structures for routine maintenance as shown for various parts of the Guadalupe River watershed in Table 2-3. The location of known drop structures are shown in Figure 2-5. Sediment would also be deposited in impoundments and in places where the flow regime changes from a high velocity reach to a deeper, slow-moving section. Specific locations where active bank erosion is occurring or could occur along tributaries to the Guadalupe River were identified in the sediment erosion surveys conducted in summer 2003 (see Appendix D of Synoptic Survey Report, Tetra Tech, 2003d). Reaches where potential erosion or bank undercutting was observed during the field surveys are identified in Figure 2-5. Examples of potential sediment erosion sites along the creeks are shown in Figure 2-6. The sediment quantities removed by the District provide an indication of the significance of sediment erosion and subsequent accumulation in the tributaries. Removal of sediment also removes mercury and prevents it from reaching San Francisco Bay. Additional data are needed to quantify sediment transport in the various creeks and to evaluate the reduction in mercury loading due to the District's sediment removal activities. In addition to the removal operations, stream bank protection projects have also been conducted. For example, in the Guadalupe River watershed, about 13,000 linear feet of bank was reworked from 1986 to 1995, and the estimated amount of future bank protection work in this watershed is 12,000 linear feet.

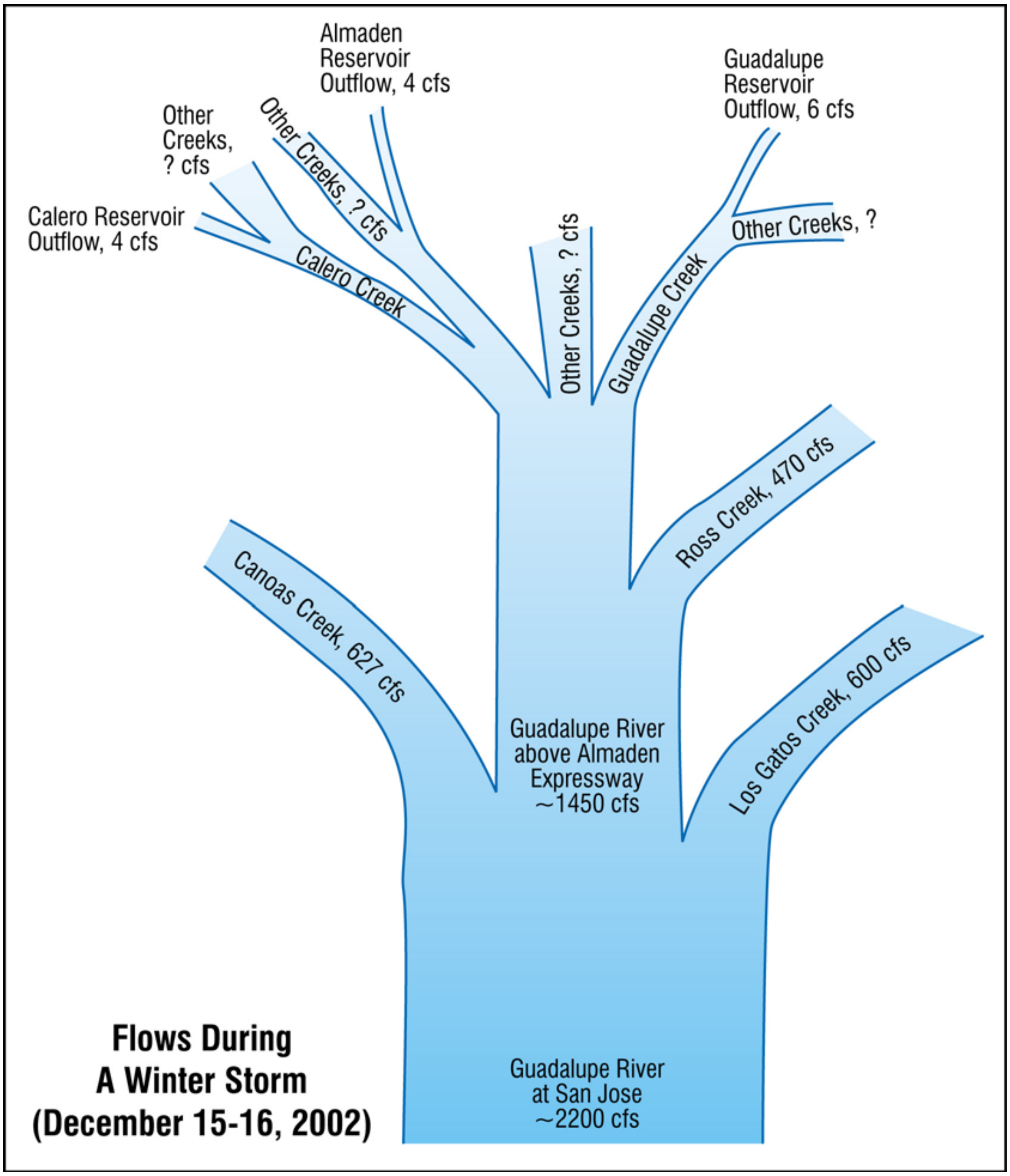


Figure 2-3. Schematic showing major flows in wet season along Guadalupe River system.

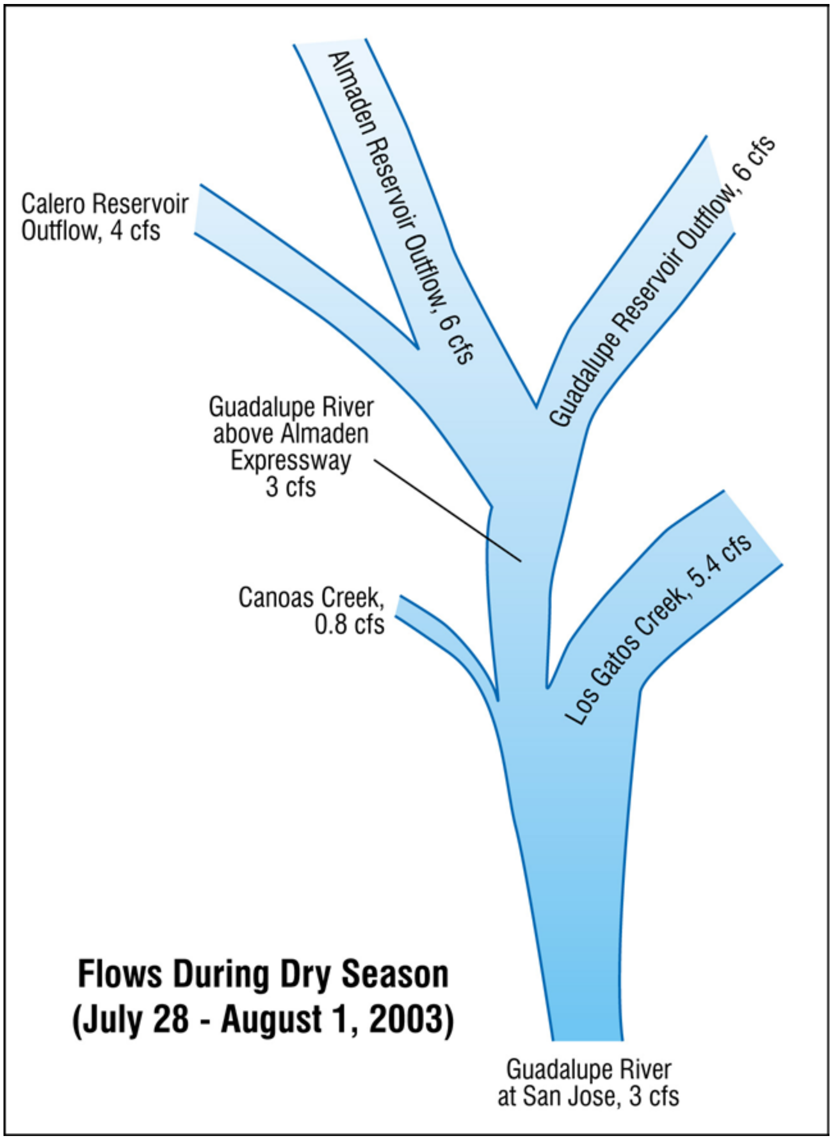


Figure 2-4. Schematic showing major flows during dry season along Guadalupe River system.

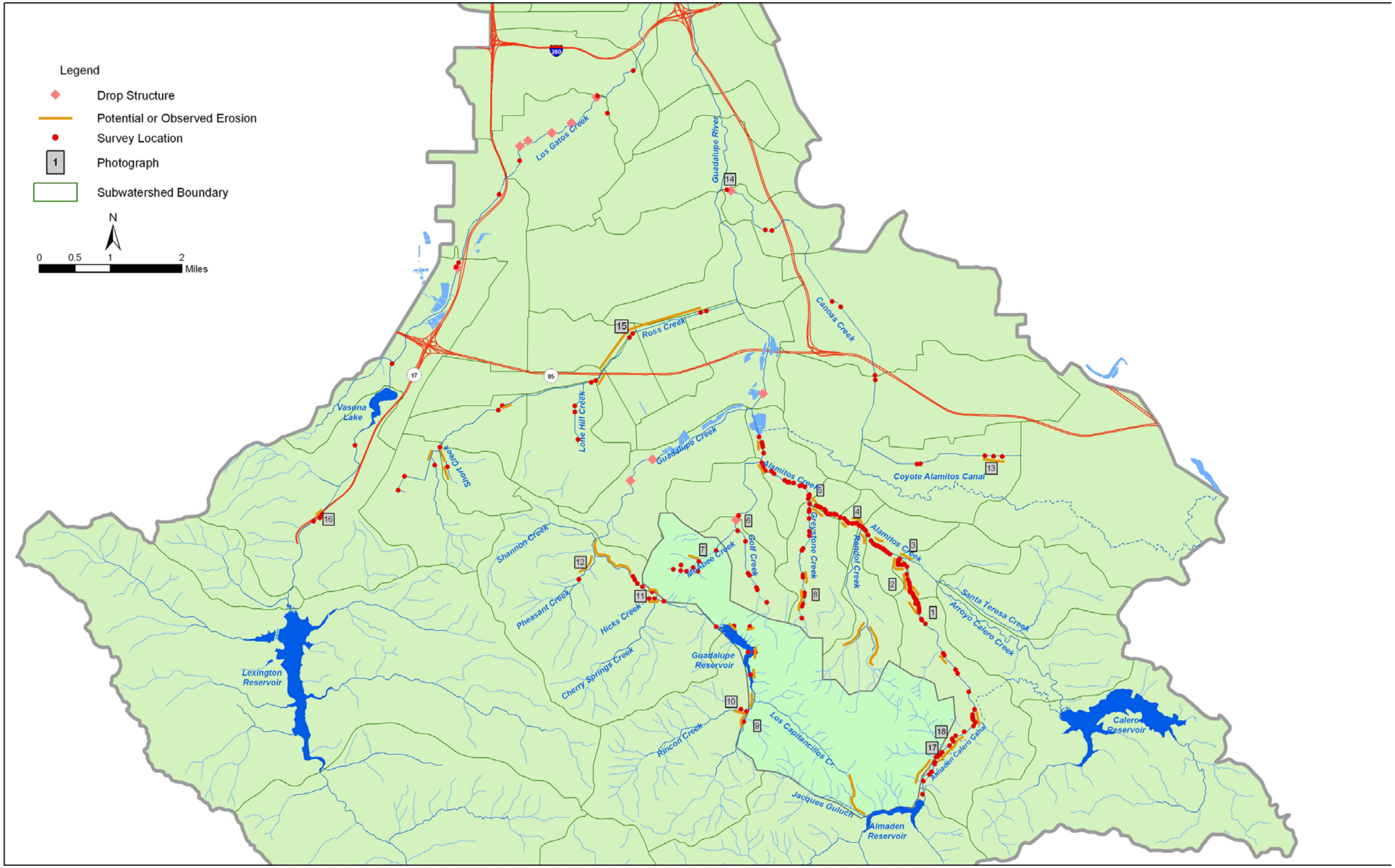


Figure 2-5. Location of potential erosion sites along the tributaries to the Guadalupe River.

Photographs of Potential Sediment Erosion Sites

Photo 1 **Eroding bank along Alamitos Creek**

Photo 2 **Undercut bank on Alamitos Creek**

Photo 3 **Gravel bar and undercut bank on Santa Teresa Creek**

Photo 4 **Potential erosion on Alamitos Creek**

Photo 5 **Steep bank on Alamitos Creek**

Photo 6 **Drop structure on McAbee Creek**

Photo 7 **Eroded bank on McAbee Creek below Senador Mine**

Photo 8 **Underbank on Greystone Creek**

Photo 9 **Potential bank erosion on Rincon Creek**

Photo 10 **Potential bank erosion on Rincon Creek**

Photo 11 **Potential bank erosion on Hicks Creek**

Photo 12 **Potential erosion on Pheasant Creek**

Photo 13 **Eroding bank on Canoas Creek**

Photo 14 **Drop structure on Canoas Creek**

Photo 15 **Eroded bank on Ross Creek**

Photo 16 **Potential erosion on Los Gatos Creek**

Photo 17 **Eroded bank on Alamitos Creek**

Photo 18 **Steep bank on Alamitos Creek**

Figure 2-6. Examples of sediment erosion and bank undercutting sites.

Table 2-3
Past Sediment Removal Operations in Guadalupe River Watershed

Creek	Sediment Removed 1980 - 89 (cu yds)	Sediment Removed 1990 - 98 (cu yds)	Sediment Removal for Next 10 Years (cu yds)
Alamitos Creek	NA	NA	NA
Canoas Creek	38,056	3515	48,000
Guadalupe Creek	330	NA	1,500
Almaden-Calero Canal	NA	NA	NA
Coyote-Alamitos Canal	NA	NA	NA
Greystone Creek	3630	15	5,000
Randol Creek	7,110	NA	3,000
Guadalupe River	12,107	33,062	94,000
Ross Creek	6,720	3,462	8,000
Golf Creek	2090	200	NA
Lone Hill Creek	NA	20	NA
Los Gatos Creek	350	NA	NA

Data are from SCVWD, 2002.
NA = Data not available at time of printing.

The recent flood control projects in downtown San Jose also involve removal of sediment and reworking of the channel. The Lower Guadalupe River Project is designed to increase the capacity of the river channel to handle the one-in-a-100-year flood between Highway 101 and the Union Pacific Bridge in Alviso. The Downtown Project is designed to make channel improvements along a 3-mile stretch from Highways I-880 to I-280. The Upper Guadalupe Project extends from I-280 to Blossom Hill Road along the Guadalupe River and from I-880 to Highway 101 along Ross and Canoas Creek. Channel modifications to improve stream habitat were made in 2001 along a portion of Guadalupe Creek above its confluence with Guadalupe River and below Masson Dam. Sediment was also removed in conjunction with projects to improve fish passage along Guadalupe Creek. A fish ladder was built to bypass the Alamitos Drop Structure in 1999 and to bypass Masson Dam in 2000. Flood control projects can also decrease the extent of erosion along stream banks by installing bank protection measures and by changing the energy gradient to reduce high velocity segments.

Mining Operations and Existing Conditions

The mercury deposits were first discovered by Indians and Mexicans prior to 1845. The New Almaden Mining District (a group of seven adjacent mines, most underground, in the upper part of the Guadalupe Creek and Alamitos subwatersheds) operated from 1846 to 1975. Figure 2-7 shows the major mine-related features in the upper Guadalupe River Watershed. Most of the ore was derived from cinnabar in silica carbonate deposits, but there was some native mercury in the underground veins such as in the Harry area near Mine Hill. A placer deposit of cinnabar nuggets in stream gravels was mined from 1945 to 1947 in lower Deep Gulch Creek where it joined Almaden Canyon (Bailey and Everhart, 1964).

A total of about 38.4 million kilograms of mercury was produced; about 70 percent of the production came before 1875, and about 80 percent before 1935. Prior to construction of the Guadalupe and Almaden Reservoirs in 1935, roasted mine wastes, called calcines, and other mine wastes were placed in or near the creeks where the materials could be transported downstream. Calcines and other mine wastes are still present along the banks of Alamitos Creek above Hacienda Yard and in some downstream reaches of Alamitos Creek from Bertram Road to Graystone Lane, Deep Gulch, Jacques Gulch, and Guadalupe Creek above Camden Avenue. Because the ore is from silica carbonate deposits, the mine wastes are often found as cemented deposits along the creek banks.

The production activities at the New Almaden Mining District are well characterized, and there is considerable information regarding concentrations of total mercury remaining in the soils. The early veins mined had rich ore of up to 20 percent mercury, which was hand-sorted prior to processing in furnaces and retorts (Bailey and Everhart, 1964). In later years, the percent mercury in the ore declined to 0.5 percent. The average grade of the ore processed over the 100-year life of the mines was nearly 4 percent, about a flask of mercury per ton of rock. As seen in Table 2-4, most of the production came from the mines on Mine Hill within the New Almaden Mining District. The ore was roasted in retorts or furnaces at a temperature of 700 to 1,200 °F; the efficiency of the equipment varied, resulting in varying mercury content in the waste calcines. Large furnaces and retorts were present in Hacienda Yard and on Mine Hill, which generated significant waste deposits. A group of 14 small furnaces were used on the banks opposite the Hacienda Furnace Yard. Retorts, used for shorter periods of time, were present at the Guadalupe, Senador, Enriquita, and San Mateo Mines, resulting in smaller waste dumps at these sites. Small retorts, which were sometimes portable units, were used at the Day Tunnel, upper Deep Gulch Creek, and San Cristobal Tunnel. Visible waste dumps were not observed at the latter site (WCC, 1992).

Prior to remediation, mercury concentrations in the mine wastes within the boundaries of Almaden Quicksilver County Park ranged from 10 to 1,000 mg/kg; the median of 37 sites was 84 ppm (CDM, 1992). Calcines and furnace dust piles around the main retort sites at Hacienda Yard, on top of Mine Hill, and near the Senador, Enriquita, and San Mateo Mines were removed in 1990, covered with soil, re-graded, and re-vegetated. Most of the calcines were placed in the San Francisco Open Cut on Mine Hill, where they were covered with soil, and revegetated. The remaining calcines at the Hacienda Furnace Yard were covered with a 2-foot soil cap (DTSC, 2002). Calcines present on the opposite bank from the Yard were not removed or covered. Calcines at Enriquita and San Mateo were buried near the former retort sites.

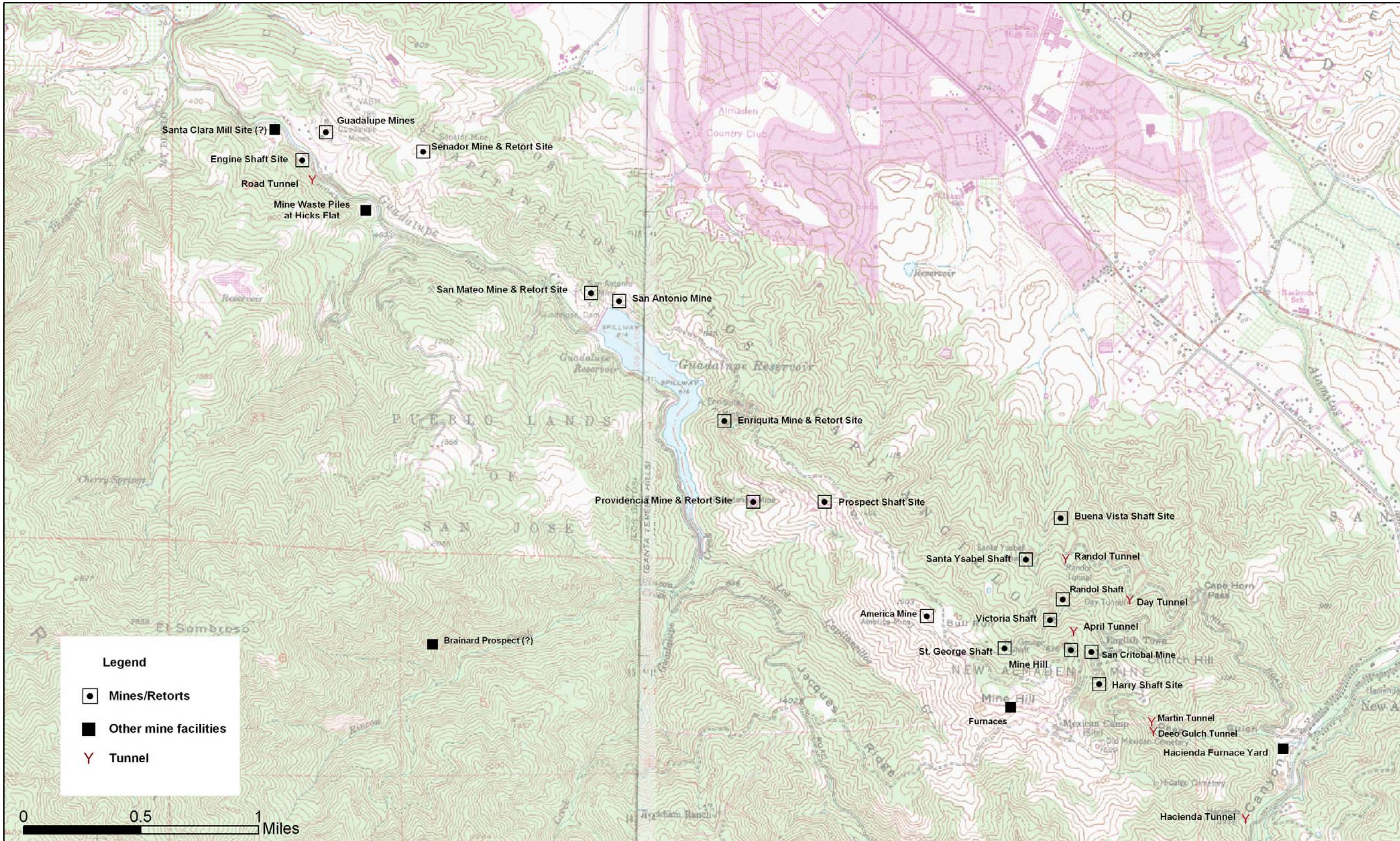


Figure 2-7. Map of major mine-related features (Mine Hill had multiple shafts and open-cut operations, not shown here).

Table 2-4
Production of Mercury from Major Mines in New Almaden Mining District
(Bailey and Everhart, 1964 and Cox, 2000)

Mine	Period of Operation	Mercury Produced (Flasks)
New Almaden Mines	1846 to 1975	1,096,411
America Mine	1800s to 1960s	<2,500
Guadalupe Mine	1846, 1920-1930 & 1947-75	112,623
Enriquita	1859-75,1892, 1927-1935	10,571 by 1865, then <100
San Mateo	1860-70s, 1890-1901,1915-1917, 1935-40	At least 1,000
San Antonio	1848, 1915-1917	Small amounts
Providencia	1860-1870,1882, 1909,1942	<2,000
Senador	1860-1900, 1916-1926, 1940s	About 24,500

On the Hacienda Yard next to Alamitos Creek, a concrete cutoff wall and gabion and rock slope protection were installed on the western bank.

Observations from recent site visits to the former mines show that the calcine disposal areas are being protected from erosion by the vegetation and runoff control measures implemented. Mine waste piles at former mines; such as near the Senador Mine, have been seeded with grass, but there are places where active erosion is occurring. The boundaries of the subwatersheds within Almaden Quicksilver County Park were used to determine which creek could receive mine-related runoff. Runoff from the Senador Mine reaches McAbee Creek, which discharges into Golf Creek, and then into Alamitos Creek. Calcines and other mine wastes are present in Jacques Gulch, which discharges into Almaden Reservoir, and Deep Gulch, which discharges into Alamitos Creek. Within Almaden Quicksilver County Park, there are former mine roads where isolated mine wastes are evident in the larger cobble and gravel size materials, which are actively eroding. Runoff in some of these areas could reach Jacques Gulch, which discharges into Almaden Reservoir. Other areas would discharge into North Los Capitancillos Creek, which discharges into Guadalupe Reservoir, and directly into this reservoir. Mine seeps are present from former tunnels and adits such as at the Day Tunnel and above Randol Creek, which both ultimately could reach Randol Creek, and then Alamitos Creek.

The locations of reaches of the creeks where calcines were observed during the field surveys in summer 2003 are identified in Figure 2-8. Example photographs of the creek reaches with cemented and loose calcines and other mine waste deposits are shown in Figure 2-9. Above the Hacienda Furnace Yard along Alamitos Creek, there are large non-cemented deposits of calcines on the slopes above the creek. Both early

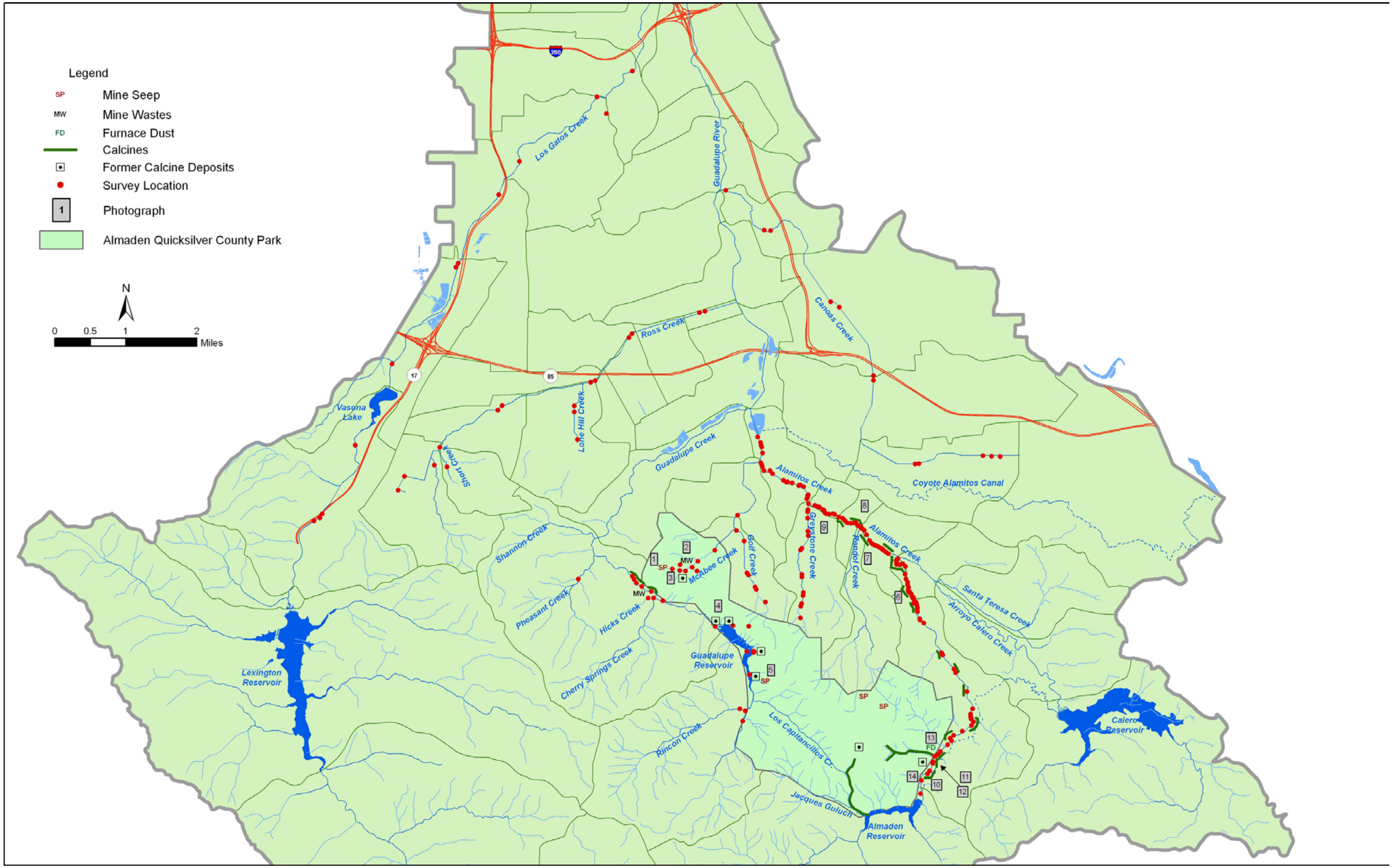


Figure 2-8. Location of exposed mine wastes and seeps along the tributaries to the Guadalupe River.

Photographs of Exposed Mine Wastes, Seeps, etc.

Photo 1 **Mine Seep at Senador mine**

Photo 2 **Mine Waste Piles at Senador Mine**

Photo 3 **Senador Mine Reduction Works**

Photo 4 **Silica carbonate outcrop at San Mateo Mine**

Photo 5 **Mine wastes and seeps near Enriquita Mine and seeps**

Photo 6 **Cemented calcine on Alamitos Creek**

Photo 7 **Cemented layers on Alamitos Creek**

Photo 8 **Undercut calcines on Alamitos Creek**

Photo 9 **Cemented calcines on Alamitos Creek**

Photo 10 **Calcines along the edge of Alamitos Creek**

Photo 11 **Calcines on the upper flood plain above Alamitos Creek**

Photo 12 **Close-up of calcines above Alamitos Creek**

Photo 13 **Furnace dust beneath an Alamitos Creek bridge**

Photo 14 **Calcine deposits on hill below road slip above Alamitos Creek**

Figure 2-9. Examples of calcine deposits and other mine wastes in or near creeks.

calcines composed of cobble-sized material and later calcines from the Scott furnaces composed of minus 3-inch material are present. These deposits could be subject to movement during large winter storms and by mass-wasting and landslides, such as occurred in February 1938. In the reach of Alamitos Creek between Bertram Road and Harry Road there are small deposits along the banks, of which some are cemented and some are loose. Many of these deposits are above the low flow channel. Clear evidence of channel movement and active erosion in the 1995 winter storm was observed along this reach. A small area of furnace dust was observed under the Almaden Road bridge, which could be eroded into the creek during large storms. Movement of larger gravel-size particles past Harry Road is unlikely due to thick vegetated sections, which occurred at several places along this reach. On Alamitos Creek downstream of Harry Road, there are calcine areas, which are often cemented and limited in extent, such as six sites between Harry Road and Graystone Lane that may be remediated under future SCVWD projects. Calcines are observed in the gravel bars along the entire reach of Alamitos Creek.

Along Guadalupe Creek outside of the Almaden Quicksilver County Park, possible calcine deposits were observed along the banks of upper Guadalupe Creek near the former Guadalupe Mine, also shown in Figure 2-8. A mine waste pile is present at Hicks Flat on the opposite side of Guadalupe Creek from the main mine. The pile is partly vegetated, but large storm events could potentially move mine wastes into Hicks Creek, then into Cherry Springs Creek, and eventually into Guadalupe Creek.

There are two much smaller mines in the Canoas Creek watershed, the Santa Teresa and Bernal Mines. The Santa Teresa mine was operated as an underground mine from 3 main adits. In 1903, a 40-ton Scott furnace was installed, which produced 9 flasks of mercury (Bailey and Everhart, 1964). The Bernal Mine was an underground mine with 2 shafts and an adit by 1902. In 1942, two new holes were drilled, and in 1946, the adit was extended, and a retort was installed. The mine was idle by 1947, and no evidence of mercury production was found in the abandoned retort.

While the mine production and location of deposits are well-characterized, we do not have sufficient knowledge about the relative importance of the mercury loading from the mining district to the overall mercury dynamics in the watershed. Nor do we have current quantitative estimates of the annual contribution of mercury from the mining area to the downstream Guadalupe River. The long-term fate and bioavailability of this source of mercury are also not well understood.

Land Uses

The Guadalupe River Watershed is located in the Santa Clara Basin and is largely undeveloped in its upper zone above the reservoirs, with pockets of high-density residential areas. Three-quarters of this area is protected. Virtually all headwaters drain from the protected areas. The lower zone is typical of watersheds in the Santa Clara Basin, with high-density residential use predominating and commercial and public/quasi-public developments being interspersed. The lower zone is atypical of other watersheds in the area due to the presence of agriculture (Santa Clara Basin Watershed Management Initiative, 2000) (Table 2-5).

2.2 Description of Existing Mercury Data and Other Relevant Data

The Guadalupe River watershed has been divided into four segments that have similar characteristics in terms of mercury contamination: reservoirs, creeks affected by mining in the Almaden Mining District, creeks not directly influenced by mining activities, and the Guadalupe River. The entire watershed receives atmospheric deposition. Guadalupe and Almaden Reservoirs are influenced by mercury mining activities. Calero Reservoir is influenced by water transferred from other sources (the Central Valley Project and Almaden Reservoir via the Almaden-Calero Canal) and by limited mine prospecting in its watershed. The creeks influenced directly by mercury mining include: Guadalupe Creek, Alamitos Creek and its intermittent tributaries Randol Creek, and McAbee Creek. The latter creek drains into Golf Creek, also a tributary to Alamitos Creek. Another tributary to Alamitos, Greystone Creek, has small intermittent tributaries that drain the eastern side of Los Capitancillos Ridge, but they are not near known mines. Calero Creek is affected indirectly as explained above.

Historical Mercury Data in Water

Several locations along the Guadalupe River system were sampled in October 2000 by the USGS under dry and wet conditions (Thomas, et al., 2002). The data from this event are summarized in Table 2-6. The flow at the USGS gauge at the time of the dry weather sampling was 14 cfs, and 147 cfs on October 26 and 23.9 cfs on October 27 during the wet weather sampling. The highest total mercury at the USGS gauge was associated with the highest observed flow. The difference in dissolved mercury was less pronounced than the total mercury.

From 1994 to 2003, water samples have been collected in the wet season at five locations that drain the Almaden Quicksilver County Park by the Santa Clara Parks and Recreation Department (SCPRD). The sites are shown in Figure 2-10. The total mercury in the 2000-2002 water samples was analyzed using EPA Method 1631. One site on Randol Creek above the Mockingbird Park entrance was not sampled recently. The Senador Mine site drains to McAbee Creek, which drains into Golf Creek, and then into Alamitos Creek. The Mine Hill site (Jacques Gulch) drains to Almaden Reservoir. Deep Gulch drains to Alamitos Creek during the wet season, but percolates underground in the summer. This site is not shown on Figure 2-10, as it was not sampled in 2003. In 2003, two sites were added: one site at North Los Capitancillos Creek above Guadalupe Reservoir, and a second site at a gully draining part of the

Table 2-5
Acreage of Existing (1995) Land Uses for the Guadalupe River Watershed

Land Use	Acreage
Residential	32,230
Commercial	4,888
Public/Quasi-Public	2,777
Industry-Heavy	3,397
Industry-Light	2,049
Transportation/Communication	1,700
Utilities	15
Landfills	–
Mines, Quarries	28
Agriculture	3,120
Forest	37,810
Rangeland	16,859
Vacant, Undeveloped	1,145
Wetlands	–
Bays, Estuaries	–
Freshwater	399
Total Acres	108,900

Adapted from: Santa Clara Basin Watershed Management Initiative. Table 4-2. (2000).

Table 2-6
Comparison of Dry and Wet Weather Water Samples for Mercury

	Dry Conditions (October 2000)	Wet Conditions (October 26-27, 2000)
Sampling Sites	**Total Hg, ng/L**	**Total Hg, ng/L**
Guadalupe River		
above Alviso Slough	86	59, 99
at Orchard Lane	19	NA
at USGS Gauging Station	26	18, 13.9
at Almaden Expressway	55	83
below Guadalupe Reservoir	NA	44
Los Gatos Creek	3	3, 2.9

Data are from Thomas et al., 2002.

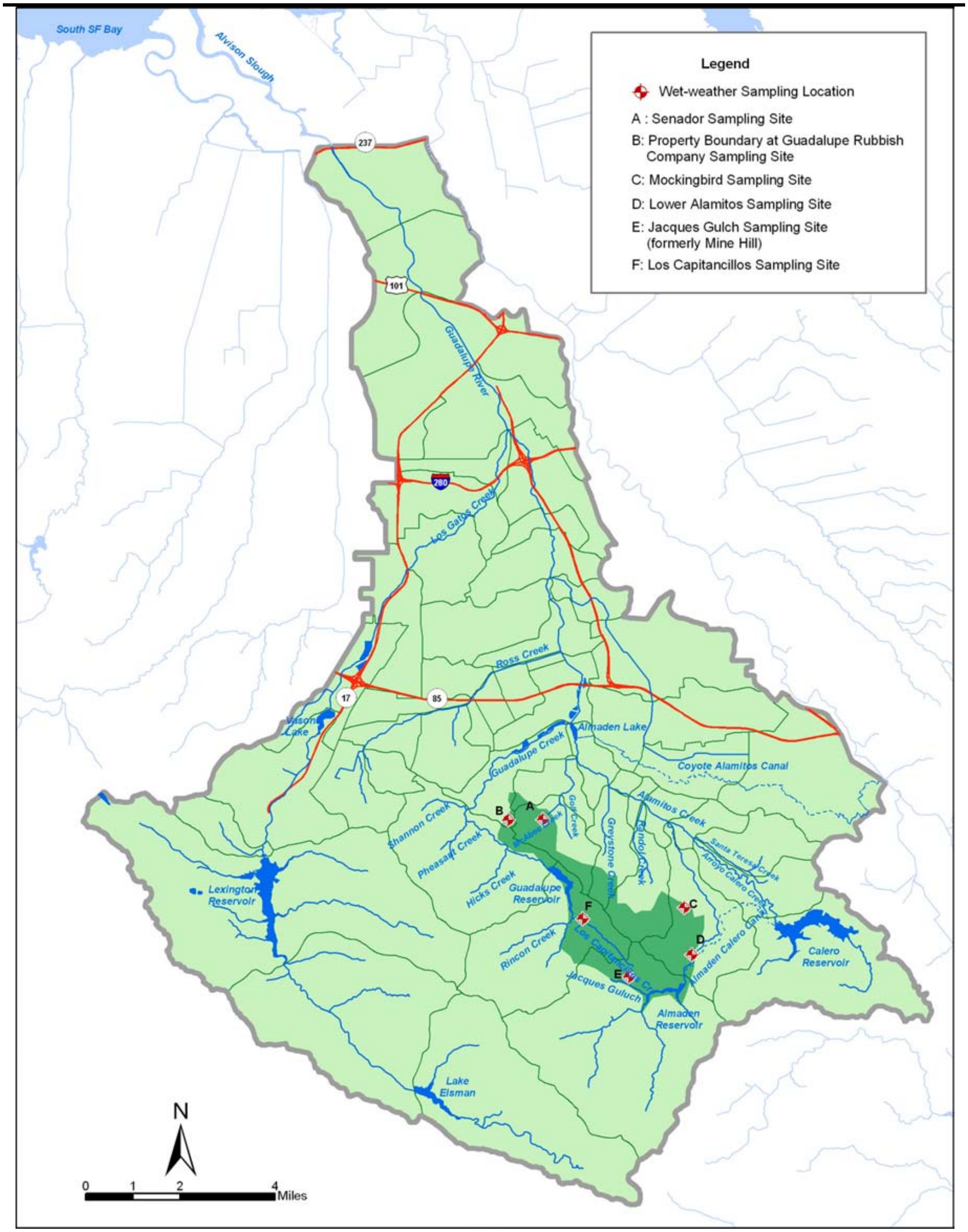


Figure 2-10. Wet-weather sampling locations used in 2003 for Almaden Quicksilver County Park by SCPRD.

Guadalupe Landfill above McAbee Creek. The Deep Gulch and Upper Alamitos Creek sites were dropped. The 2000-2003 data for these sites are summarized in Table 2-7. The highest mercury concentrations occurred in January 2000 at most sites when the suspended solids were high and the total rainfall for the day before sampling was 2.52 in and 3.11 in on the day of sampling (SCPRD, 2003).

Water samples were collected under both dry and wet conditions at several locations along Guadalupe Creek prior to the restoration project that extended from Masson Dam to Almaden Expressway (Tetra Tech, 2000 and 2001). The total mercury on Guadalupe Creek above Camden Avenue at the gauge on Hicks Road was 51.6 ng/L in September 2000 and 64 ng/L in February 2000, compared to 33.15 ng/L in July 2003 under low flow conditions. Methylmercury concentrations were 1.61 ng/L in September and 0.53 ng/L in February, compared to 5.2 ng/L in July. The downstream end of Guadalupe Creek was also sampled on these dates. Total mercury in the 2003 samples was 38.9 ng/L, which was within the range of the 2000 samples, 11.6 to 74.1 ng/L. Methylmercury was 1 ng/L in the July 2003 sample and 0.31 to 0.51 ng/L in the 2000 samples. The higher methylmercury and lower total mercury is consistent with summer conditions.

Historical Sediment Data

Numerous measurements of total mercury have been made in stream and river sediments and in the embankments along the Guadalupe River system, as summarized in Table 2-8. Past sediment and soil sampling in drainages of the mining area has identified areas with mercury concentrations of concern, such as Alamitos Creek and Jacques Gulch.

Sediment samples were collected in 1989 at several locations in the upper parts of the watershed in or near the former mining areas (Dames & Moore, 1989). The 1989 samples were collected prior to the remediation efforts on Mine Hill and in the lower portions of Deep Gulch Creek within the Hacienda Yard. Sediment samples from Deep Gulch Creek had total mercury ranging from 2 to 590 mg/kg on a wet weight basis. Sediment sampling was conducted in Alamitos Creek from 1985 to 1989 below the reservoir; total mercury ranged from 1.5 to 95 mg/kg on a dry weight basis (WCC, 1992). A tributary of Randol Creek sampled in 1992 had total mercury of 5.1 to 230 mg/kg on a wet weight basis (WCC, 1992). These data illustrate the high mercury concentrations present in the mining area prior to the remediation efforts.

Guadalupe Creek above Camden Avenue was sampled from 1980 to 1989 by the USGS; total mercury ranged from 0.04 to 70 mg/kg dry (WCC, 1992). These samples had higher mercury than those from Los Gatos Creek, not affected by mining. Sediment samples from Los Gatos were collected by the USGS at Lincoln Avenue, above the confluence with the Guadalupe River and further upstream. The total mercury in the samples from Lincoln Avenue in 1980 to 1983 was 0.03 to 0.07 mg/kg dry.

Table 2-7
Mercury Concentrations in Stream Water Samples Draining Almaden Quicksilver County Park

Sampling Site	Dates Sampled (Number of Dates)	Total Suspended Solids (mg/L)	Total Mercury (ng/L)
Deep Gulch Creek	2000-2002 (6)	<1-11	23–2,180
Upper Alamitos Creek	2000-2002 (6)	5.1-19	10.6-71.7
Lower Alamitos Creek	2000-2003 (8 +2 replicates)	2.2-19	18-2,456
Senador Mine	2000-2003 (8 +2 replicates)	<0.5-57	21.9-3,692
Mine Hill	2000-2003 (8 +2 replicates)	<1-680	4.3-6,667
N. Los Capitancillos	2003 (2 +2 replicates)	5.4	5.8-26
Landfill Gully	2003 (2 +1 replicates)	1.9-21	79-60

Table 2-8
Existing Data on Mercury Concentrations in Sediment and Bank Soils in Guadalupe River Watershed

River/Creek Reach	Total Mercury	Methylmercury
Upper Guadalupe River Project	<0.1-250 mg/kg wet bed and Bank Sediments	NS
Downtown Guadalupe River Project	<0.1-22 mg/kg wet bed and Bank Sediments	NS
Lower Guadalupe River Project	<0.1-120 mg/kg wet bed and Bank Sediments	NS
Almaden Reservoir and Canal	0.8-41.2 mg/kg Almaden Reservoir; 0.14-0.85 mg/kg dry Almaden-Calero Canal	NS
Guadalupe Reservoir	2.3-2.4 mg/kg dry Guadalupe Reservoir; 9.6-40.6 mg/kg dry Guadalupe Cr above Reservoir	NS
Calero Reservoir	0.06-1.2 mg/kg dry Calero Reservoir; 1.1-3.1 mg/kg dry Calero Creek	NS
Guadalupe Creek	0.72-69 mg/kg dry Floodplain Soils; 0.35-31.7 mg/kg dry Guadalupe Cr sediments 0.03-203 mg/kg dry Bank Soils	0.0004-0.042 mg/kg dry Guadalupe Cr sediments
Alamitos Creek	1.5-95 mg/kg dry below reservoir	0.0013 mg/kg
Other Tributaries	Los Gatos Cr below reservoir; 0.02-1.5 mg/kg dry Canoas Cr: 0.1 mg/kg wet	NS
Upper Guadalupe River Watershed Creeks	Sediments from Tributaries draining former mining area: 0.7-730 mg/kg dry	NS

Data are presented in more detail in the Preliminary Problem Statement (Tetra Tech, 2003b). Wet or dry refers to weight basis for soil/sediment samples.

Sediment samples were collected from the Guadalupe River in October 2000 by the USGS at the Alamitos Fish Ladder, at Hillsdale Avenue, and at Almaden Expressway (Thomas et al., 2002). Total mercury was 33.4 mg/kg dry upstream of the ladder, 6.72 mg/kg below the ladder and 2.8 mg/kg at Almaden Expressway. Methylmercury at these locations was 0.0078, 0.0018, and 0.0017 mg/kg dry, respectively. The July 2003 sample below the drop structure (site 10) had 69.5 mg/kg dry total mercury and 0.0017 mg/kg dry methylmercury.

Sediment sampling from Alamitos Creek below Harry Road was conducted in 2002 (LAS, 2002). Total mercury ranged from 0.5 mg/kg in a bank sample to 97 mg/kg in a sediment sample from the edge of the creek. Additional samples have been collected from Alamitos Creek by the SCVWD. Bank sediment samples above Mazzone Drive had total mercury of 24 mg/kg in a sediment sample from the active channel and 6.6 to 62 mg/kg in bank samples. Composite samples from the flat bench above Alamitos Creek above Graystone Lane had 4.1 to 17 mg/kg (HSR, 2003). Composite samples taken further upstream opposite Pricewood Court had mercury in two samples closest to the creek of 61 and 130 mg/kg and 40 to 64 mg/kg further away from the active channel.

Mercury Data from Synoptic Survey

Water and sediment sampling were conducted in four reservoirs, at Almaden Lake, in six creeks, and below a mine seep during July 28-31, 2003 in the Guadalupe River watershed as described in the Synoptic Survey Report (Tetra Tech, Inc., 2003d). The sampling locations are shown in Figure 2-11; the location and rationale are provided in Table 2-9.

Results for Reservoirs

Water samples were collected from four reservoirs. Almaden, Guadalupe, and Calero Reservoirs were sampled at three locations: at 1 foot and at a depth of 40 feet near the dam, at 1 foot in a shallow area about 10 ft deep, and at 1 foot in a shallow area with vegetation near the shoreline. Lexington Reservoir was sampled only at 1 foot and 40 feet near the dam. In the reservoirs near the dams, the depth of 40 feet was about 10 to 20 ft below the thermocline. All four reservoirs were stratified and had less than 1 mg/L of dissolved oxygen in the deeper hypolimnion. Suspended solids were similar in all the reservoirs, less than 3.6 mg/L. All the reservoirs were alkaline and eutrophic. Total mercury concentrations ranged from 5.64 to 19.96 ng/L in Guadalupe and Almaden Reservoirs, compared to 1.37 to 3.44 ng/L in Calero and Lexington Reservoirs (Figure 2-12). Methylmercury concentrations ranged from 0.29 ng/L to 4.62 ng/L (Figure 2-13).

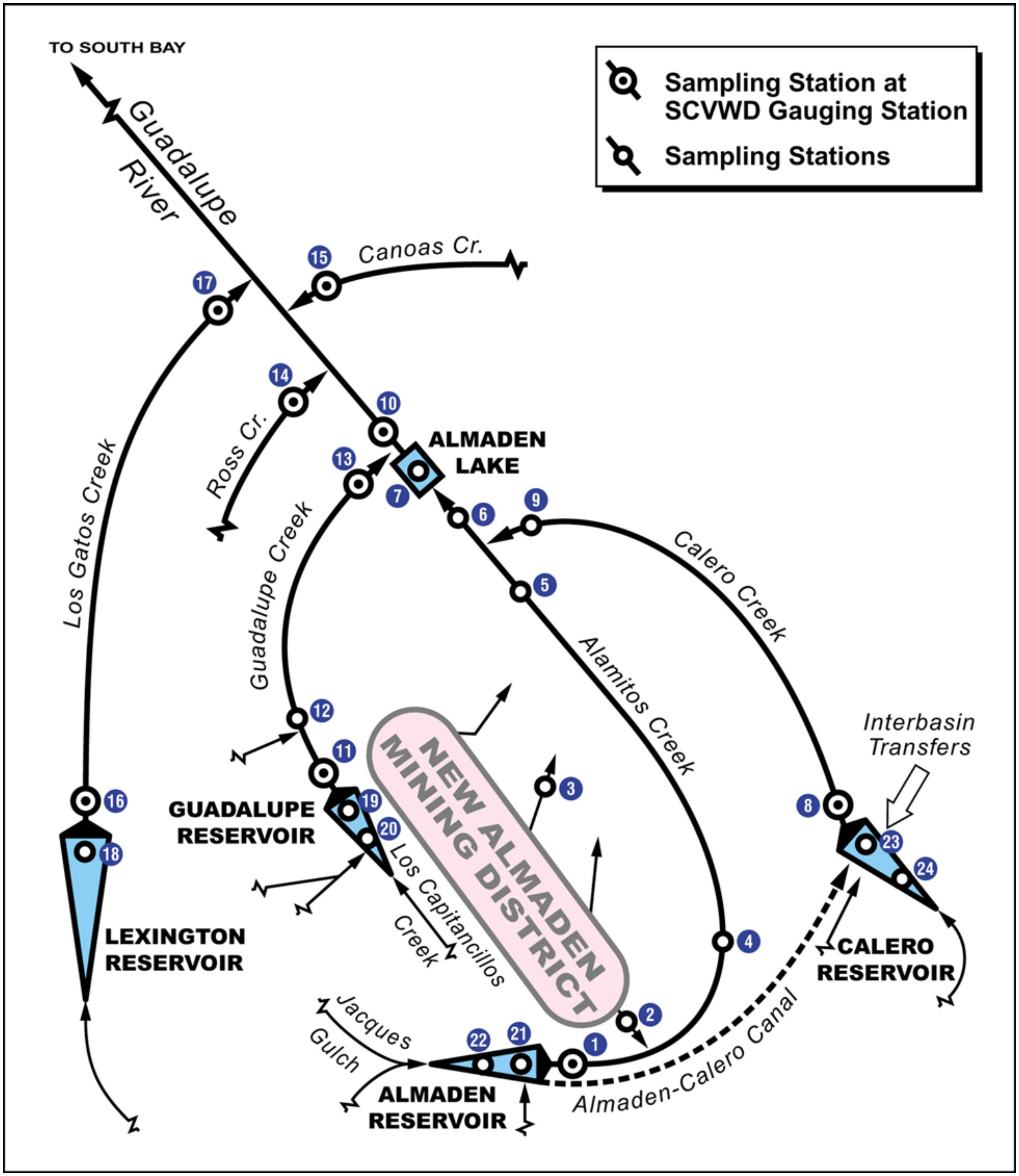
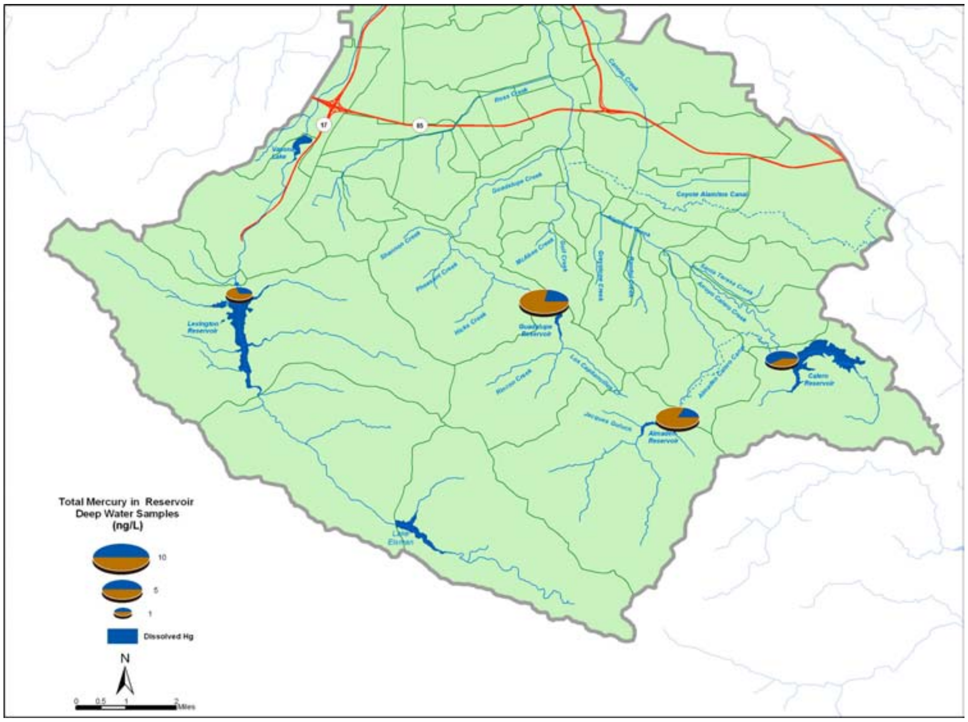


Figure 2-11. Schematic diagram of sampling locations. Numbers identify individual sampling stations, see Table 2-9.

Table 2-9
Sampling Locations and Rationale

Sample No.	Sample Type	Waterbody(ies)	Location(s)	Rationale for Sampling
1, 4 – 6, 11 - 13	Creek Water and Sediment	Guadalupe and Alamitos Creeks	7: Outlet of reservoir & 2 on Guadalupe; outlet & 3 stations on Alamitos	• Determine Hg concentrations (total and MeHg, filtered and unfiltered) in creeks below reservoirs in mining district • Contribute to establishment of existing conditions
2	Creek Water and Sediment	Deep Gulch Creek	Mouth of creek	• Determine Hg concentrations (total and MeHg, filtered and unfiltered) in creek that drains mining district • Contribute to establishment of existing conditions
3	Mine Seep Water and Sediment	Mine Seep near Randol Creek	Mine seep	• Determine Hg concentrations (total and MeHg, filtered and unfiltered) in mine seep • Compare to creek samples from mining district
7	Lake Water	Almaden Lake	Central area	• Determine Hg concentrations (total and MeHg, filtered and unfiltered) in lake • Compare to creek samples to determine changes across lake
8, 9	Creek Water and Sediment	Calero Creek	2: Outlet of Calero Reservoir and mouth of creek	• Determine Hg concentrations (total and MeHg, filtered and unfiltered) in creek that is in lightly-developed area • Contribute to establishment of existing conditions
10	River Water and Sediment	Guadalupe River	Below confluence of Guadalupe & Alamitos Creeks	• Determine Hg concentrations (total and MeHg, filtered and unfiltered) at start of river • Contribute to establishment of existing conditions
14 - 17	Creek Water and Sediment	Los Gatos, Canoas, Ross (dry)	4: Outlet of Lexington Reservoir & mouth of each creek	• Determine Hg concentrations (total and MeHg, filtered and unfiltered) in tributaries in area without mine influence, but influenced by urbanization • Contribute to establishment of existing conditions
18	Reservoir Water	Lexington Reservoir	2: Above and below thermocline at single station	• Absence of direct mine-derived Hg source, control for other reservoirs
19 - 24	Reservoir Water	Guadalupe, Almaden, Calero	4: Shallow & deep; above and below thermocline	• Determine Hg concentrations (total and MeHg, filtered and unfiltered) • Compare waterbodies with different limnological and Hg-source characteristics • Contribute to establishment of existing conditions

a) Deep Water



b) Shallow Water

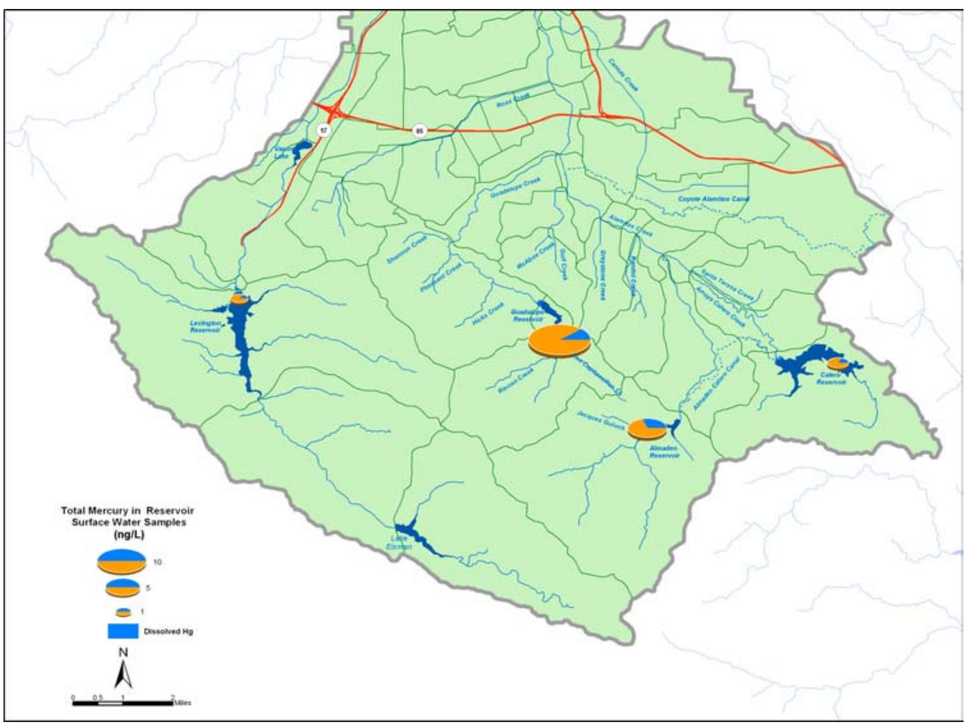
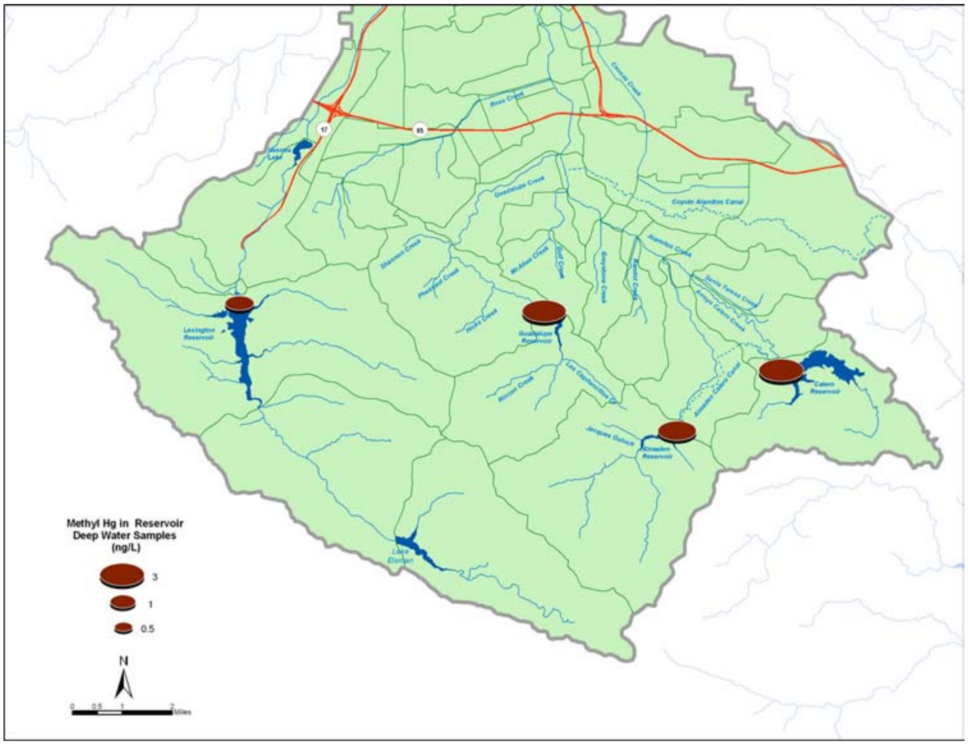


Figure 2-12. Total mercury in reservoirs a) deep water and b) shallow water (size of disk is proportional to total mercury concentration. Proportion of dissolved mercury is indicated for each sample).

a) Deep Water



b) Shallow Water

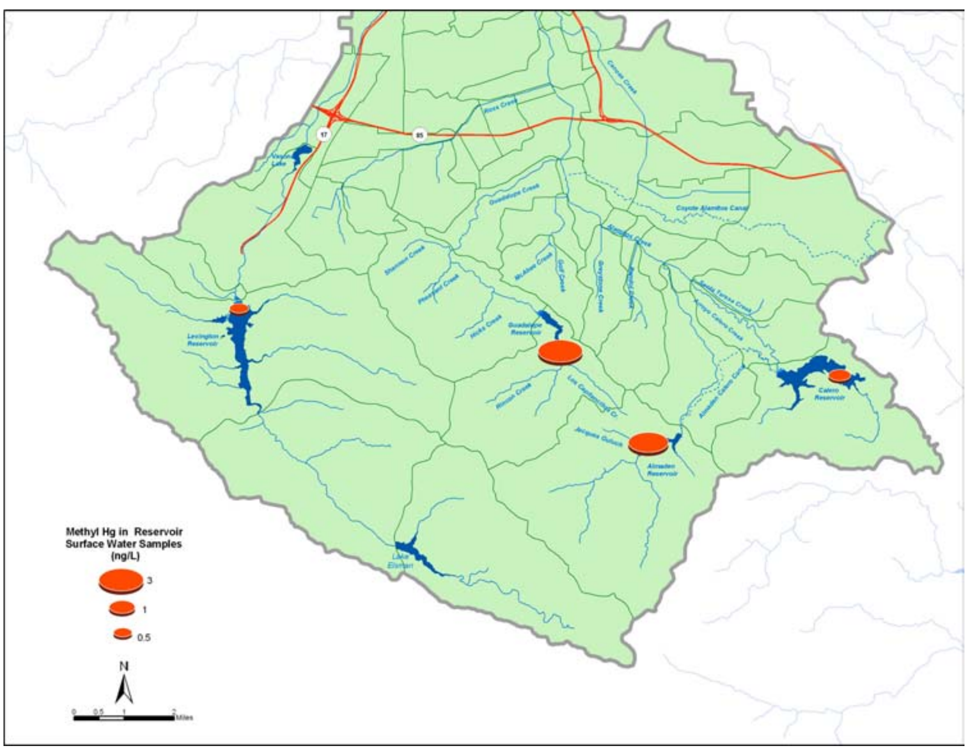


Figure 2-13. Methylmercury in reservoirs a) deep water and b) shallow water.

Results for Creeks and Other Locations

Water samples were collected at 16 locations along Alamitos Creek, Deep Gulch Creek, Guadalupe Creek, Calero Creek, Canoas Creek, Los Gatos Creek, and Almaden Lake. A water sample was also collected from below a mine seep on a tributary to Randol Creek. Ross Creek above its confluence with Alamitos Creek was dry at the time of sampling on July 28, 2003, although it had 0.2 cfs upstream at Cherry Avenue. The creeks in this summer survey had low suspended solids concentrations, except in Almaden Lake (53.8 mg/L). Moderate to high dissolved oxygen (5.3 to 10.3 mg/L) was present in the creeks downstream of the reservoir. The samples from the reservoir outlets, however, had low dissolved oxygen (0.7 to 1.3 mg/L), except for the outlet from Lexington Reservoir, which had high dissolved oxygen, 9.5 mg/L, due to the turbulent nature of its discharge structure. The pH and alkalinity showed that all the creeks are alkaline. Sulfate in the sample from Deep Gulch Creek (190 mg/L) and the mine seep to Randol Creek (420 mg/L) were higher than the remaining creek samples (15 to 99 mg/L).

The total mercury concentrations in the creek samples ranged from 3.2 to 570.4 ng/L, while the dissolved mercury ranged from 1 to 34.3 ng/L (Figure 2-14). Higher total mercury concentrations were measured in the downstream portions of the creeks, compared to the reservoir outlet samples, except for Los Gatos Creek. Methylmercury concentrations were highest in Almaden Lake (17.8 ng/L). Methylmercury concentrations in the creeks ranged from 0.037 to 8.27 ng/L, and decreased along a given creek below the reservoir (Figure 2-15).

Sediment Samples from Creeks Results

Sediment samples were collected from 17 locations in the creek beds. All the sediment samples were alkaline. Sulfate concentrations ranged from 24 to 142 mg/kg dry. Iron was detected in all sediment samples, while sulfide was detected in most samples, except for Los Gatos Creek. The concentration of phosphorus in the sediment samples ranged from 148 to 918 mg/kg dry. The highest mercury was present in the sediment below the mine seep (143.7 mg/kg) and in Alamitos Creek below the town (168.5 mg/kg). Methylmercury in these two samples was 0.0015 mg/kg and 0.0358 mg/kg, respectively. The second highest methylmercury concentration was 0.0094 mg/kg in a sediment sample with a total mercury concentration of 23.29 mg/kg collected further downstream on Alamitos Creek at Harry Road. Guadalupe Creek sediment had total mercury concentrations from 125.3 mg/kg at the outlet to 21.9 mg/kg at the confluence with Alamitos Creek. The methylmercury along this same reach was 0.00067 mg/kg at the outlet and 0.00229 mg/kg at the confluence. Considerably lower total mercury was found in Calero, Ross, Canoas, and Los Gatos Creek sediments; these sediment concentrations ranged from 0.04 to 0.6 mg/kg of total mercury. Methylmercury concentrations in Calero, Ross, Canoas, and Los Gatos Creeks ranged from 0.000039 mg/kg to 0.0019 mg/kg.

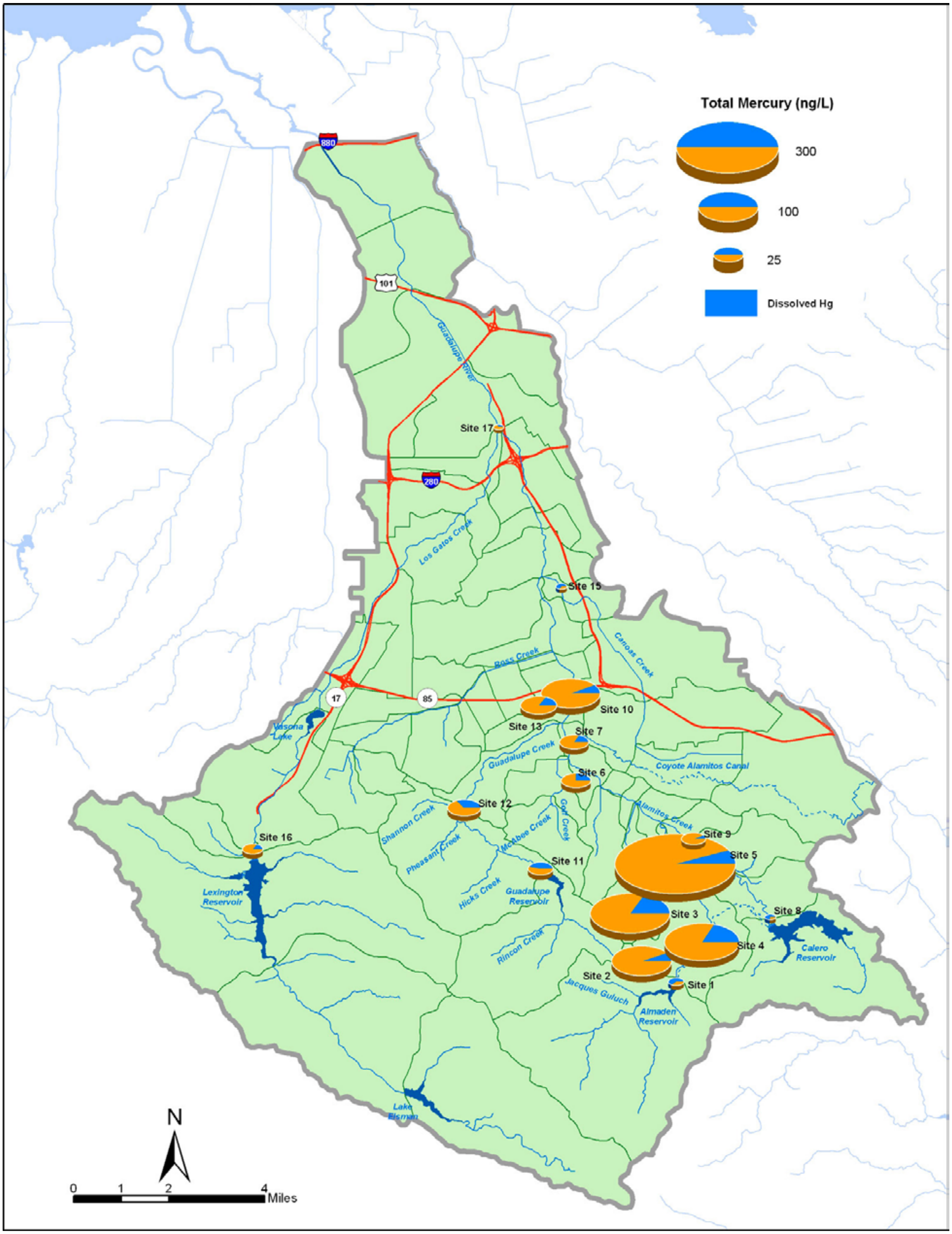


Figure 2-14. Total mercury in creek water samples.

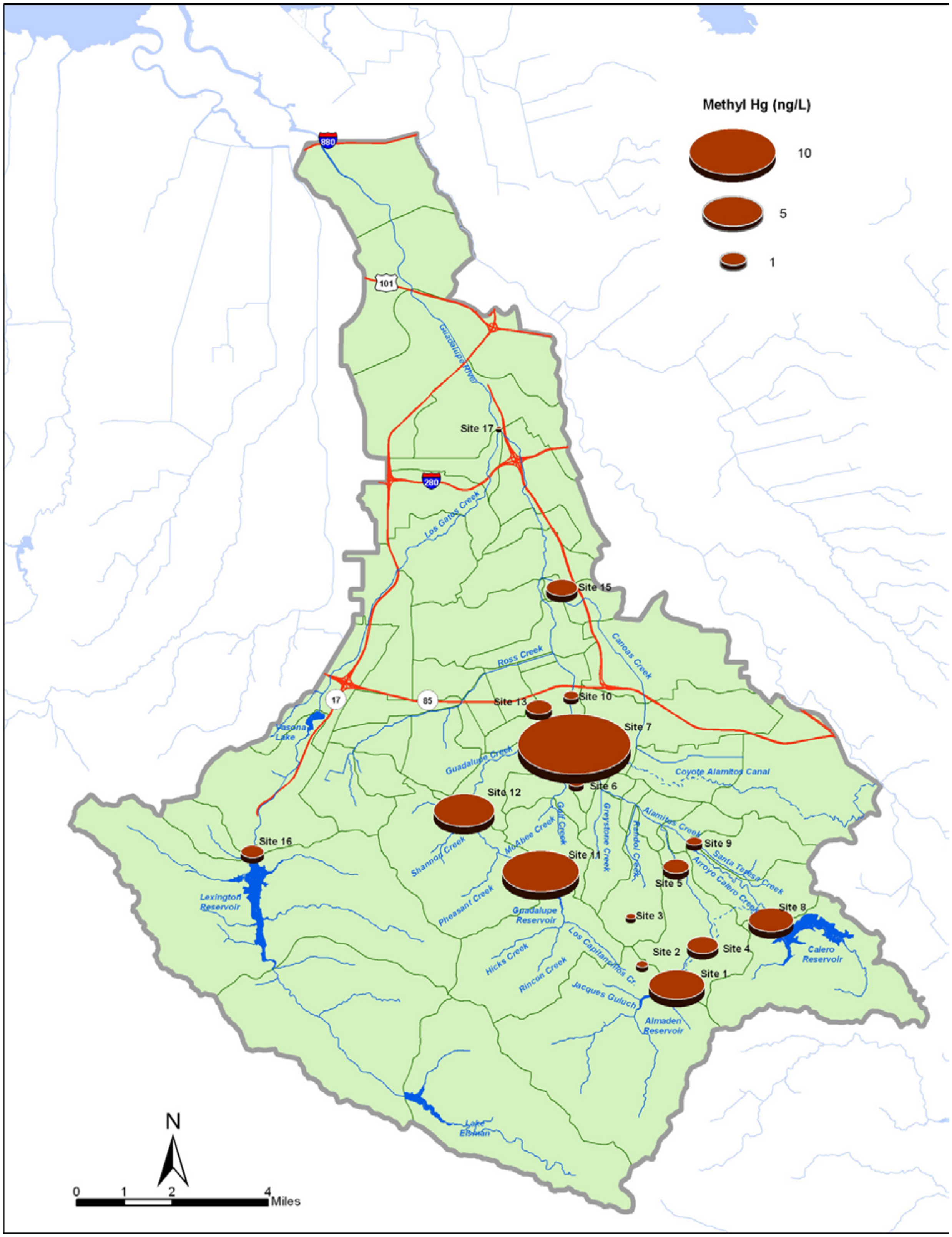


Figure 2-15. Methylmercury in creek water samples.

Remaining Mercury Mine-related Sources

The surveys of the former mining area and creeks showed that there are reaches in Alamitos and Guadalupe Creeks where calcines and other mine wastes are present, as shown in Figure 2-8. Some of these deposits are cemented, but some have been undercut by the stream along parts of Alamitos Creek.

Calcines around the main retort sites at Hacienda Yard, near the top of Mine Hill, and near the Senador, Enriquita, and San Mateo Mines were removed in 1990, covered with soil, re-graded, and re-vegetated. Most of the calcines were placed in the San Francisco Open Cut on Mine Hill, where they were covered with soil, and revegetated. However, there are calcine deposits on the floodplain and banks of Alamitos Creek opposite the Hacienda Furnace Yard and downstream of the Yard. Erosion was seen on some of the former mine roads, now used as trails. There is a small retort on Deep Gulch Creek that has not been remediated. Calcines are present in the creek bed and banks of Jacques Gulch, and in the upper part of this drainage area. Jacques Gulch drains into Almaden Reservoir.

Several mine waste piles (not calcines) in the Senador Mine reduction works area are poorly vegetated and eroding. Runoff from the Guadalupe Landfill area, which was formerly mined, also partly drains into this area. A mine seep from the former 260-foot adit forms the headwaters of McAbee Creek. This drainage is routed through a small emergent wetland area to a small pond that was largely dry at the time of the survey, but still supported a growth of cattails. Seasonal wetlands exist downstream of this pond in the reduction works area in the winter and spring.

Mine seeps are present in a tributary to Randol Creek, which was sampled for this survey, and above Senador Mine and at the Day Tunnel, which were not sampled. Under summer conditions, seepage from these locations does not reach the lower channels of Randol or McAbee Creeks, respectively, and hence does not reach Alamitos Creek.

Former mine sites along Guadalupe Creek near the former Guadalupe Mine include: the Engine Shaft site, which has a covered vertical shaft, the possible Santa Clara mill site, the mine waste pile at Hicks Flat, and the Road Tunnel (see Figure 2-7 for locations of these areas). The Road Tunnel is sealed, but there is a small opening at the top. Of these sites, the calcines observed along Guadalupe Creek near the former Guadalupe Mine and the mine waste pile at Hicks Flat could possibly result in runoff or sediment containing mercury reaching Guadalupe Creek. Previous sampling of the mine waste pile showed that wastes had 1.8 to 330 mg/kg of total mercury and 3.9 to 140 mg/kg in the surrounding area (Secor, 1995). A sediment sample next to the waste pile had 59 mg/kg, while both upstream and downstream samples from the Hicks (or Dry) Creek had from 0.01 to 1.3 mg/kg. A sediment sample from Guadalupe Creek below the confluence with this creek had total mercury of 0.1 mg/kg. The data show that there is a potential for transport of mercury to Guadalupe Creek.

Other Potential Sources of Mercury in Watershed

Mercury in storm runoff can be from atmospheric deposition and from contaminated sites. A bay-wide urban storm drain sediment sampling program was conducted in 2000 and 2001 for the Joint Stormwater Agency Project (Kinnetic Laboratories, 2001 and 2002). Forty-five of the sediment sampling sites were located in Santa Clara County, representing industrial, open, residential/commercial, and mixed land uses. In 2000, the total mercury in the Santa Clara County sites sampled was 0.1 to 4.26 mg/kg dry; the range for the 2001 sites was 0.02 to 3.04 mg/kg dry. The sites in other parts of the Bay ranged from 0.02 to 1.91 mg/kg dry; this maximum concentration was from an industrial site in San Mateo County. Statistical analyses were conducted for this study using concentrations normalized to the fine fraction of the sediment (<62.5 microns). Using the normalized results, the highest total mercury concentrations were found in three sites in Marin County, three in San Mateo County, and one site in Santa Clara County. Median concentrations of mercury in urban sites were three times greater than nonurban sites. Methylmercury was measured in the sediment only in the 2000 study. Methylmercury in the Santa Clara County samples ranged from 0.00007 to 0.00249 mg/kg, and was not significantly different among the Bay regions.

Other possible sources of mercury include runoff, groundwater seepage, and emissions from landfills, such as the Guadalupe Landfill, located in the Guadalupe Creek watershed. Evasion of mercury can occur from soils with high mercury in the former mining area, in downstream non-cemented mine waste deposits, and in contaminated soils on former industrial sites. The fate of this mercury is not known. There are no permitted wastewater discharges to the Guadalupe River.

Existing Fish Tissue Mercury Data

Mercury concentrations in fish tissue have been measured in samples from several creeks and reservoirs in the Guadalupe River Watershed. The historical fish mercury data consist of 263 measurements in 16 different species of fish collected from multiple locations in the Guadalupe River Watershed. These data were presented in the Guadalupe River Mercury TMDL Workgroup's Recommended Interim Sampling and Monitoring Plan (EOA, 2000). The majority of these data were collected from 1971 – 1987.

Tetra Tech collected largemouth bass and black crappie from Guadalupe Reservoir on May 28, 2003, in conjunction with the U.S. EPA's National Lakes Survey. Tetra Tech collected 15 largemouth bass between 27.3 and 50.5 cm. in total length (TL), and 10 black crappie between 13 and 17 cm. TL. Muscle tissue was collected from each sample for mercury analysis.

A summary of the existing mercury measurements for the most abundant species is presented in Table 2-10. Because of the differences in size and number of fish at each location, these data are of limited value for making comparisons between locations. However, these data show that the mercury concentrations in fish muscle tissue in the

Guadalupe River Watershed exceed the U.S. EPA human health mercury fish criterion (0.3 mg/kg [ppm], U.S. EPA, 2001) at all locations sampled.

Table 2-10
Summary of Fish Mercury Measurements from Guadalupe River Watershed

Location	Sample Size	Avg. Hg (ppm)	Avg. Length (cm)	Weight (g)
Rainbow Trout				
Alamitos Creek	27	2.9	13.5	108
Guadalupe River	21	1.0	14.4	41.2
Almaden Reservoir	8	0.5	–	–
Guadalupe Reservoir	6	1.3	25	263
Largemouth Bass				
Guadalupe Perc. Pond	21	0.9	14.5	51.2
Guadalupe Reservoir	15	4.0	37.4	700.0
Calero Reservoir	11	2.2	78.6	1179.7
Lexington Reservoir	5	0.7	26.2	436.6
Bluegill				
Guadalupe River, Perc Ponds	19	0.4	–	–
Guadalupe Reservoir	21	2.8	18.6	169.1
Lexington Reservoir	3	0.05	17.3	135.3
Sucker				
Guadalupe Perc. Pond	15	0.6	–	–
Guadalupe River, Highway 17	20	0.4	–	–
Black Crappie				
Calero Reservoir	14	1.3	20.7	164.5
Guadalupe Reservoir	10	1.9	15.5	52.0

2.3 WETLAND VEGETATION

Wetland vegetation along the creeks represents areas where fine sediment may be accumulating and sources of organic carbon are present. These conditions may support potential zones for methylation in anoxic sediments or microzones around plant roots. Creeks visited to see if wetland vegetation was present included: Alamitos Creek, Guadalupe Creek, Calero Creek, Los Altos Creek, Canoas Creek, Ross Creek, Golf Creek, McAbee Creek, Greystone Creek, Randol Creek, and Santa Teresa Creek. Two creeks were surveyed in detail for vegetation: Alamitos Creek and Los Altos Creek.

Wetland areas of limited spatial extent were present along Alamitos Creek between Almaden Lake and Harry Road. The vegetation is stratified, with some low-growing or flat vegetation growing at the edge of the stream, grading into a dense herbaceous layer that begins at the edge of the stream and extends outward throughout the moist zone of the stream, such as shown in Figure 2-16. A shrub understory appears above the moist zone, but many of the species undoubtedly have long tap roots that access the water table. The furthest layer out from either side of the stream is composed of riparian trees such as various willow species *(Salix sp.)*, sycamore *(Platanus racemosa)*, and big-leaf maple *(Acer macrophyllum)*. Conspicuous in its absence from this layer was Fremont cottonwood *(Populus fremontii).*

Figure 2-16. Example of wetland vegetation on Alamitos Creek at Station 18 between Harry Road and the confluence with Calero Creek.

The most dominant species observed during the survey of Alamitos Creek was watercress *(Rorripa nasturtium-aquaticum).* Where it was rooted at the edge of the stream, it invariably spread laterally over the surface of the water. Other species observed rooting directly in the flooded streambed were cattail *(Typha latifolia)*, curly dock *(Rumex crispus),* Eurasian milfoil *(Myriophylum spicattum)*, and duckweed *(Lemna minor).* Vegetation was most dense on the bank immediately adjacent to the stream. Most stands of cattails were small in spatial extent. One of the larger patches is at the pedestrian bridge near Mt. Forest Drive. Extensive wetland stands were present upstream of the confluence with Golf Creek, up and downstream of the Mazzone Street bridge, below the confluence with Randol Creek, upstream of Almaden Lake. Wetland plants were present along portions of Almaden Lake.

The reach of Alamitos Creek upstream of Harry Road to Almaden Reservoir had fewer wetlands with well-established cattails. Two such areas were present near the upper end of Hacienda Yard and at a small seep near the base of the dam. Instead of cattails, there were several large stands of tall bamboo, which grew across the entire stream channel in places below the most downstream Bertram Road bridge. These stands may restrict fish migration and coarse sediment movement. Parts of the banks were highly-vegetated with large sycamore or oak trees, blackberry bushes, and sometimes bamboo. In-stream vegetation along the edges of the stream was more common in the flatter reaches of the creek downstream of the major tributary, Callanlan Gulch, at the bend in the creek.

The tributaries to Alamitos Creek, which drain the eastern side of the mountains between Almaden and Guadalupe Reservoirs include Randol Creek; McAbee, which drains into Golf Creek; Ross Creek, and Greystone Creek. These creeks have small wetlands in the upper reaches, but the creeks do not contribute flow to Alamitos Creek in the dry season. Randol Creek has abundant wetland vegetation in some areas such as above Rajikovitch Drive. McAbee Creek has a small wetland at its headwaters fed by a mine seep. Golf Creek flows in a channelized section that had some emergent wetland vegetation along the edges of the channel. Greystone Creek also flows in a channelized section; the lower part of the channel had no wetland vegetation. Ross Creek has reaches with abundant grass and wetland vegetation including cattails, particularly at Cherry Avenue and between Kirk Road and Harwood Avenue.

Calero Creek, which also discharges to Alamitos Creek, has a natural channel that is bordered by scattered trees and brush such as blackberry bushes. No large areas with wetland vegetation were found between the reservoir and its confluence with Alamitos Creek. A small wetland area was observed below Harry Road and in one upstream location above McKean Road. Santa Teresa Creek, a tributary to Calero, had wetland vegetation with cattails near Henwood Road, but mostly dry grasses upstream.

Guadalupe Creek has an impoundment at Masson Dam and small wetland patches just downstream of Camden Avenue and above Almaden Expressway. The restored section of the creek from Almaden Expressway and Masson Dam has newly planted trees and in-stream root wads, which may promote sediment deposition in the future. Cattails were present in limited sections of the creek

Canoas Creek flows in a concrete channelized section throughout most of its length. Grasses and other vegetation are present in the stream area. Emergent wetland plants such, as cattails were present in some areas such as between Snell Avenue and Springer Way.

Los Gatos Creek has a series of impoundments including Vasona Reservoir, a drop structure at Camden Avenue, and an underground section beneath the town of Los Gatos. Significant wetland vegetation with cattails and tall sedge exists in the reaches upstream of Campbell Avenue, the ponds at the drop structure at Camden Avenue and the immediate downstream reach, and the reaches below the pedestrian bridge near Lark Avenue. Upstream of Vasona Reservoir there is less emergent wetland vegetation.

The surveys showed that small areas with in-stream wetlands are present in some reaches of the creeks. However, several of these creeks do not contribute flow to a main stem tributary in the dry season such as Alamitos or Guadalupe Creek. Thus, while methylation may be occurring on a local scale, the effect on the larger creeks and main stem is reduced.