Section 3 Needs and Opportunities

This section describes the needs and opportunities identified relative to the SMMP goals and objectives outlined in Section 2. Identification of needs and opportunities was essentially the "gaps analysis" portion of the SMMP: where a goal or objective is not being met for any given resource area, a need or opportunity to meet the objective was identified. Stakeholder participation was an essential component of identifying needs and opportunities for each study reach.

3.1 Definition of Needs and Opportunities

The identification of needs and opportunities for each of the SMMP resource areas was conducted using the reach-by-reach approach and stakeholder input. As discussed in Sections 1 and 2, the resource areas examined for the SMMP include:

- Flood Protection and Drainage
- Erosion and Sedimentation
- Water Supply
- Water Quality
- Habitat and Environment
- Trails, Recreation, and Public Education

Additionally, needs and opportunities for the resource areas were identified through a literature review, and field investigation in order to compare the existing conditions in the study reach to the goals and objectives for each resource area. Literature that was reviewed included existing reports and studies prepared for Zone 7 and other agencies and organizations with a role or interest in management of the streams and arroyos in the SMMP study area. A complete list of literature reviewed can be found in Appendix A.

Where an objective for one of the SMMP resource areas was not met in any given reach, a need was identified. Opportunities to meet the need or enhance the conditions of the resource area were also identified based on the literature review, field investigation, and stakeholder input. The identified needs and opportunities became the basis for project development and are summarized below.

3.1.1 Delineation of the Reaches

Zone 7 owns and maintains approximately 39 miles of improved flood control channels from the eastern edge of Alameda County on the east to the confluence of Alameda Creek and Stonybrook Creek on the west. To effectively identify needs and opportunities, and thus projects in the SMMP study area, Zone 7's service area was subdivided into twelve individual reaches. Identification of needs and opportunities for each resource area was done on a reach-by-reach basis for the twelve study reaches, through literature review, field investigation, and several workshops with SMMP stakeholders. Figure 3-1 presents the twelve study reaches. A list of the streams and flood control channels and their location relative to the twelve study reaches is provided in Table 3-1.

Figure 3-1: Reach Map for the Zone 7 SMMP

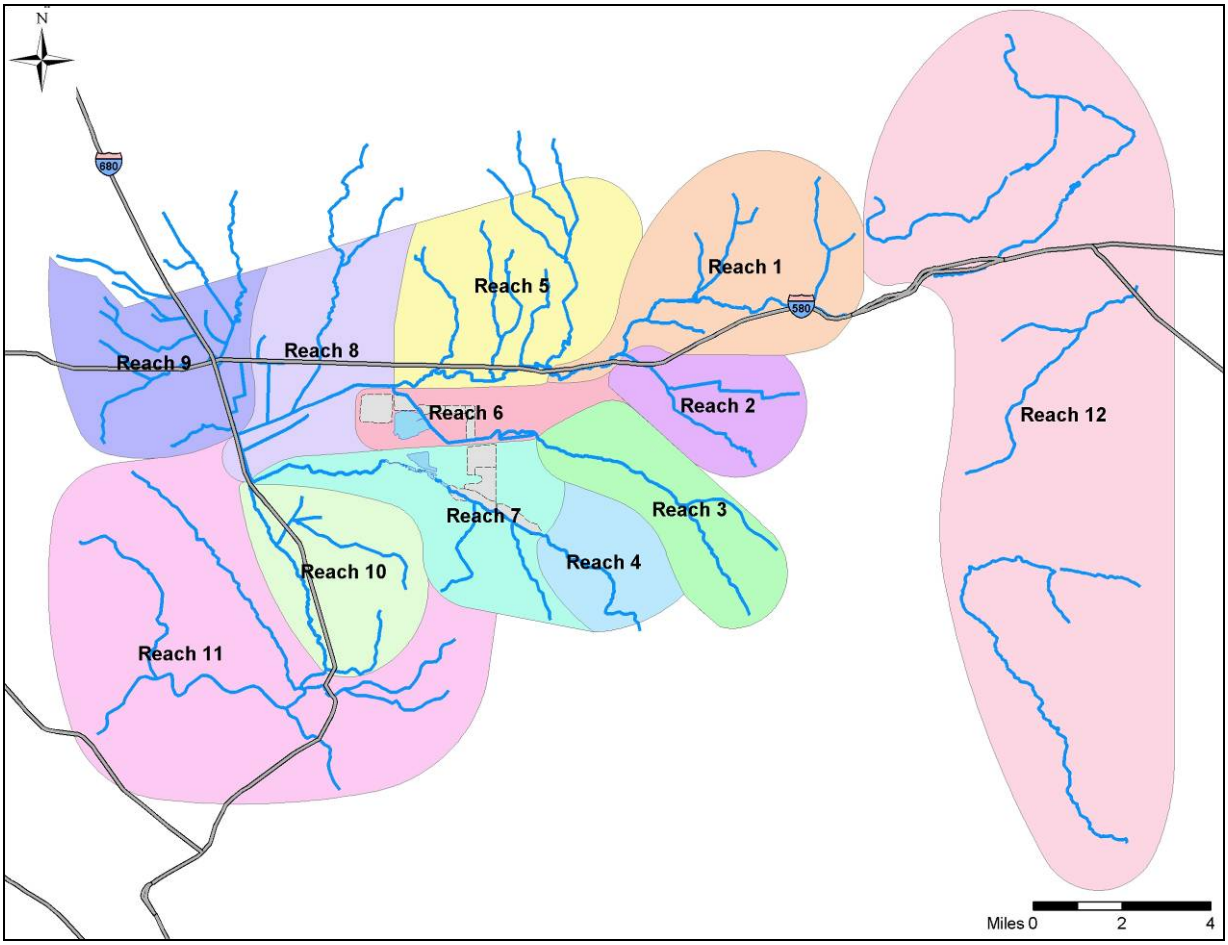


Table 3-1: Streams and Project Locations within the SMMP Study Area

Reach Number	Streams	Location of Projects within Reach
1	Altamont Creek Arroyo las Positas	STA 145+00 to 00+00 STA 520+00 to 280+00
2	Arroyo Seco Realigned Arroyo las Positas	STA 130+00 to 00+00 STA 62+00 to 00+00
3	Arroyo Mocho	STA 672+00 to 350+00
4	Arroyo del Valle	STA 536+00 to 400+00
5	Arroyo las Positas (above Chain of Lakes) Cayetano Creek Cottonwood Creek Collier Creek	STA 220+00 to 45+00
6	Arroyo Mocho Chain of Lakes (Lakes E through I, Cope Lake)	STA 350+00 to 200+00
7	Arroyo del Valle Chain of Lakes (Lakes A-F)	STA 400+00 to 00+00

Reach Number	Streams	Location of Projects within Reach
8	Arroyo Mocho	STA 170+00 to 00+00
	Arroyo de la Laguna	STA 380+00 to 335+00
	Chabot Canal	STA 120+00 to 5+00
	Tassajara Creek	STA 86+00 to 0+00
	Pleasanton Canal	STA 20+00 to 00+00
9	Alamo Canal	STA 135+00 to 25+00
	Alamo Creek	
	South San Ramon Creek	STA 28+00 to 00+00
	Line F-4	STA 50+00 to 00+00
	Line J-1	STA 56+00 to 35+00
	Line J-3	
	Line J-5	
	Line G-1-1	STA 80+00 to 00+00
10	Arroyo de la Laguna	STA 330+00 to 00+00
	Line B21	
11	Alameda Creek	
	Sinbad Creek	
12	Line X-1	
	Line Y-1	

3.2 Regional Flooding

3.2.1 Area Description

Zone 7 manages the storm water flows into the Livermore-Amador Valley area within the major drainage ways of the Valley floor. Zone 7 owns and maintains approximately one-third of all the creeks and arroyos in the Valley. The remaining two-thirds of the channels in the SMMP are owned and maintained by the cities of Livermore, Pleasanton, Dublin, Alameda County, or are privately owned. The Valley is located in the northern part of the upper Alameda Creek watershed. The principal stream in the study area is ADLL, which drains the Valley into Alameda Creek. The tributary area of ADLL extends from the Sunol Valley in the south to the Black Hills of Contra Costa County in the north and to Altamont Pass in the east. ADLL is fed by three major tributaries including Arroyo del Valle, Alamo Canal, and Arroyo Mocho. A map of these streams is shown in Figure 1-2.

ADLL was historically the outlet of a lake located in the western end of the Valley, southeast of the I-580/I-680 interchange. This lake persisted until the early 1900's when ADLL and other streams were deepened and channelized, causing local groundwater levels to lower enough to drain the lake. The primary tributary to ADLL was formerly Arroyo del Valle, until the dam for Del Valle Reservoir was constructed as part of the SWP in the 1960s. The largest tributary to ADLL today is Arroyo Mocho, which has Arroyo las Positas as its largest tributary. Arroyo las Positas and Arroyo Mocho originate in grasslands above the City of Livermore and travel west through Livermore to meet immediately downstream of the Chain of Lakes area east of ADLL.

3.2.2 Background

The Chain of Lakes and other areas of the Valley are subject to flooding in major storm events. The largest storm of record in the watershed occurred in December 1955. The peak flow in ADLL downstream of the confluence with Arroyo del Valle was recorded to be 18,200 cubic feet per second

(cfs) during this storm event (USACE 1985). Del Valle Dam began regulating flows in Arroyo del Valle in 1968, but other activities in the Valley have increased the projected peak flow rates since that time. Growth has encroached on floodplain areas of the Valley, some broad arroyos have been converted to trapezoidal channels, and construction of new roads and buildings has increased the total impervious surface area in the watershed. These changes are predicted to result in about 50 percent increase in peak runoff from the time of construction of Del Valle Dam to the time of General Plan build-out for the cities of Pleasanton, Dublin, and Livermore (varies by city – up to 2030; WYA 2002b). The fact that there is a potential flooding problem in the Valley has been known for some time, and even smaller events, such as the 10- to 15-year event in 1998, have caused significant flooding in localized areas. In this case, flood waters overtopped the Arroyo Mocho channel along Stanley Boulevard and resulted in flooding around the Chain of Lakes area (along Stanley Boulevard near the El Charro Road crossing). Areas flooded during this event are shown below in Figure 3-2 and Figure 3-3.

Figure 3-2: 1998 Flood Waters in Arroyo Mocho at the El Charro Road Crossing

Figure 3-3: 1998 Flood Waters at the El Charro Ranch near the Chain of Lakes Area

In 1960, following studies of the area's topography, rainfall and runoff characteristics, and channel profiles, Zone 7 developed a plan to provide storm-drainage and flood protection under ultimate development conditions (ACFCWCD 1960). The plan included a proposed Federal project on Alameda Creek and its tributaries as well as local improvements and construction of storm drainage facilities in the Valley. These improvements were based on general channel profiles prepared as part of the Zone 7 Master Plan. These profiles showed natural channel configurations (slope, bank elevations, and surface water elevations) and corresponding improvements including construction of earthen, trapezoidal channels (new channel slope and corresponding change in water surface elevations), levees, drop structures, culverts, debris barriers, and other related structures. As explained by S&W in June 2000, the proposed improvements were based on 100-year, full build-out design discharges calculated using the Rational Formula (S&W 2000). The compilation of channel profiles, calculated design discharges, and proposed channel improvements comprised Zone 7's Master Plan, also referred to as the "Green Book." After the USACE determined the proposed Federal project on Alameda Creek was not cost effective, the Zone 7 Board established a financial plan (the SDA 7-1 plan) to finance Green Book improvements. This plan proposed to impose drainage fees on all new developments constructed within the Zone 7 service area. It was anticipated that 50 percent of the plan would be funded through drainage fees imposed upon developers. The other half of the plan would be funded through Federal grants, cooperative agreements with other agencies, and local taxes. The SDA 7-1 plan was passed by the Board on May 17, 1966 (ACFCWCD 1966).

Zone 7's Master Plan (Green Book) has remained unchanged since it was first developed in the 1960s. Channels owned by Zone 7 are shown in Figure 1-3. Some of these channels have been modified to Green Book standards while others (most notably the lower portion of ADLL below its confluence with Arroyo del Valle) have remained unchanged. In recent years, the way agencies approach the management of streams and flood control channels has been modified to include new regulatory requirements, floodplain development, increased public involvement in habitat protection and enhancement, and inclusion of channel access for recreational purposes. In recognizing these changes, Zone 7 began updates to the Green Book and commenced development of the SMMP. To update the Green Book, a series of reports and TMs were prepared for Zone 7 by S&W, WYA, and RMC. These are discussed in

detail in Appendix B. These reports were used to develop a picture of current flooding conditions is the area, as discussed in the ensuing section.

3.2.3 Flooding Conditions

Most of the flood protection studies conducted within the Zone 7 service area have recognized the linkages between peak flows in the upstream and downstream arroyos, and the importance of evaluating the timing of the peaks for each arroyo. The purpose of this section is to assess the flooding potential along the Valley's streams and arroyos resulting from a 100-year flood event.

Three major references were used to analyze flooding conditions in the Zone 7 service area:

- Flood Insurance Studies (FIS), FIRMs, and LOMRs developed by the FEMA dating from the mid 1970s to 1997;
- *Draft Zone 7 Special Drainage Area 7-1 Program Update of Channel Improvement Costs* (S&W 2000) presenting the estimated 100-year peak flows assuming full build-out of future land uses (i.e. the SMMP's adopted design flows); and
- WYA *Issue Paper No. 2 Flood Flows in Zone 7 Channels*, describing the current capacities of the main channels.

The first reference was used to identify flooding areas under current development conditions during a 100-year design storm. The second and third references were used to determine capacity constraints with respect to the SMMP's 100-year design flows (i.e. future build-out 100-year peak flows). These capacities were compared to future build-out flows to determine flooding potential in the future if channel improvements are not implemented.

FEMA FIS are developed to identify flood hazards based on existing land use and channel conditions. These studies are periodically updated to reflect flood control projects completed in the study area. In the 1980s, FISs were published for the cities and unincorporated areas of the Zone 7 service area. Peak flow rates for design storms ranging from a 5-year to a 500-year event were identified based on 1970s development and channel conditions. A 100-year and 500-year floodplain boundary was delineated in these studies. In 1997, FEMA updated the FISs based on updated hydrologic analyses and assuming 1997 development conditions. However, the updated hydrologic analyses focused on upstream channels in Pleasanton and Livermore and did not cover the primary downstream channels in the study area including ADLL, Alamo Canal south of I-580, and Arroyo Mocho downstream of its confluence with Arroyo las Positas. As a result, the floodplain boundaries delineated by FEMA for the Pleasanton area near ADLL have not changed since the 1980s, except where LOMRs have been approved by FEMA. Because an updated FEMA floodplain map is not currently available, the latest available map as shown on Figure 3-4, with modifications to reflect approved LOMRs, has been used to highlight areas of concern.

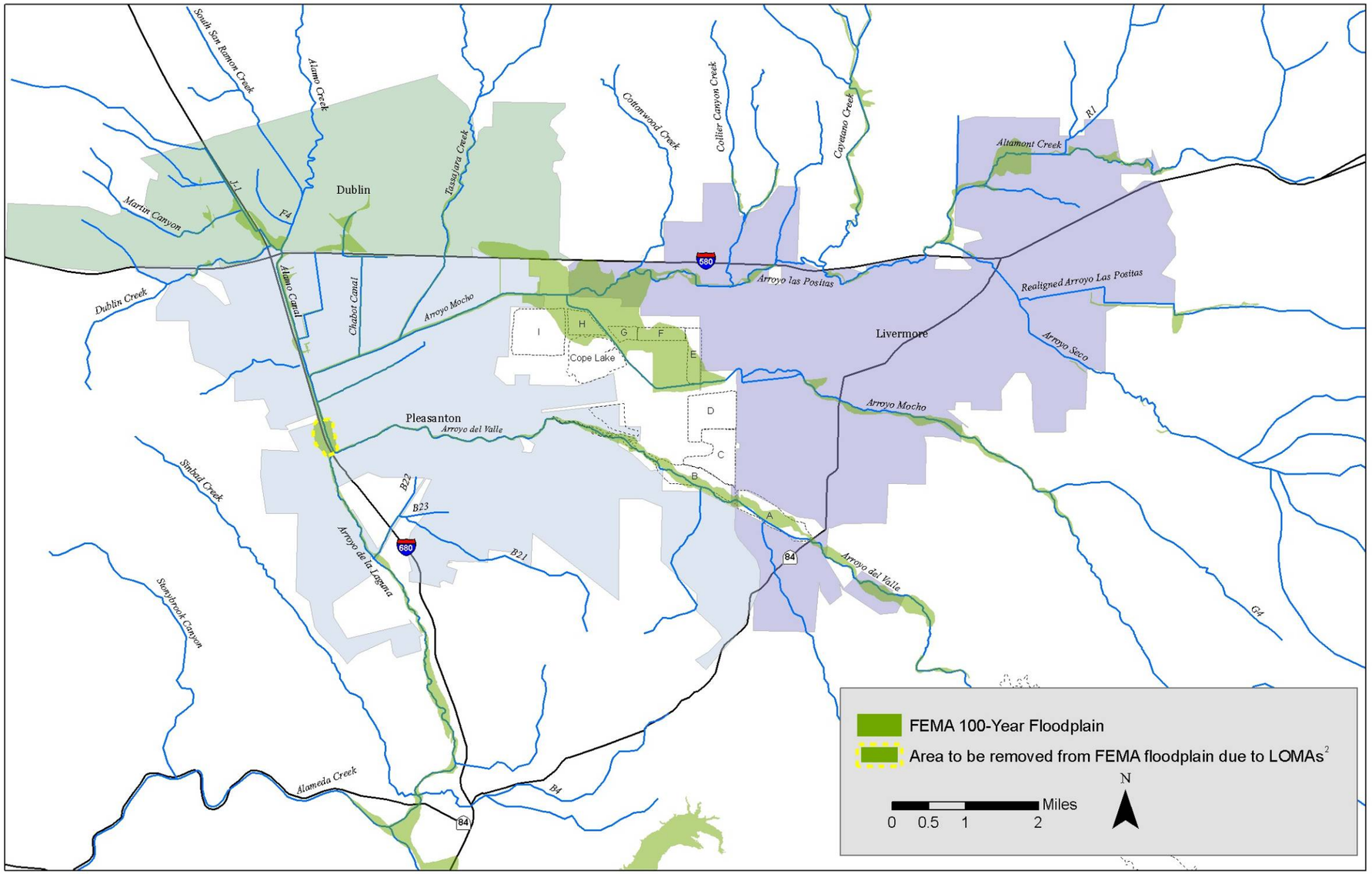
As can be seen from Figure 3-4, the primary areas subject to flooding include:

- Area around the Chain of Lakes in the City of Livermore, bound to the west by the confluence of Arroyo Mocho and Arroyo las Positas, and to the east by Isabel Avenue;
- The Springtown Natural Communities Reserve along Altamont Creek, in the northeast corner of the City of Livermore;
- Areas in Dublin, upstream of Interstate I-580 (I-580) discharging to Chabot Canal and adjacent to the I-580 and Interstate I-680 (I-680) crossing;
- Lands along Arroyo Mocho, within the Chain of Parks area (from Robertson Park to Mocho Park) and adjacent to Valley Memorial Hospital in the City of Livermore; and
- Smaller areas along Realigned Arroyo las Positas, Arroyo del Valle, and lower ADLL.

FEMA's hydrologic analyses used to develop these floodplain boundaries are based on 1997 development conditions as well as 1970s development conditions in the case of ADLL, Alamo Canal, and Arroyo Mocho (downstream of its confluence with Arroyo las Positas). As a result, they are not representative of future build-out development conditions.

A reach-by-reach discussion of flooding conditions follows.

Figure 3-4: 100-Year Event Floodplain[1]



[1] This floodplain map represents a modified version of the current FEMA floodplain map. Modifications were made to exclude areas of Livermore, Dublin, Pleasanton and Unincorporated Alameda County where LOMRs have been approved as of March 2006 (http://msc.fema.gov). This map reflects current flow conditions.
[2] The area of Pleasanton located within the dotted yellow line will be removed from the 100-year event FEMA floodplain due to recently filed LOMAs not yet reflected in the FEMA floodplain map (City of Pleasanton, February 2006).

Reach 1

As shown in Figure 3-1 and Table 3-1, Reach 1 is located in northeast Livermore and includes Altamont Creek and the upper reach of Arroyo las Positas. The major area in this reach currently expected to flood during a 100-year flood event is the Springtown Natural Communities Reserve along Altamont Creek. The Springtown area supports a habitat of alkali sink scrub vegetation and vernal pool areas and as a result, represents an opportunity for habitat enhancement (EMEC 1996). Upstream sections of this channel are not currently expected to flood as the 100-year floodplain boundaries extend only slightly over the banks of the creek. It is important to note that the FEMA floodplain for this area has been modified to reflect LOMRs developed as a result of a reduction in development plans for northeast Livermore. This area is shown in Figure 3-4. Areas along Arroyo las Positas, below its confluence with Altamont Creek are also located within the 100-year floodplain, although the boundaries extend only slightly over the banks of the creek.

Reach 2

The current floodplain boundary along Reach 2 (Realigned Arroyo las Positas) stays mainly within the channel banks although it extends over the stream banks for a short stretch of stream east of LLNL.

Reach 3

The current 100-year floodplain along Reach 3 (upper reach of Arroyo Mocho) is mainly confined within the "Chain of Parks" from Robertson Parks to Mocho Park, but extends significantly outside of the channel banks downstream of Mocho Park near the Valley Memorial Hospital. Figure 3-5 shows the floodplain map along the Chain of Parks and the extended floodplain near the Valley Memorial Hospital.

Figure 3-5: Floodplain Map for the Chain of Parks Area along Arroyo Mocho (Reach 3)

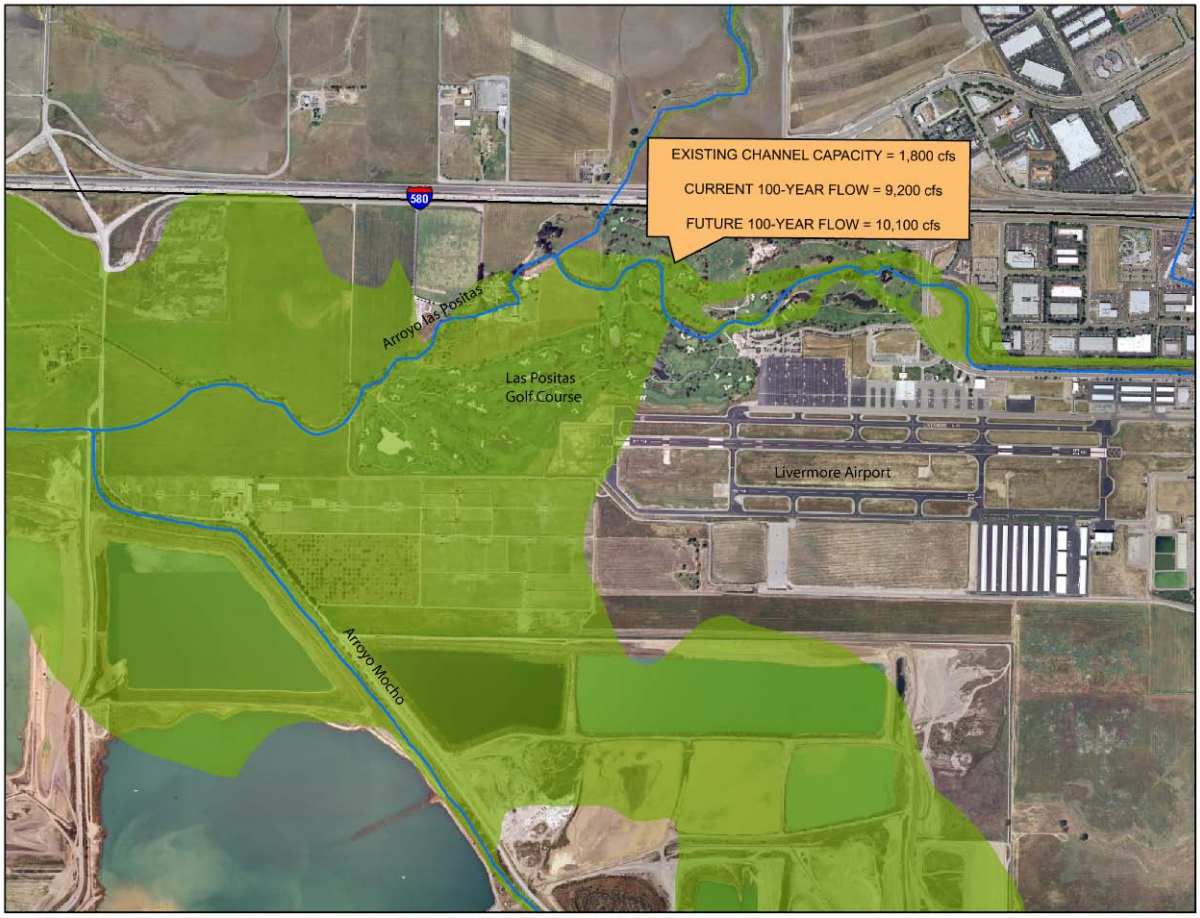
Reach 4

Reach 4 includes Arroyo del Valle just downstream of Lake del Valle to Highway 84. As shown in Figure 3-4, the current 100-year floodplain boundaries along this reach extend only slightly over the banks of the creek.

Reach 5

Reach 5 is located in the City of Livermore just north of the Chain of Lakes Area, and includes Arroyo las Positas from its confluence with Cayetano Creek near I-580 to its confluence with Arroyo Mocho. Several smaller drainages located north of I-580, including Cayetano Creek, Collier Creek, and Cottonwood Creek are also located in this reach. As shown in Figure 3-6, the floodplain boundaries along this reach extends well beyond the channel banks onto the City of Livermore's Las Positas Golf Course and airport. The current and future 100-year flows and the current channel capacity are also shown.

Figure 3-6: Floodplain Map for the Arroyo las Positas Area near the Chain of Lakes



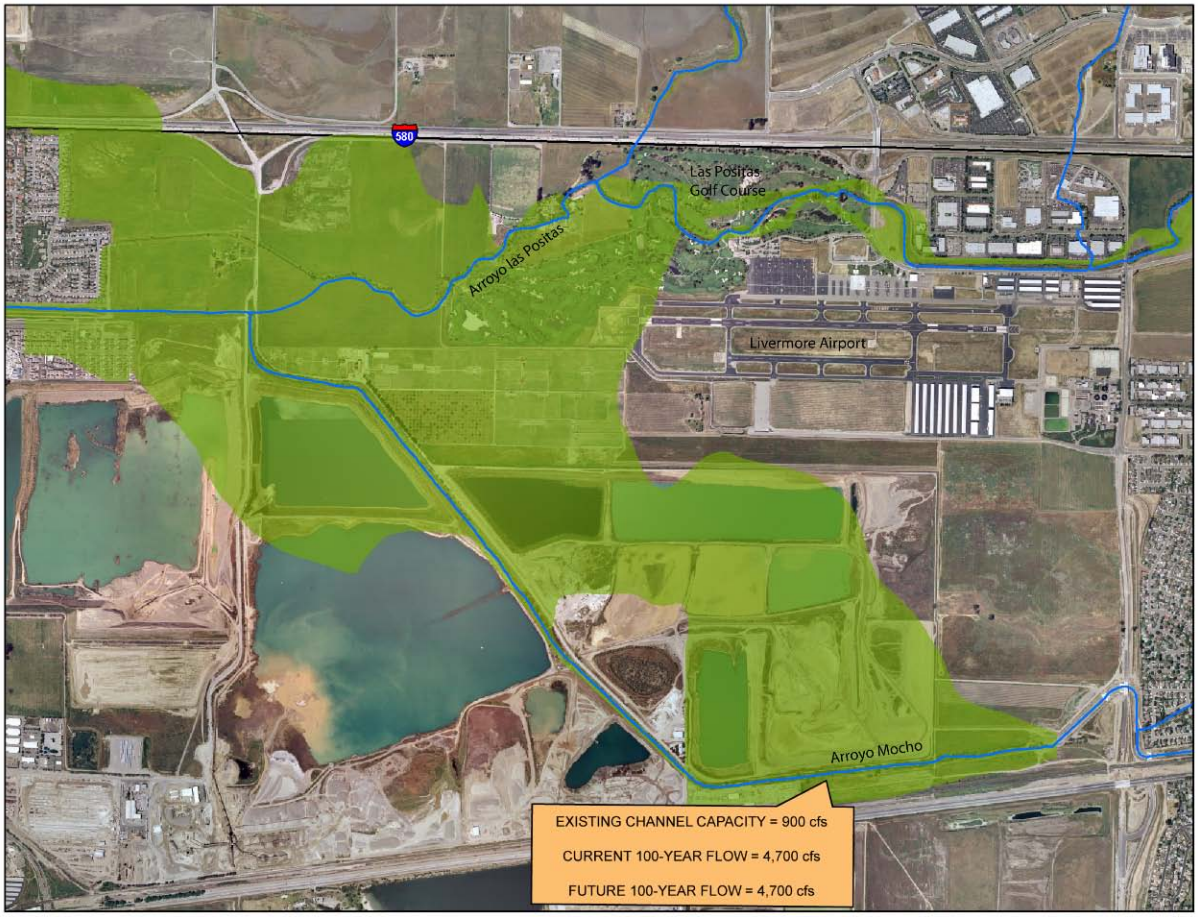
As shown in Figure 3-6, existing channel capacity along Arroyo las Positas at Las Positas Golf Course is approximately 1,800 cfs (WYA 2002b), while the current 100-year flow is approximately 9,200 cfs (S&W 1997) and the estimated design flow under projected build-out conditions is approximately 10,100 cfs (S&W 2000). Due to its capacity constraints and the estimated future increases in flood flows, the future floodplain around this area is expected to extend beyond the current 100-year FEMA floodplain.

Reach 6

Reach 6 is located in the center of the SMMP study area and includes Arroyo Mocho from Stanley Boulevard to its confluence with Arroyo las Positas. The reach also includes the majority of the Chain of Lakes, Lakes E, F, G, H, and I, and the off-chain, former siltation pond, Cope Lake. Flooding in the

Chain of Lakes area is a result of insufficient capacity along Arroyo las Positas (Reach 5) and Arroyo Mocho. Figure 3-7 below shows the current and future 100-year flows and the current channel capacity.

Figure 3-7: Floodplain Map for the Arroyo Mocho Area near the Chain of Lakes



As shown in Figure 3-7, existing channel capacity along Arroyo Mocho is approximately 900 cfs (WYA 2002b), while the current and future 100-year flow is approximately 4,700 cfs (S&W1997). The capacity is further reduced by heavy sedimentation in Arroyo Mocho from Stanley Boulevard until just upstream of El Charro Road, and by heavy in-stream vegetation from Lake E to the confluence with Arroyo las Positas. This reach experienced localized flooding and bank overtopping during the 10- to 15-year flood event that occurred in 1998. If improvements in this reach are not implemented, flooding during a 100-year event is expected to continue under future build-out conditions.

Reach 7

Reach 7 includes Arroyo del Valle downstream of Highway 84 to its confluence with ADLL at I-680. The reach includes the "upper" portion of the Chain of Lakes, Lakes A, B, C, and D. Arroyo del Valle flows are regulated by the Del Valle Reservoir. As a result, the current 100-year floodplain boundaries are shown to be contained within the channel banks.

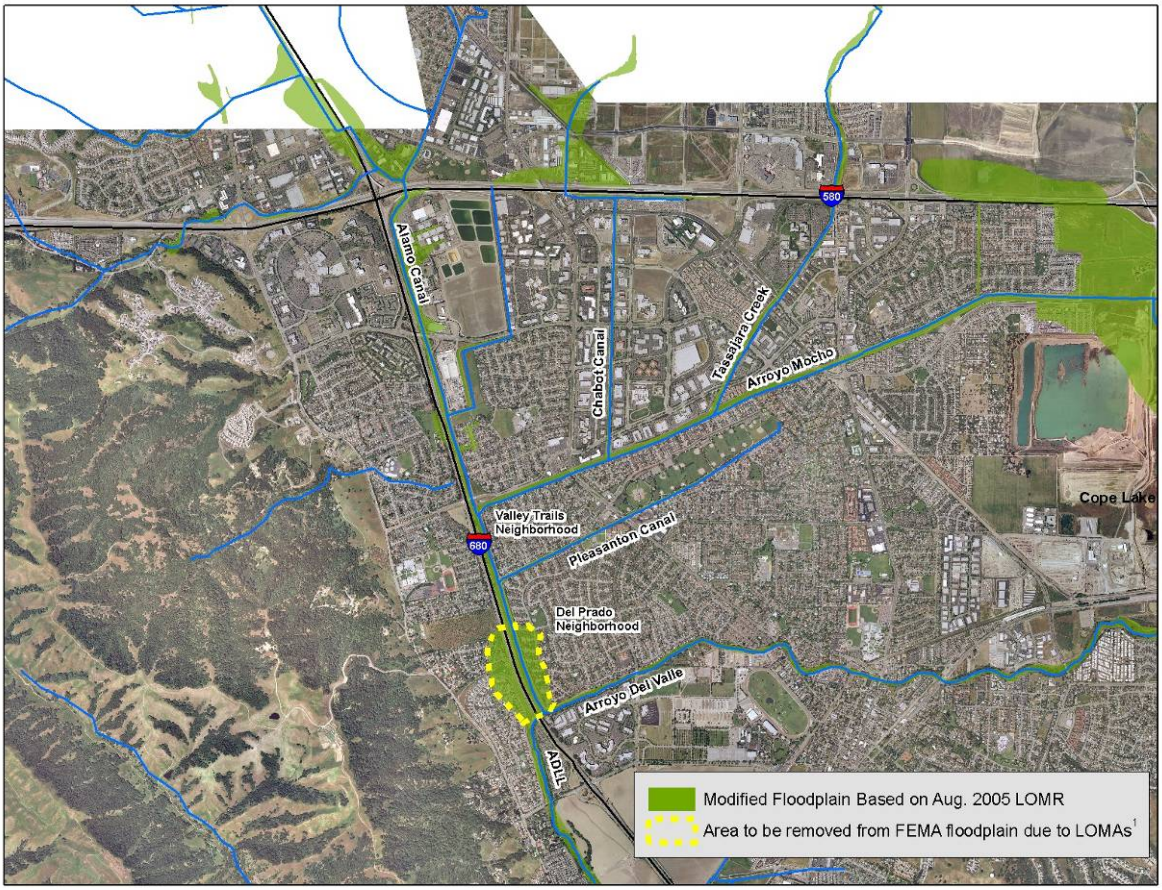
Reach 8

Reach 8 is located in the cities of Dublin and Pleasanton and includes Arroyo Mocho from the confluence of Arroyo las Positas to ADLL, Tassajara Creek, Chabot Canal, Pleasanton Canal, and upper ADLL. The Pleasanton/Dublin BART station and Hacienda Business Park are located in this reach.

As shown in Figure 3-8, current flooding in this reach is limited to areas adjacent to Chabot Canal (upstream of I-580). As discussed in Chapter 1, the FEMA floodplain used to cover parts of the Valley Trails and Del Prado neighborhoods. Based on an August 2005 LOMR approved by FEMA, the Valley Trails neighborhood was removed from the floodplain. Additional LOMAs have also been recently submitted by property owners in the Del Prado neighborhood. These LOMAs have been approved by FEMA and the Del Prado floodplain shown in Figure 3-8 will be removed in the next FIRM.

Due to the capacity restraints in upstream tributary streams (Reach 5 along Arroyo las Positas and Reach 6 along Arroyo Mocho), the tributary 100-year flood flows are not expected to reach the lower reach of Arroyo Mocho. As a result, if the channel capacities in Reach 5 and 6 remain unchanged (i.e. channel improvements are not implemented), and the floodplain along this reach is not expected to change significantly in the future.

Figure 3-8: Floodplain Map for Reach 8



[1]The area of Pleasanton located within the dotted yellow line will be removed from the 100-year event FEMA floodplain due to recently filed LOMAs not yet reflected in the FEMA floodplain map (City of Pleasanton, February 2006).

Reach 9

Reach 9 includes portions of Dublin and Pleasanton near the confluence of I-580 and I-680 and includes Alamo Canal, Alamo Creek, South San Ramon Creek, and a number of other small tributary streams such as Line T-1, J-1, and F-4. As shown in Figure 3-4, this reach has small areas within the city of Dublin that are located in the current 100-year FEMA floodplain. These areas include lands adjacent to Line J-1 and the upper reaches of Alamo Canal (at the I-580 and I-680 crossing).

Reach 10

Reach 10 includes ADLL from its confluence with Arroyo Mocho to the Paloma Way crossing. Some tributary lines such as Lines B-1, B-2-1, and B-2-3 are also important parts of Reach 10. The current 100-year floodplain in this reach is primarily confined within the channel banks except at the SFWD property (immediately upstream of the railroad bridges) where floodwaters overtop the channel banks onto the SFWD property as well as the area immediately upstream and downstream of the Niles Canyon Road Bridge.

Reach 11

Reach 11 is the outlet of the SMMP study area. It includes the last section of ADLL, Vallecitos Creek, Sinbad Creek, Stonybrook Canyon, and Alameda Creek from I-680 to the Fremont city limits. As shown in Figure 3-4, these reaches are not located within the FEMA current 100-year floodplain.

Reach 12

Reach 12 is located in the eastern edge of the SMMP study area and includes the streams draining into San Joaquin County from Alameda County. These streams include Lines U-1, V-1, X-1, and Y-1. The reach is mostly rural, and is not located within FEMA's current 100-year floodplain.

3.3 Sedimentation

The Valley's channels and arroyos have experienced excessive erosion and sediment deposition throughout the watershed. While sedimentation is a natural process essential to the health of the watershed, excessive sediment deposition exacerbates flooding by reducing the channel capacity to convey flood flows. In addition, excessive deposition impedes the function of flood control facilities such as storm drains, outfalls, and flap gates resulting in potential effects on drainage of adjacent properties. Bank erosion also compromises bank stability and contributes to higher sediment loads in downstream reaches which in turn, impacts water quality. Impacts to the stream's water temperature, turbidity, and nutrient loading can have a negative effect on aquatic habitat. Excessively turbid water could also threaten in-stream groundwater recharge operations in the watershed and receiving streams such as Alameda Creek.

The dominant supply of sediment to the watershed originates from Holocene alluvial fans in the Arroyo Mocho and Arroyo las Positas watersheds. The sediment from these watersheds is characterized as sandy gravels or gravelly sands (greater than 2 millimeters; mm). Sediment from Arroyo las Positas is characterized as containing a greater portion of silt and fine to medium sands (less than 0.5 mm; Weiss 2004). Other sources of sediment are in-stream bank erosion and landslides which are abundant in the hills of the watershed (Ayres 2001).

Channel stability varies throughout the SMMP area. A detailed analysis of the overall watershed sediment yield and in-stream sediment transport has been attached in Appendix C. This analysis was conducted to assess the effect of SMMP flood management recommendations on the overall sediment yield or output of the watershed. Total sediment load is comprised of two parts: suspended load and bed load. Suspended load carried in streams originates from sediment eroded from overland areas and carried in flood waters. This sediment is generally composed of fine particles (less than 0.5 mm) carried in suspension. Bed load is composed of coarser sediment generally eroded from the channel banks and bed and includes coarser sands, gravels, and cobbles (greater than 1 mm; Weiss 2004). This material is transported through the channel by various means including rolling, sliding, saltation, and surface creep (RCE et al. 1994). The transport rate of the suspended load is generally greater than that of bed load.

The amount of sediment derived from overland erosion (suspended load) is dependent on various climatic and physical characteristics of the watershed. This load is controlled by the availability of erodible soils in the watershed and is therefore not dependent on the hydraulic conditions of the stream. On the other hand, bed load originates from the channel banks and bed and is therefore dependent on the channel's sediment characteristics (i.e. size distribution), geometry, and hydraulic conditions. Discussions on suspended load and bed load are presented under separate sub-sections below (Section 3.3.1 and Section 3.3.2).

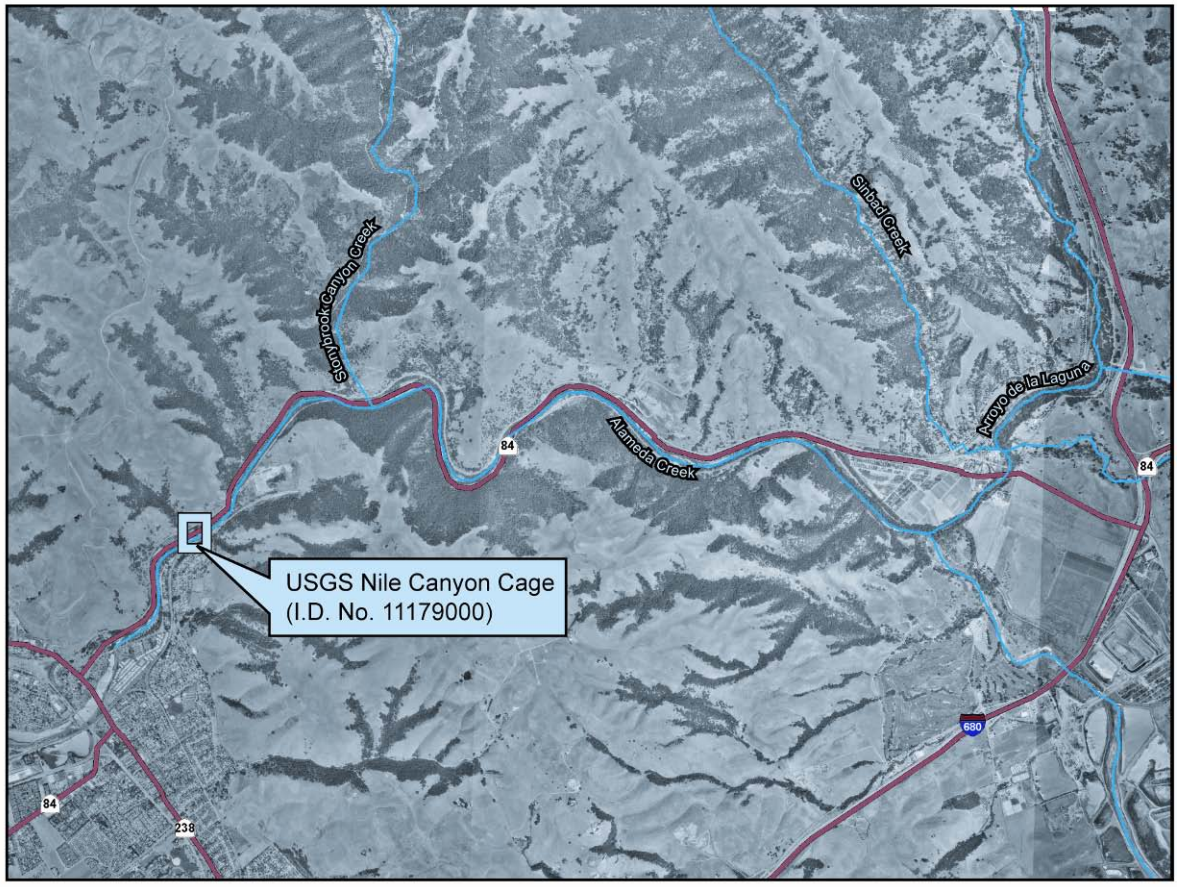
3.3.1 Suspended Sediment Load

Numerous studies exist with varying estimates of the Valley watershed's suspended load. As previously mentioned, a detailed analysis of the overall suspended sediment yield of the watershed was conducted as part of the SMMP development. This analysis is summarized in a TM that has been attached to Appendix C. The analysis was conducted to assess the effect of SMMP flood management recommendations on the watershed's suspended sediment yield. The suspended sediment load was calculated using the Pacific Southwest Inter-Agency Committee (PSIAC) method (PSIAC 1968). This method estimates suspended sediment input into the stream by evaluating the condition of the watershed including the surface geology, soils, climate, runoff, topography, ground cover, land use, upland erosion, and channel erosion and sediment transport. The method is intended for broad-planning purposes to obtain an order-of-magnitude estimate of suspended load. Using this method, the suspended sediment load currently exiting the watershed was estimated at 184,000 cubic yards per year ($yards^3$/year).

A study performed by Weiss Associates estimated the suspended sediment load at the U.S. Geological Service's (USGS) Niles gage on Alameda Creek. The location of this gage is shown in Figure 3-9. This study was conducted as part of an effort by the San Francisco Public Utilities Commission (SFPUC) to evaluate impacts resulting from the partial removal of Sunol and Niles Dam on Alameda Creek. The suspended sediment load at this gage originates from Alameda's upper and lower creek basins including ADLL. The portion of the total suspended load originating from the lower creek basin is expected to be smaller since creeks in this basin drain into two reservoirs (the San Antonio and Calaveras reservoirs) and the soils eroded from the uplands would be trapped behind the reservoirs. Weiss Associates calculated the annual suspended sediment load using a sediment rating curve fitted to the USGS suspended sediment data taken at the Niles gage. A 23-year period (1981-2003) was used to represent current load conditions. This period encompassed both wet and dry years, with annual peak flows ranging from an 18-year event to less than a 1.25 year event. The mean annual suspended sediment load was estimated at 256,000 tons per year (tons/yr; Weiss 2004). To convert this mass load to volumetric load, the suspended sediment density was assumed to be equal to that of uniform inorganic silt (0.0495 tons per cubic feet or 99 pounds per cubic feet; Lambe et al. 1969). Applying this assumed density, the estimated suspended load based on the USGS gage data was approximately 192,000 yards^3/year.

Based on these two studies, the estimated suspended sediment load currently exiting the ADLL watershed ranges from 184,000 to 192,000 yards^3/year.

Figure 3-9: USGS Niles Canyon Gage (11179000) Location



The amount of sediment yield from ADLL affects the water quality of Alameda Creek which in turn affects the stream's aquatic habitat. The restoration of a steelhead trout population in Alameda Creek is an ongoing goal of federal and State regulatory agencies as well as conservation groups such as the Alameda Creek Alliance. Although anadromous steelhead, a federal threatened species, are currently

unable to access much of the Alameda Creek watershed due to migration barriers, the future restoration of a steelhead population in the watershed remains a distinct possibility. As a result, maintaining a balanced supply of sediment is important to contribute towards these efforts. In addition, heavy sediment loads in Alameda Creek can impact the groundwater recharge operations along the stream.

The suspended sediment yield from ADLL is expected to decrease in the future due to increased development in the watershed. Urbanization tends to increase runoff and decrease sediment yield since the area of ground cover types with the highest sediment yield rates (e.g. grasslands) decreases and is replaced by ground cover types with low erosion potential (e.g. paved surfaces). Using the PSIAC method, as described in the TM attached to Appendix C, the estimate of future suspended sediment yield is approximately 172,000 yards^3/year. This estimate assumed full build out development conditions and current channel capacities, that is, it assumed that channels remained unimproved. The suspended sediment carried in waters overtopping the channel banks will be deposited on the floodplain. The suspended sediment load carried in flood waters is not expected to change with implementation of SMMP flood control measures. Instead, by concentrating flood flows in the Chain of Lakes, implementation of the regional storage solution will provide a controlled environment to manage suspended sediment in the watershed. Therefore, from a sediment perspective, the difference between unimproved channels and implementation of the SMMP regional storage solution is management of flows and sediment in the watershed. Sediment accumulation on the storage ponds will need to be considered as part of the overall operation and maintenance of the Chain of Lakes regional storage program.

A summary table of estimated current and future suspended sediment yields is given in Table 3-2 below.

Table 3-2: Current and Future Suspended Sediment Yields

	PSIAC Method (see TM shown in Appendix C)		USGS Niles Canyon Gage (Weiss 2004)	
	(yards^3/year)	(tons/year)	(yards^3/year)	(tons/year)
Current Suspended Sediment Yield[1]	184,000	246,000	192,000	256,000
Future Suspended Sediment Yield[2]	172,000	230,000	NA	NA

Notes:
[1] Volumetric and mass loads were calculated assuming a density equal to that of uniform inorganic silt (0.0495 tons per cubic feet or 99 pounds per cubic feet; Lambe et al. 1969).
[2] Future suspended yield remains constant with or without implementation of the SMMP's Chain of Lakes regional storage project.

3.3.2 Sediment Bed Load

Bed material load is composed of sand and coarser sediment material eroded from the channel banks and bed. The quantity of bed load transported through the channel will depend on the bed load transport capacity of the channel and the sediment supply. A detailed analysis of bed load transport in the watershed was conducted as part of the SMMP development. This analysis is summarized in a TM that has been attached to Appendix C.

A sediment transport capacity relationship was developed by Ayres Associates utilizing regression analysis, the Meyer-Peter and Muller bed load equation, and the Zeller and Fullerton Power Function Relation (Ayres 2001). This relationship is a function of variables known to influence sediment transport capacity including channel hydrology, channel geometry, and sediment size and gradation. The analysis determined whether a particular reach of a channel was eroding or agrading (i.e. was subject to sediment deposition) based on an overall balance of sediment inflow and the reaches' bed load transport capacity.

For a more detailed description of the methodology used including technical assumptions, refer to Appendix C.

The current bed load discharged into Alameda Creek during a 2-year flood event was estimated at 12,000 yards^3/year. This load dramatically increased during a 100-year flood event to approximately 170,000 yards^3/year. The bed load transported under build-out conditions was estimated at approximately 18,000 yards^3/year during a 2-year event and 120,000 yards^3/year during a 100-year flood event. The increase in impervious cover under full build-out conditions results in a reduction in lag time and an increase in peak flows. Larger peak flows augment the channel's sediment transport capacities resulting in an overall increase in erosion or sediment deposition trends.

A second analysis of bed load estimated the bed load at the USGS Niles gage on Alameda Creek to be approximately 13,000 tons per year (Weiss 2004). Assuming a bed load density equal to that of silty sand and gravel (0.053 tons per cubic feet or 118 pounds per cubic feet; Lambe et al. 1969), the volumetric load is approximately 9,100 yards^3/year. The period used to represent bed load conditions encompassed both wet and dry years, with annual peak flows ranging from an 18-year event to less than a 1.25 year event.

A summary table of estimated current and future sediment bed loads is given in Table 3-3 below.

Table 3-3: Current and Future Sediment Bed Loads

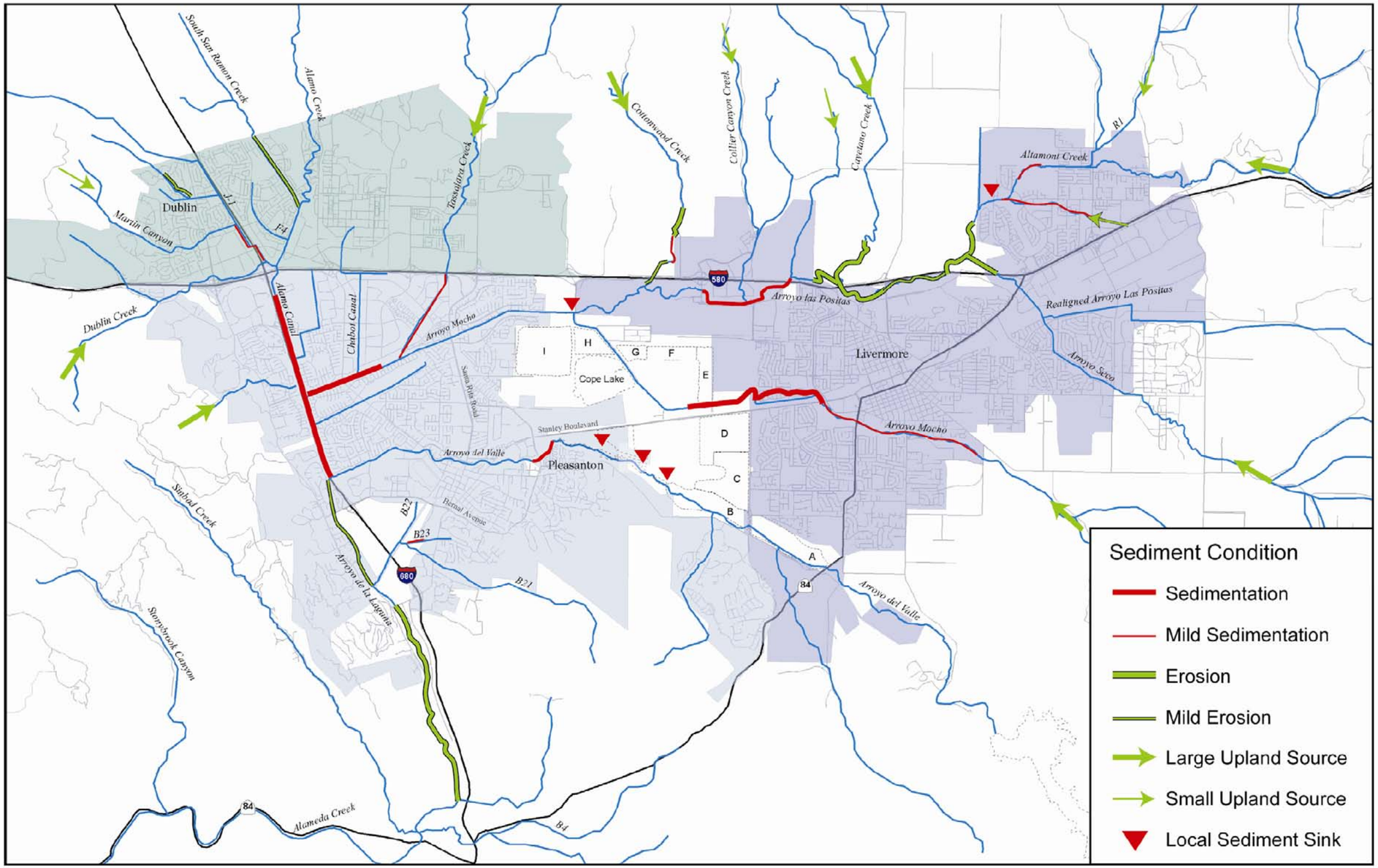
	Meyer-Peter & Muller Bed Load Equation (see TM shown in Appendix C)		Wilcock Model (Weiss 2004)
	2-Year Event (yards^3/year)	**100-Year Event (yards^3/year)**	**1.25 to 18-Year Event[1] (yards^3/year)**
Current Bed Load	12,000	170,000	9,100
Future Suspended Sediment Yield[2]	18,000	120,000	NA

Notes:
[1] The bed load was originally depicted as a mass load (i.e. tons per year). To convert this estimate to a volumetric load, the density of the bed load was assumed to correspond to that of silty sand and gravel (0.053 tons per cubic feet or 118 pounds per cubic feet; Lambe et al. 1969).

3.3.3 Sediment Routing

Numerous field visits were conducted by RMC, WYA, and Ayres Associates to evaluate channel stability in the watershed. These observations were supplemented with the sediment analysis shown in Appendix C. A discussion follows to describe reach-by-reach the state of the streams from a sediment perspective. An overview of the channel's sediment condition is shown in Figure 3-10.

Figure 3-10: Overall Sediment Conditions in the SMMP Study Area



Reach 1

Altamont Creek is included in Reach 1 and is characterized by sediment deposition as shown in Figure 3-11. Maintenance on Altamont Creek in 2004 included removal of approximately 10,000 cubic yards along a 250-foot stretch of the creek immediately upstream of the Bluebell Avenue Bridge and 350 cubic yards immediately upstream of Broadmoor Avenue.

Figure 3-11: Sediment Deposition and Vegetation Debris in Reach 1 along Altamont Creek

The upper portion of Arroyo las Positas (Reach 1) is subject to both stream down cutting (along I-580 up to the confluence with Line S-1) and sediment deposition (upstream of the confluence with Altamont Creek). Channel bank erosion is shown in Figure 3-12. Sediment deposition in the upper reaches of Arroyo las Positas (upstream of the confluence with Altamont Creek) is associated with vegetation debris as evidenced in Figure 3-13.

Figure 3-12: Stream Downcutting in Reach 1 along Arroyo las Positas Downstream of Line S and in the Vicinity of the North Livermore Crossing

Figure 3-13: Vegetation Debris on Arroyo las Positas at Bluebell Drive Bridge

Reach 2

High velocity, paired with erosion is an issue along Realigned Arroyo las Positas west of LLNL. No additional sediment related issues were identified in these channels.

Reach 3

The stretch of Arroyo Mocho between Wente Street and Stanley Boulevard is characterized by significant sediment deposition and gravel transport and deposition. Much of this gravel is deposited at the Holmes Street and Stanley Boulevard bridges, causing capacity problems at these locations. The source of these gravels and sediments appears to be the alluvial fan located further upstream along Arroyo Mocho (within the narrower valleys of the upper watershed). This alluvial fan is considered to be the greatest supply of sediment to the Valley's flood control system (WYA 2001b). Figure 3-14 shows gravel deposits at the Holmes Street Bridge. Sediment removal at this site is currently conducted once every two years by the City of Livermore. On average, approximately 800 to 1,000 cubic yards is removed although they have removed up to 1,500 cubic yards from the stream. Additionally, some erosion along the reach of Arroyo Mocho between Concannon Blvd. and Arroyo Road has been observed.

Figure 3-14: Gravel Deposits along Arroyo Mocho at Holmes Street Bridge in Reach 3

Reach 4

Reach 4 includes Arroyo del Valle (downstream of Lake del Valle to Highway 84) and does not experience significant erosion or sediment deposition.

Reach 5

Reach 5 is characterized by heavy sediment deposition immediately upstream of the I-580 crossing and along Airway Boulevard. The sediment deposition is partly caused by a discontinuity in channel design upstream and downstream of the Airway Boulevard crossing. Upstream of the crossing, the channel is very wide (approximately 100 feet) with a relatively flat slope. Downstream of the crossing (along the Las Positas Golf Course), the channel narrows to less than 10 feet resulting in poor sediment transport capacity (Ayres 2001). The two sediment deposition locations are shown on Figure 3-15 and Figure 3-16, respectively.

Figure 3-15: Sediment Deposits along Arroyo las Positas at the I-580 Crossing

Figure 3-16: Sediment Deposits under Airway Boulevard

The sediment deposition has contributed to a reduction in stream capacity and is undermining the capacity of the I-580 crossing and culverts along Airway Boulevard. Arroyo las Positas discharges into a sediment basin located at the confluence with Arroyo Mocho. This concrete basin was constructed in 2003 following the completion of the Arroyo las Positas realignment. The basin is scheduled for maintenance in 2007 with an estimated 350 cubic yards of material to be dredged.

Reach 6

This reach is characterized by sediment deposition along the improved channel through the Chain of Lakes area which reduces the capacity of Arroyo Mocho and exacerbates flooding problems along the reach.

Reach 7

Arroyo del Valle within Reach 7 does not experience significant erosion or sediment deposition.

Reach 8

The lower reach of Arroyo Mocho within Reach 8, is subject to sediment deposition from the confluence with ADLL to Stoneridge Drive bridge. This reach of Arroyo Mocho was also included in the 1997 desilting survey. The survey indicated that an estimated 113,200 cubic yards of sediment had been deposited on the channel since it was improved to Zone 7's Green Book standards (WYA 2001b). Tributaries to the lower reach of Arroyo Mocho include Tassajara Creek and Chabot Canal. Only Tassajara Creek exhibits slight sediment deposition from the I-580 crossing to its confluence with Arroyo Mocho. Chabot Canal is not subject to erosion or sediment deposition.

The upper portions of ADLL upstream of the Bernal Avenue Bridge are subject to sediment deposition. This reach was also inspected in the 1997 desilting survey which indicated severe sediment deposition with an estimated 94,000 cubic yards of material deposited on the channel (WYA 2001b). Maintaining capacity in this reach is of particular importance due to the adjacent Valley Trails and Del Prado neighborhoods which are currently in the FEMA 100-year floodplain. Any decrease in the stream's capacity could exacerbate future flooding in this area.

Reach 9

This reach is characterized by areas of both erosion and sediment deposition. Erosion sources in this reach include areas in the hills west of Dublin and Pleasanton, channel bed erosion in South San Ramon Creek near the confluence with Alamo Creek, and bank erosion along Alamo Creek and South San Ramon Creek. All of these erosion sources lead to sediment deposition further downstream in Alamo Canal south of I-580. Line J-1 (from Amador Valley Boulevard to its confluence with Alamo Canal) is also subject to sediment deposition. According to Zone 7 maintenance records, this reach was desilted in 2004 with approximately 620 cubic yards of sediment removed along 600 feet of concrete lined channel. This reach had been last desilted in 2002.

Reach 10

ADLL is subject to both bed and bank erosion and sediment deposition. The lower portions of ADLL downstream of the Bernal Avenue Bridge crossing are incising as evidenced by large bank failures. To counteract the bed level drop and resulting nick points in the channel, six grade control structures are currently located along ADLL from the Alameda Creek confluence to the Arroyo del Valle confluence. Particular areas of concern include areas downstream of Bernal Avenue Bridge, downstream of Castlewood Drive (as shown in Figure 3-17), immediately upstream and downstream of the Verona Road Bridge down to the confluence with Alameda Creek. Erosion in some of these areas threatens properties located along the channel banks.

Figure 3-17: Bank Erosion along ADLL Immediately Downstream of the Verona Avenue Footbridge

Reach 11

Sinbad Creek is defined as Reach 11. It discharges into ADLL and is located at the outlet of the SMMP study area. Localized erosion spots along Sinbad Creek are visible along the lower reaches of the channel. Properties adjacent to channel banks may be affected if the bank undercutting shown in Figure 3-18 and in other locations is not addressed.

Figure 3-18: Bank and Toe Erosion in Sinbad Creek

Reach 12

Sheer stream banks, as shown in Figure 3-19 are a common feature in the upland region of this reach. As the walls erode and fall into the streambed, land is lost and roads and properties may eventually be threatened. As a result, there are opportunities to stabilize stream banks where erosion threatens property or roads.

Figure 3-19: Bank Erosion in Patterson Run (Line Y-1)

3.4 Water Supply

Needs and opportunities relating to water supply are apparent in Reaches 1, 3, and 4 through 8. Water from the SBA which travels through the SMMP study area, is diverted by Zone 7 for uses including recharging the main groundwater basin. The paths and processes of this recharge program falls under the auspices of Zone 7's Artificial Recharge Program. Water supply needs and opportunities are discussed by reach in greater detail below.

In Reach 1, Zone 7 uses Altamont Creek and Arroyo las Positas to convey water from the SBA to Livermore for irrigation purposes (Springtown Golf Course). Less frequently, water is released for recharge purposes, or to improve the water quality of the water that is recharging along Arroyo las Positas (from Springtown to the confluence of Arroyo Mocho). While there is limited recharge occurring in Reach 1 (1-3 cfs in Arroyo las Positas), pollutants can be carried by overland flow to either stream compromising water quality in flows critical to recharge areas downstream. For these reasons, it is a priority of Zone 7 to protect the water quality of the stream, and to maintain the SBA turnout in the upper reaches of this subwatershed.

Arroyo Mocho in Reach 3 contributes significantly to groundwater recharge, especially downstream of the intersection of the arroyo with the SBA. As such, Arroyo Mocho is a critical part of the Zone 7's Artificial Recharge Program. As part of this program, SWP water is released from the SBA into Arroyo Mocho during the spring, summer and fall to allow water to percolate through the permeable creek bed soils into the groundwater basin. Because of the critical role Arroyo Mocho plays in the Artificial Recharge Program, there is a need to protect this stream function and the quality of water in Arroyo Mocho for recharge. Figure 3-20 and Figure 3-21 portray the SBA diversion and the flow immediately downstream of the outfall.

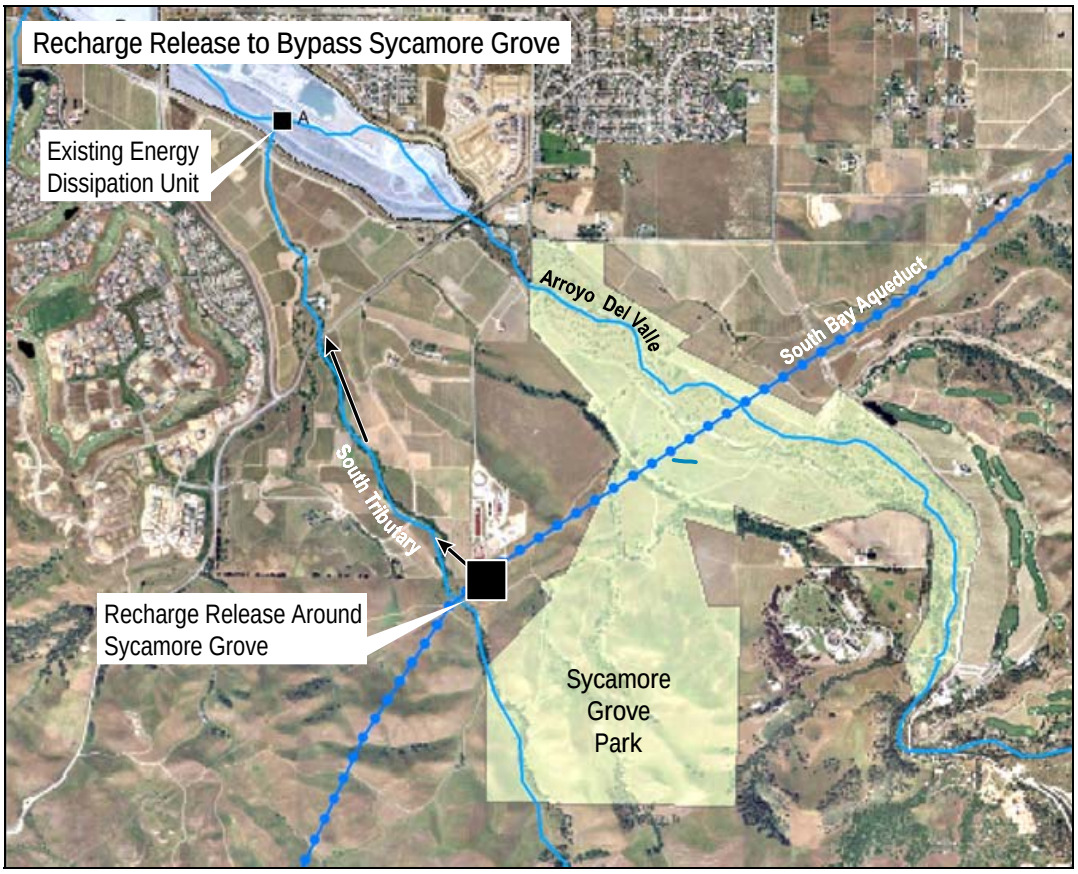
Figure 3-20: SBA Diversion Outfall to Arroyo Mocho

Figure 3-21: Arroyo Mocho Immediately Downstream of the Outfall

Reach 4 is critical for conveyance and groundwater recharge. It is believed that the modified hydrology through the Sycamore Grove Park starting in the 1970s, along with regional climatic conditions during the 1985-1992 drought may have resulted in the decline of sycamores in the 1980s and 1990s (SA 2004). LARPD and Zone 7 have analyzed the impact of Arroyo del Valle hydrology on sycamore health in the Sycamore Grove Park Draft Resources Management Plan (SA 2002), and developed the Sycamore Grove Recovery Program and Technical Report (SA 2004). The recent findings are that the sycamores are no longer in decline, and the situation is improving due to Zone 7's management of the Artificial Stream Recharge Program, groundwater levels, and water flows through the Park. An opportunity currently being explored by Zone 7 is to release SBA water into the South Tributary stream and reduce the releases of Del Valle Reservoir into Arroyo del Valle during summertime based on recommendations in the 1989 HortScience Study and 2002 Recovery Management Plan. This scenario is shown in Figure 3-22, and would provide flexibility in operation of del Valle releases and management of park hydrology, while providing additional groundwater recharge. A detailed management plan for the sycamore grove and the

water releases at Arroyo del Valle remains to be developed, but it is believed that that the health of the mature trees can be sustained by maintaining summer groundwater levels within the general range recommended in the 1989 report.

Figure 3-22: Sycamore Grove Park Proposed Recharge Bypass



Arroyo Mocho in Reach 6 is one of the most important streams in terms of water supply and is critical for both recharge and surface water storage. As described in Reach 3, water is released from the SBA and conveyed in Arroyo Mocho for recharge. In addition to recharge, flows from Arroyo Mocho are also an integral part of Zone 7's surface water storage in the Chain of Lakes. Zone 7 is proposing to construct a diversion facility with an inflatable rubber dam to divert water into Lake H for storage and, ultimately, recharge into the groundwater basin.

The Chain of Lakes, particularly Lakes H and I, play an important role in Zone 7's water supply and aquifer recharge operations. In these lakes, water is allowed to percolate through the sides of the lake thus augmenting recharge to the main Groundwater Basin. Based on size and location, Lake I is the primary recharge basin.

The Chain of Lakes could also act as a storage reservoir during dry years when SWP deliveries are reduced. The Zone 7 water accounting model indicates that, in order to meet 2020 demand predictions of 100,300 AFY, 50,000 AF of above-ground Chain of Lakes storage would be necessary (WTA 1999). This storage of water in the Chain of Lakes allows Zone 7 to conjunctively manage surface water to augment supplies by recharging the groundwater basin in preparation for drought periods. The estimated available surface water storage in the Chain of Lakes at completion is approximately 100,000 AF (Zone 7 2005). This volume could include storage of recycled water from the Livermore Water Treatment Plant or other unidentified sources in appropriate areas of the Chain of Lakes.

Arroyo del Valle in Reach 7 is also used for conveyance and recharge as part of Zone 7's Artificial Stream Recharge Program. The upper Chain of Lakes will also become important components of Zone 7's water supply management once they are turned over to Zone 7. There are plans to construct a diversion facility from Lake A to Lake C. This would allow excess surface water flows from Del Valle to be transferred from Lake A to Lakes C and D to be stored for recharge in the Chain of Lakes.

3.5 Water Quality

Water quality issues relating to the streams and arroyos in Zone 7's service area include the quality of drinking water, in-stream water, and runoff (both urban and non-urban sources). While Zone 7 has a limited role in the quality of water arriving in its service area; they can play a role in timing releases to capture lower total dissolved solids (TDS) water to minimize impacts on the underlying basin.

Water quality needs and opportunities are categorized into protection of potable supplies, and non-point source issues. Each category is discussed by affected reach in greater detail below.

3.5.1 Protection of Potable Supplies

From a drinking water perspective, water quality is important in all reaches because water in the arroyos recharges the groundwater basins that provide potable water to the Livermore-Amador Valley and Niles Cone Groundwater Basin users. In particular, Reaches 3, 4, 5, 6 and 7 have the greatest potential for impacting groundwater quality in the Livermore-Amador Valley Groundwater Basin because of the high infiltration rates that occur along these gravelly stream channels.

The primary constituents of concern are the dissolved salts the stream waters that occur naturally and as irrigation runoff. These dissolved minerals are not removed by the natural processes within the groundwater basin and thus contribute to the groundwater's salinity and hardness. There is also a need to protect the streams and groundwater basin from contaminants generated by urban and non-urban activities such as hydrocarbons, pesticides, and fertilizers.

Zone 7's Salt Management Plan (Zone 7 2002a) addresses the methods in which Zone 7 plans to halt and prevent the further degradation of the Livermore-Amador Valley main groundwater basin from the dissolved salts, including conjunctive use and groundwater demineralization. The Salt Management Plan is a component of Zone 7's overall Groundwater Management Plan, adopted in September 2005.

As outlined in the Groundwater Management Plan, protection from urban and non-urban contaminants can be achieved within the watershed through source control and an increase in security measures. Source control activities include public outreach activities, and coordination with local agencies and business likely to generate pollutants. Protection measures against security threats include inspection, construction and maintenance of fencing, gating, and visual surveillance measures. Security measures should be addressed as part of an Operations Plan for projects identified in the Chain of Lakes area.

3.5.2 Non-Point Source Issues

From a non-point source water quality perspective, streams within the SMMP study area are characterized as impaired for diazinon under Section 303(d) of the Clean Water Act. Diazinon is a pollutant resulting from urban runoff that has been identified in most of Zone 7's streams (including Reaches 1, 3, 5, 6-9, and 11) and in most streams located in urbanized areas of the Central San Francisco Bay Region. In addition to diazinon, the Regional Water Quality Control Board (RWQCB) has identified other general pollutants of concern for all Central San Francisco Bay streams, which includes the streams in the SMMP study area. Pollutants of concern need to be addressed because of their impact on downstream waters discharging into San Francisco Bay. Such pollutants include Mercury, Copper, Selenium, Dioxins, PCBs, and pesticides.

The RWQCB has characterized all streams to be impacted by pollutants of concern due to the lack of data available. There are opportunities to develop constructed wetlands to improve stormwater runoff in Reach

1 near I-580, and Reach 3 near Robertson Park and possibly in the Chain of Lakes region. Constructed wetlands can be designed and used to remove pollutants from stormwater runoff through microbial breakdown of pollutants, plant uptake, retention, settling, and absorption. Utilizing constructed wetlands as stormwater Best Management Practices (BMPs) can provide benefits in addition to water quality improvement such as habitat enhancement and education and outreach opportunities.

Additional water quality issues include high TDS reported in water entering Reach 5 due to soil conditions in Reach 1, and cattle access to portions of Reach 5 and the lower portion of ADLL in Reach 10. The SMMP recommends constructing cattle fences, and purchasing land where grazing within the stream occurs in a couple reaches to curb the water quality effects from cattle access.

3.6 Habitat and Environment

Needs and opportunities relating to habitat and the environment present themselves throughout the SMMP area. There are many special status species, including the Bird's Beak, the California tiger salamander, the western pond turtle and the California red-legged frog within Reach 1, 2, 5, 9 and 10. Fisheries issues are also a concern in several reaches, which could include fish migration barriers and lack of adequate riparian cover. Other areas for habitat improvement include Reach 4, which is home to one of the largest Sycamore groves in California, and riparian areas along ADLL in Reach 10. The major needs and opportunities are categorized and discussed in greater detail below.

3.6.1 Special Status Species

Special status species are known to occur throughout the region. Special status species occur within the channels, along the banks, and in the floodplain areas. Areas with special status species present opportunities for preservation and habitat improvement and enhancement. Specific reaches with special status species needs and opportunities are listed below.

There are many special-status species in Reach 1, including the Bird's Beak, the California tiger salamander, the western pond turtle and the California red-legged frog (EMEC 1996; Questa et al. 1998; PWA 2000; and WYA 2001e). Pictures of these species are shown in Figure 3-23, Figure 3-24, Figure 3-25, and Figure 3-26. In particular, the Springtown Natural Communities Reserve, located Reach 1, is an area that should to be preserved and provides opportunities for habitat enhancement. The Springtown area contains a complex variety of wetland, scrub and grassland plant communities that support a habitat of alkali sink scrub vegetation and vernal pool areas (EMEC 1996). Many special status species have the potential to occur in the Springtown area including Bird's Beak, California tiger salamander, and burrowing owl (EMEC 1996).

Figure 3-23: Bird's Beak (Chaparral)

Figure 3-24: California Tiger Salamander

Figure 3-25: Western Pond Turtle

Figure 3-26: California Red-Legged Frog

Because Reach 2 is mostly urbanized, the only area with significant habitat potential to be preserved is north of I-580, just upstream of the confluence with Arroyo las Positas. Although California red-legged

frogs and burrowing owls have been spotted along Realigned Arroyo las Positas (WYA 2001), implementation of projects in this area is not feasible due to security restrictions and requirements of LLNL.

The upper reach of Arroyo Mocho (Reach 3) is mostly agricultural and hosts many special-status species, including sycamore trees, the California red-legged frog, California tiger salamander, and western pond turtles (Questa et al. 1998; PWA 2000; and WYA 2001e). Downstream of Wente Street, there are opportunities to enhance the parks habitat by providing enhanced riparian cover including willows and sycamore trees.

In addition to the Sycamore trees in Reach 4, the park is home to many special-status species including the California red-legged frog, California tiger salamander, western pond turtle, and Alameda whipsnake (SA 2002). Opportunities to enhance these species are discussed in the Sycamore Grove Park Draft Resources Management Plan and include vegetation management of exotic species, vegetation management within seasonal breeding ponds, and predator control and management programs (SA 2002).

California red-legged frog sightings have also been reported in Reach 5 along Arroyo las Positas and in the Cayetano Creek watershed north of I-580 (ESA 2002a). This reach also has been identified with moderate to high potential for California tiger salamander (ESA 2002a). As a result, there is a need to enhance and protect habitat for these special status species in this reach. Opportunities for habitat protection and enhancement include creation of off-line seasonal ponds, improvement of riparian habitat through expansion of willows and Valley Oak cover, and implementation of erosion and sediment control measures (ESA 2002a).

There is an opportunity for habitat enhancement in Reach 6 by creating a low-flow meandering channel along Arroyo Mocho, and conducting vegetation management along the banks. Similar opportunities are available in Reach 7 by filling riparian gaps with native species, and conducting non-native species removal activities along Arroyo del Valle.

A need for a low-flow meandering channel has been identified in Reach 8 along portions of Arroyo Mocho, and ADLL. Other opportunities in Reach 8 include the need for shaded riverine aquatic cover on top of banks, and slopes of Arroyo Mocho and ADLL.

Reach 9 contains primarily urbanized areas, except along Alamo Creek upstream of the confluence with South San Ramon Creek and in the hills west of Dublin. These less urbanized areas contain habitat that may support the California tiger salamander and the California red-legged frog (ESA 2002a). Alamo Creek in the northern part of the reach could support the western pond turtle (ESA 2002a). Habitat conditions in these less urbanized areas are good, and should be preserved and maintained.

There is a need to preserve habitat along ADLL (Reach 10) in order to preserve common species associated with riparian oak woodland community, and species of concern including the western pond turtle, observed in this reach (ESA 2002a). ADLL provides many opportunities for stream bank restoration and habitat enhancement.

3.6.2 Fisheries Issues

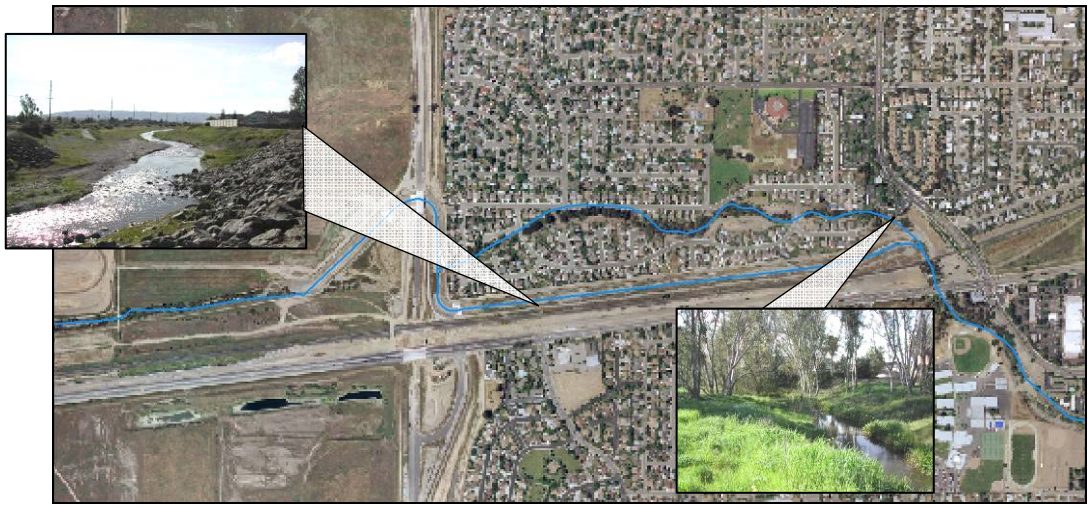
It is speculated that Arroyo Mocho would be the primary steelhead migration corridor from Alameda Creek to the suitable spawning areas identified in the upper reaches of Arroyo Mocho (Gunther et al., 2000). As a result, habitat needs and opportunities for these potential migration corridors focus on improving and maintaining channels in order to allow for future fish passage. Fish passage problems at culverts or other road-crossings result from excessive drops (perched outlets); constriction of flow at crossings causing high velocities and turbulence; lack of fish take-off pools of sufficient depth at crossings; and debris accumulation across inlets, or within crossings (Love 2001). Other barriers with respect to in-migration include man-made structures within the stream channel, natural landscape features within the channel, and inadequate streamflow or unacceptable water quality (Gunther et al. 2000).

Barriers with respect to out-migration include inadequate flow between rearing region and area of tidal influence, inappropriate water temperatures, and not-suitable refuge from predators (Gunther et al. 2000). Criteria in categorizing barriers as fish-passable or not, include high and low fish passage design flows, water velocity, water depth, and other stream characteristics; all of which should be determined on a case-by-case basis (NMFS 2001).

Several fish impediments/barriers within the SMMP area were identified by Gunther et al. in the *Assessment of the Potential for Restoring a Viable Steelhead Trout Population in the Alameda Creek Watershed* (Gunther et al. 2000). During field investigations, other structures within the SMMP area that had similar characteristics to the impediments/barriers identified by Gunther et al. were also incorporated into this Draft SMMP as barriers requiring modification or removal. Specific reaches with fisheries needs and opportunities include Reaches 3, 6, 7, 8, and 10, and are discussed in greater detail below.

Upstream of the Chain of Lakes in Reach 3, a flood control bypass channel between Isabel Avenue and Stanley Boulevard was constructed in 2000. Habitat conditions along the original channel are good and there is an opportunity to use this portion of the original channel as the potential steelhead migration corridor. Conditions in the original and relocated channel are shown in Figure 3-27.

Figure 3-27: Channel Location in Arroyo Mocho between Stanley Boulevard and Isabel Avenue



The most pressing need for habitat in Reach 3 is the removal of fish barriers in the reach. This is a critical need because the upstream portions of Arroyo Mocho could represent a critical corridor for steelhead migration (CEMR 2000). The old railroad bridge footing located at Stanley Boulevard, shown in Figure 3-28, could act as a barrier to fish migration (Gunther et al. 2000) and will need to be removed or modified to allow for future fish migration.

Figure 3-28: Railroad Crossing Footing at Stanley Boulevard

Figure 3-29: Dragon's Teeth Downstream of Isabel Avenue

As a result of the spawning habitat designation, habitat needs and opportunities for Reach 6 focus on improving and maintaining Arroyo Mocho through the Chain of Lakes area in order to allow for future fish passage. Opportunities for improving conditions include removal or modification of fish barriers, such as the energy dissipation unit downstream of Isabel Avenue (Figure 3-29), fish barriers on Lower Arroyo del Valle (Figure 3-30), removing invasive species in the stream channel such as Arundo Donax (Figure 3-31), and providing appropriate riparian cover. Significant construction activities have occurred along Arroyo Mocho in the Chain of Lakes over the past year. These activities included the relocation of the lower Arroyo las Positas and the widening of Arroyo Mocho. In addition, a permanent diversion structure on Arroyo Mocho is being proposed for placement in 2007 or 2008. All these projects have included or are proposing to include mitigation to allow fish passage and improve the riparian habitat. Any future construction project in the Chain of Lakes area will need to include similar mitigation measures.

Lower sections of Arroyo del Valle (Reach 7) are identified as potential corridor for steelhead (Gunther et al. 2000). As such, there is a need to remove or modify existing fish barriers at Hopyard Road, Santa Rita Road, Stanley Boulevard, and at the confluence of Arroyo del Valle and ADLL. Figure 3-30 shows one of these barriers.

Figure 3-30: Fish Barriers in Lower Arroyo del Valle

There is very good riparian cover along most of the length of Arroyo del Valle. However, there are pockets of lower quality riparian cover along the length of this reach, particularly at major road crossings such as Bernal Road. There is an opportunity to enhance these lower quality areas through control of invasive species and installation of native plantings

Activities required to maintain Reach 8 for fisheries migration include removal or modification of the drop structure near the confluence of Arroyo Mocho and ADLL, and enhancement of riparian cover through installation of shaded riverine aquatic cover along portions of Arroyo Mocho and ADLL.

Most of Reach 10 serves a fisheries migration corridor only and likely does not provide good rearing or spawning habitat due to poor pool formation and high summer temperatures, however, portions in the lowermost section could potentially serve as seasonal habitat (Gunther et al. 2000). As a result, there is a need to preserve and enhance ADLL for migratory fish passage through removal or modification of fish barriers, such as the drop structure at Castlewood Golf Course, and to preserve and enhance shaded riparian cover in Reach 10.

3.6.3 Other Significant Habitat

Other areas for habitat improvement and enhancement include the Sycamore Grove along Arroyo del Valle in Reach 4, and the oak woodlands along ADLL in Reach 10. The stand of Sycamores in Sycamore Grove Park is one of the oldest and the third largest stand of western sycamore in California. The trees are also distinguished by being a nearly pure stand of trees of similar age (SA 2002). The trees have been stressed by several factors including altered hydrology (as discussed above), regional climatic conditions, and invasive plant species such as giant reedgrass (*Arundo donax*).

Within Reach 10, ADLL represents one of the last reaches of mature riparian oak woodland forest, sycamores, and willow-scrub within the Valley. There is a need to preserve this habitat in order to preserve common species associated with riparian oak woodland community. Measures proposed in Reach 10 include enhancement of riparian corridor, and bank stabilization measures.

Figure 3-31: Arundo Donax

3.7 Trails, Recreation, and Public Education

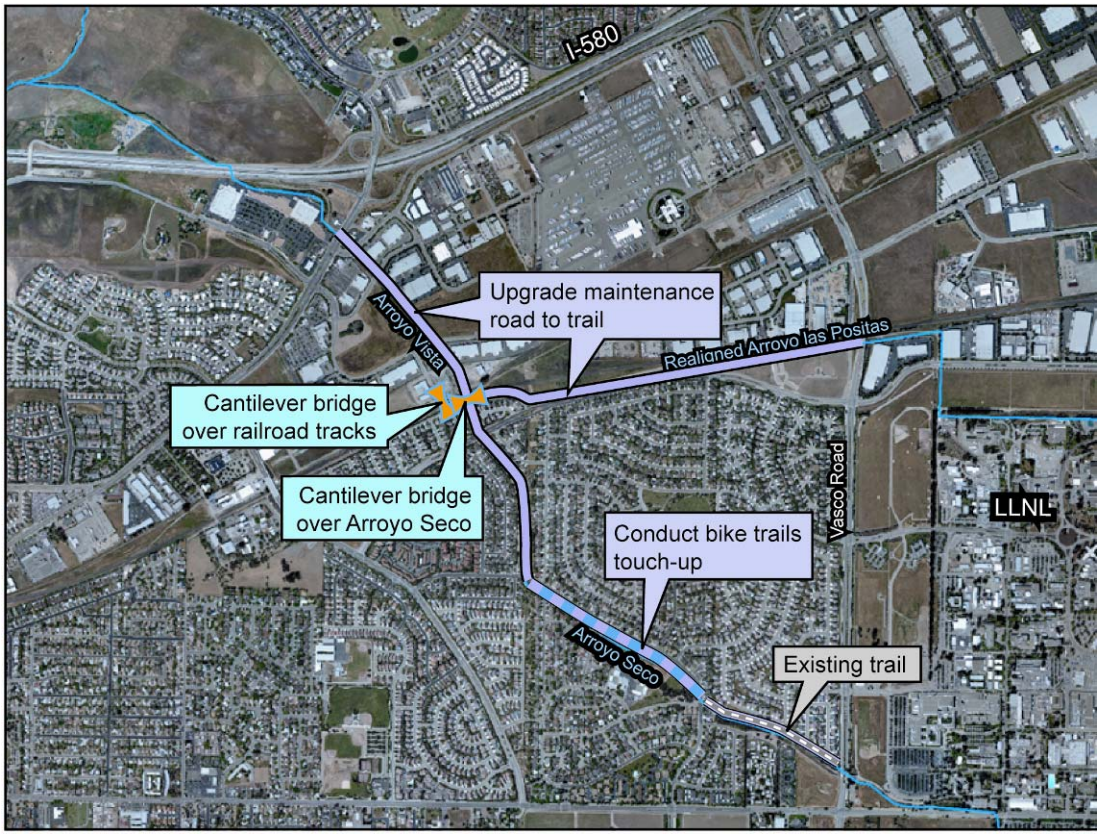
Numerous opportunities for trails, recreation capabilities, and public education present themselves throughout the SMMP area. These opportunities are discussed by reach in greater detail below.

3.7.1 Trails and Recreation

There is an opportunity to provide a linkage of existing trail corridors in Reach 1 through development of multi-purpose trails and connection of existing trails. Streamside trails have already been created throughout much of Reach 1, however, many segments are not connected which greatly reduces their local and regional benefits. Trail gaps, especially from Hartford to Bluebell near the Springtown area, should be filled.

A major feature in Reach 2 is LLNL, which is one of the largest employers in the Tri-Valley region. There is also a local Altamont Commuter Express (ACE) train station on the north side of Realigned Arroyo las Positas near Vasco Road. As a result, there is an opportunity to utilize stream corridors as non-motorized commuter routes to link the ACE station with the nearby residential communities. Where limited right-of-way prevents implementation of stream side trails, there are large, well maintained bike lanes on residential streets that can link trail segments. Reach 2 is linked to the rest of the Valley system via a proposed bike lane along Las Positas Road. Figure 3-32 summarizes the potential for non-vehicular transportation corridors associated with Reach 2 streams and arroyos.

Figure 3-32: Stream Corridor Trail Map for the SMMP Reach 2



There is a well developed trail system along Arroyo Mocho in Reach 3. There is an opportunity to extend the Mocho trail further upstream to provide recreational access to the rural areas of eastern Livermore but such an extension would not act as a corridor linking populated places. Projects in this reach should focus on maintaining the existing trail connectivity by incorporating trail replacement or upgrading if any existing trails are moved or destroyed. Trail projects identified include a boardwalk trail at Robertson Park, multi-use trail along Arroyo Mocho, and connecting the Iron Horse Trail through use of the abandoned railroad bridge at Stanley Boulevard.

Opportunities related to recreation in Reach 4 include connection of Sycamore Grove Park trails to the EBRPD trail system and Veteran's Park. There is also the need to build a bike/pedestrian bridge at Veterans hospital, and at Vallecitos Bridge.

Reach 5 is critical to the regional trail system, and has the potential to provide the link between trails in eastern Livermore to trails in the rest of the SMMP study area to the west. There is a need to connect trails proposed in Reaches 1 and 2 to trails that exist at the downstream end of this reach where Arroyo las Positas meets Arroyo Mocho. There is an opportunity to provide this trail connection through development of trails along Arroyo las Positas where right-of-way permits, and adjacent to the stream where there is limited right-of-way. There are also opportunities to expand the trail network along drainages north of I-580, and to connect these drainages to areas south of I-580 through development of a seasonal trail undercrossing at I-580 near Kitty Hawk Road.

Currently, there is an existing trail in Reach 6 along Arroyo Mocho from Stanley Boulevard to Isabel Avenue. However, there is currently a trail gap at Isabel Avenue, and there is a need to construct a pedestrian bridge over the road. As mining operations are completed in the Chain of Lakes in Reach 6, there are opportunities to incorporate recreational features into the area as the lakes are turned over to Zone 7. However, because of the water supply and recharge activities in the Chain of Lakes, recreation features should be limited to trail development. Connections to regional trails such as the Iron Horse Trail along Stanley Boulevard south of the Chain of Lakes and the potential trail along Jack London Boulevard (in Reach 5) to the north, and a connection to the planned park at Oaks Business Park could contribute to developing a dense trail system around the lakes.

In Reach 7, trails and maintenance roads can be upgraded to trails along most of Arroyo del Valle downstream of Shadow Cliffs. There is a small gap due to private property restrictions but this can be bypassed by utilizing bike paths and low-use, residential streets. EBRPD has plans to construct a trail along Vineyard Avenue between Shadow Cliffs and Vallecitos Road, which will provide additional connectivity between the east and west sides of the study area. In addition to trails, there are opportunities for recreation at Lakes A and B. Trail loops and recreation such as boating could be developed at Lakes A and B.

Reach 8 is located in a highly residential and urbanized area. As a result, there are opportunities to expand existing trails in order to connect transit centers and neighborhoods to schools and businesses. Specific opportunities include:

- Constructing a trail along Tassajara Creek from Owens Drive to Dublin Boulevard
- Providing a seasonal passage below I-580 along Tassajara Creek
- Constructing a trail along Chabot Canal to link the existing trail long Arroyo Mocho to the Iron Horse Trail at Dublin/Pleasanton Bay Area Rapid Transit (BART) Station
- Constructing a pedestrian bridge over ADLL to link the existing trail along the east side of I-680 with potential trails along ADLL on west side of I-680

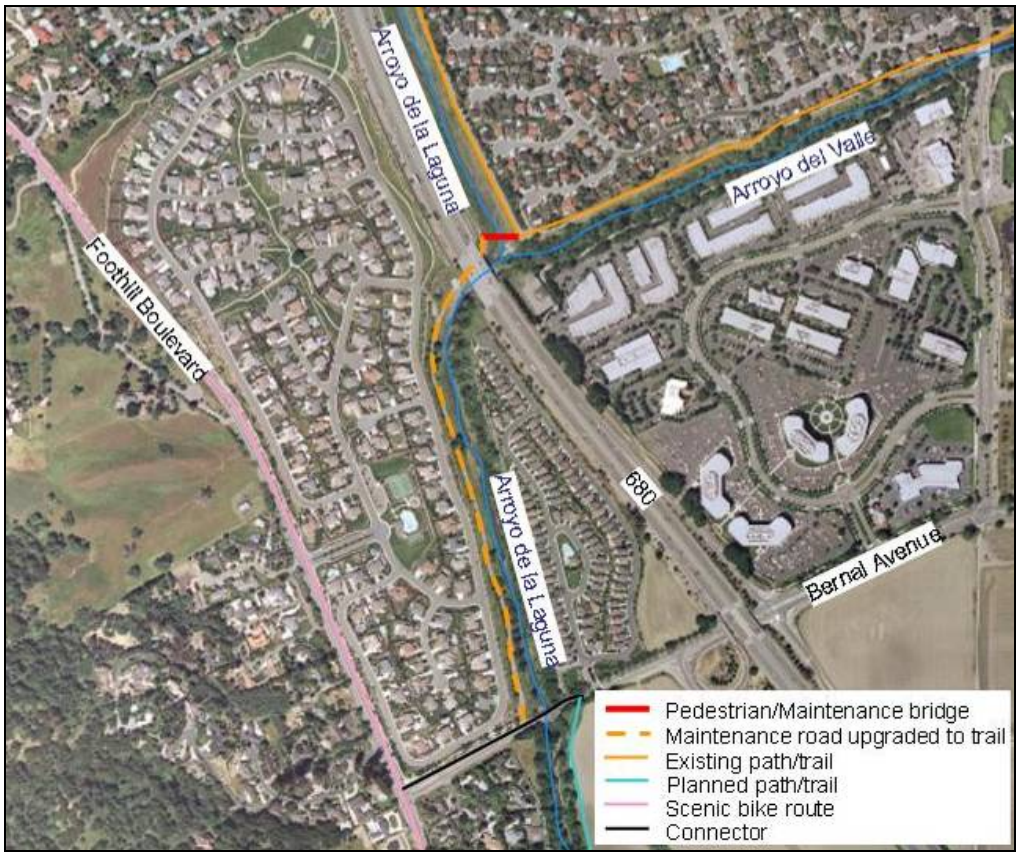
A major trail gap currently exists in Reach 9 between trails along Alamo Canal in Dublin north of I-580 and trails along Alamo Canal south of I-580. An opportunity exists to fill this gap by extending the trail in Dublin under I-580 to existing trails south of the freeway, as shown in Figure 3-33. Providing a link between the north and south sides of I-580 would benefit regional trail connectivity and increase opportunities for non-vehicular passage been Dublin and Pleasanton.

Figure 3-33: Trail Gap at 580 looking South

a) End of Trail Segment **b) Column Spacing under Bridge**

There are many opportunities for recreation, regional connectivity, and public education in Reach 10. Upgrading maintenance roads, installing pedestrian bridges (Figure 3-34), constructing multi-use trails, and coordinating with the golf course to open maintenance roads for trail purposes are some of the recreational activities planned for Reach 10. Interpretive kiosks could be installed along the trail at interesting locations such as the new USGS gauge station at Verona Bridge. Extending the trail system further south utilizing maintenance roads and abandoned railroad right-of-ways could provide a connection to the Sunol area and an existing trail along Alameda Creek.

Figure 3-34: Bridge across ADLL (Local Paths and Trails)



3.7.2 Public Education

In addition to trail connections, there are numerous opportunities to implement public education and outreach within most SMMP Area reaches. Tools identified for education and outreach include the construction of interpretative kiosks to be located along trails and arroyos in high pedestrian traffic areas, and the implementation of Adopt-a-Creek programs. These opportunities are identified for relevant reaches below.

Interpretive Kiosks

Interpretative kiosks providing educational information could be located at major trail/arroyo confluences in Reaches 1, 6 through 8, and 10. Opportunities in Reach 1 include constructing a kiosk or an education platform near the Springtown area or to develop education facilities in conjunction with habitat or water quality improvements implemented in this reach as part of the SMMP. In Reach 6, kiosks could document the history of the Chain of Lakes from mining activities to water resources management could provide an educational and outreach component to any trails developed in this reach. In Reach 7, kiosks could be located along trails near Lakes A and B which discuss the recharge potential and the importance of these lakes to the region's water resources. Many of the existing trails are highly traveled in Reach 8, and an opportunity exists to install interpretive kiosks at major trail/arroyo confluences, such as the confluence of Arroyo Mocho and ADLL. Interpretive kiosks could be installed along the trail at key locations such as the new USGS gauge station at Verona Bridge in Reach 10.

Zone 7 Schools Program

Zone 7's Schools Program raises creek awareness in the community by providing educational resources to area schools. By offering several water science programs to students, the Schools Program is a model for public education activities.

Adopt-a-Creek Outreach Programs

There are also opportunities to provide education and outreach components with SMMP improvements that are implemented in highly visible areas along Reach 3 such as Robertson Park, Mocho Park, and near Granada High School. The proximity of Granada High School provides an opportunity for development of classrooms and an Adopt-a-Creek program in this reach.

In Reach 11, there is an opportunity for public outreach and education through an Adopt-a-Creek program for Sinbad Creek. Currently, there are several areas where illegal dumping takes place along the creek, as shown in Figure 3-35. One of the goals for the project would be to increase public awareness of dumping and its effects on the habitat, water quality, and aesthetic impact of a riparian area.

Figure 3-35: Arm Chair Discarded into Sinbad Creek Stream Bed

Opportunities for public outreach and education exist in Reach 12, and could be met through an Adopt-a-Creek program for Line Y-1. Currently, there are significant areas along Line Y-1 where illegal dumping has taken place, as shown in Figure 3-36. One of the goals for the project would be to increase public awareness of dumping and its effects on the habitat, water quality, and aesthetic impact of a stream channel. An example of the dumping found in this reach is shown in Figure 3-36.

Figure 3-36: Illegal Dumping along Line Y-1

An opportunity also exists to increase a sense of stream stewardship in Reach 12 by allowing landowners to identify problems within the creek that is located in or next to their property. Funds could be made available to reduce erosion or sedimentation, improve local habitat, or keep the stream clear of trash and debris.