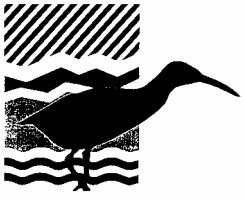
Sediment Management Practices Assessment Report for Stevens Creek Watershed



Santa Clara Valley
Urban Runoff Pollution
Prevention Program

September 10, 2004

TABLE OF CONTENTS

Sediment Management Practices Assessment Report for Stevens Creek Watershed

1.0 Introduction

1.1 Objectives and Approach

On August 30, 2002, the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) submitted to the San Francisco Regional Water Quality Control Board (Regional Board) a *Work Plan for Conducting Watershed Analysis and Management Practice Assessment in Other Creeks* (than San Francisquito Creek) *Potentially Impaired by Sediment from Anthropogenic Activities* (Work Plan) (SCVURPPP 2002b), which was in fulfillment of the SCVURPPP NPDES Permit Order No. 01-024 Provision C.9.f.iii paragraph 2. This provision requires a workplan and time schedule to "conduct a watershed analysis and management practice assessment in the other creeks which may be impaired by excessive sediment production from erosion due to anthropogenic activities." Stevens Creek was identified as a high priority creek because it contains sensitive aquatic life uses (i.e., steelhead trout) and some evidence suggested that stream erosion was occurring. The Work Plan identifies five tasks to conduct a sediment assessment of Stevens Creek beginning in FY 03-04. This report addresses Task 2 of the Work Plan, Assess Sediment Management Practices for Stevens Creek.

The objectives of the sediment management practices assessment is to inventory and document management practices relevant to erosion processes and sediment transport and deposition within the Stevens Creek watershed, and to evaluate the effectiveness of these practices in reducing impacts from excessive sediment from anthropogenic sources. The assessment approach relied on available information identifying existing sediment management practices and policies implemented by SCVURPPP Co-permittee municipalities and agencies that have jurisdictions within the Stevens Creek watershed. The evaluation component of the assessment summarizes the relevant issues related to potential anthropogenic sources of sediment found in the Stevens Creek watershed and identifies data and information needed to further evaluate the effectiveness of existing management practices.

2.0 Background

2.1 Stevens Creek Sediment Assessment

Task 2 of the Work Plan, Conduct Watershed Analysis, was developed as a two phased approach to conduct sediment assessments for Stevens and Coyote Creeks, both of which were previously identified as high priority creeks in the SCVURPPP Potentially Sediment Impaired Creek Report (SCVURPPP 2002a). Phase I includes conduct a watershed assessment using a Limiting Factors Analysis (LFA) approach and assess sediment management practices in the Stevens Creek watershed. Phase II includes conducting a rapid sediment budget if results of the LFA study indicate excessive sediment caused by anthropogenic activities is a significantly limiting steelhead survival and production. If Phase II is determined to be unnecessary for Stevens Creek, SCVURPPP will conduct a watershed analysis in the Coyote Creek watershed.

SCVURPPP selected the LFA approach as a method for determining potential sediment impairment of existing aquatic life beneficial uses in Stevens Creek by investigating factors limiting production of key aquatic indicator species. Steelhead was selected as the indicator species due to extensive knowledge on their habitat requirements and an understanding of how excessive fine sediment impacts fish production. A limiting factors analysis has also been used to investigate potential impacts from sediment on steelhead production in both the San Francisquito Creek and Napa River as part of a Sediment TMDL occurring in both watersheds.

The objectives of the Stevens Creek Steelhead Limiting Factors Analysis, performed by Stillwater Sciences Inc., was to "identify and fill information gaps related to physical and biological factors controlling population dynamics of the focus species" and to " identify the impacts of fine sediment on the focus species relative to other potential limiting factors." Based on existing information and reconnaissance surveys, several focused studies were developed to test hypotheses on potential limiting factors for steelhead. The focus analyses performed include fish passage barriers, gravel permeability, pool filling, bed mobility, overwintering habitat, and water temperature.

Summary of findings presented in the June 15, 2004 Stevens Creek LFA Draft Technical Report are stated below:

- Barriers limit access to a substantial amount of habitat; effects on smolt production depend on ability of fish to pass barriers (upstream and downstream);
- Gravel permeability is low but not likely limiting production;
- Pool filling is low, indicating high sediment transport capacity relative to sediment supply;
- Bed mobility (and therefore redd scour) is relatively low in upper reaches but increases downstream;
- Overwintering habitat is likely the key limiting factor prior to outmigration; and
- Water temperature is elevated but not likely limiting production, as evidenced by size of age 0+ and 1+ steelhead.

The SCVURPPP Sediment AHTG will review the results of the LFA study and provide recommendations on next steps to the Program's Management Committee.

2.2 San Francisquito Creek Sediment Assessment

Concurrent to the Stevens Creek Sediment Assessment, a project to determine the sources and extent of sediment impairment in another watershed within Santa Clara County (i.e., San Francisquito) is underway. The following description of the project is provided to demonstrate the similarities between the methodologies used in assessing the potential and existing impacts of excessive sediment in the San Francisquito and Stevens Creek watersheds.

A work plan for conducting a watershed analysis for San Francisquito Creek was submitted to the Regional Board on August 31, 2001 by SCVURPPP and SM-STOPPP consistent with SCVURPPP NPDES Permit Provision 9.f.i. and SM-STOPPP NPDES Permit Provision C.10., respectively. In addition, a work plan to assess sediment management practices was submitted to the Regional Board on March 1, 2002 by SCVURPPP consistent with SCVURPPP NPDES Permit Provision 9.f.ii. These studies

adopt elements of a watershed assessment approach proposed for San Francisquito Creek, which is listed as impaired by sedimentation under Section 303(d) of the Clean Water Act and requires the development of a Total Maximum Daily Load (TMDL) for sediment.

The objectives for the two plans includes: (1) a quantitative characterization of sediment and water inputs to the creek; (2) evaluation of the relative roles of sediment associated with natural and anthropogenic land use discharges; (3) characterization of sediment conveyance from headwaters to the Bay, (4) development of a rapid sediment budget, and (5) assessment of both currently and proposed management practices implemented to prevent or reduce excess sediment impairment in urban creeks. A Proposition 13 Phase I grant was awarded to the stakeholder group to conduct the watershed analyses and produce a sediment reduction plan for the watershed.

The Final Analysis and Sediment Reduction Plan was completed in May 2004 (NHC 2004). The sediment reduction plan incorporated results from previous studies that were reported in a series of technical memoranda developed for this project. These studies included a historical and existing conditions analysis, a sediment budget analysis, and an assessment of existing management practices. The assessment was designed "to access existing policies and regulations that provide erosion control or channel protection in the San Francisquito watershed, identify deficiencies, and recommend improvements" (NHC 2004).

In addition, a work plan was developed by the Santa Clara Valley Water District (SCVWD) as part of the San Francisquito Creek sediment TMDL, to assess aquatic habitat condition and conduct a limiting factors analysis for steelhead and other sensitive species in the San Francisquito Creek watershed. The limiting factors analyses is anticipated to produce information that will assist the Regional Board staff to confirm or reject the validity of the sediment impairment listing and help to identify other causes of impairment to aquatic species and their habitat.

2.3 Study Area

2.3.1 Description of Watershed Area

Hydrology

Stevens Creek drains an approximately 30 mi^2 watershed in the Santa Clara Valley that discharges into South San Francisco Bay (Figure 1). The creek originates at an elevation of 2,500 feet in the Santa Cruz Mountains, flowing southeast for just over five miles along the San Andreas Fault, then bending northeast and flowing an additional three miles before reaching Stevens Creek Reservoir (Stillwater 2004). From the reservoir, Stevens Creek flows northward for approximately 12.5 miles before emptying into Lower South San Francisco Bay.

A reservoir was constructed on Stevens Creek in 1935 for the purpose of storing winter runoff for the recharge of the Santa Clara Groundwater Basin during the summer months (SCBWMI 2001). Stevens Creek Reservoir is managed by the SCVWD and has a current capacity of 3,465 acre-feet of water (SCBWMI 2001). Under current management, approximately 5.7 miles of the creek downstream of the reservoir (to Fremont Avenue) is typically wetted to allow for groundwater recharge during the

summer. Maintaining summer surface flows along this length of stream nearly depletes the reservoir volume each year (Abel 2001). The typical dryback zone extends downstream of this area for approximately 3.25 miles (Abel 2001).

Two tributaries join Stevens Creek below Stevens Creek Reservoir. Heney Creek drains an area of 0.64 mi^2 and enters Stevens Creek 3.7 miles below the reservoir (SCBWMI 2001). A diversion from Permanente Creek (constructed in 1959) diverts winter storm flows (up to 1,500 cfs) into Stevens Creek approximately 6.3 miles below the reservoir (SCBWMI 2001). In the past, imported water from the Trans-Valley/West Pipeline provided water to the aquifer and instream gravel dams were installed seasonally and extended the percolation zone downstream to El Camino Road (Abel 2001).

Geomorphology

Stillwater (2004) identified four distinct geomorphically significant reaches (Upper, Transition, Middle, and Lower) from the reservoir to the Bay based on field reconnaissance observations of floodplain geometry and channel function. The highest level of natural floodplain and channel function occur in the Upper Reach, located between the dam and a point two miles downstream, where incision and entrenchment was observed to be the lowest of all reaches. Here, the creek flows through a relatively wide, well vegetated inset valley that is relatively unconfined by urban development and is free to meander.

In the Transition Reach, located between 2.0 mile and 4.3 mile point below the dam, Stillwater (2004) observed "the channel and floodplain function progressively degrade as the channel narrows and residential houses encroach. Here, the channel is straight, point and lateral bars shrink or disappear altogether, and an increasing number of concrete walls and weirs act as grade control and bank stabilizing structures. Transport capacity increases as the number of roughness elements (i.e. bedforms, bar deposits, sinuosity) decrease and anthropogenic influences increase. As a result, a greater amount of scour and incision was observed."

Floodplain entrenchment and observed incision values were greatest in the Middle Reach, located from reach mile 4.3 to reach mile 10.0 below the dam, which is primarily straight and narrow. Stillwater (2004) reports "Of the few existing bar deposits, most are perched 4–6 feet above the active channel. A number of concrete and steel structures exist in the channel and along the banks, and frequent 15–25 foot bluffs continually provide fine sediment to the channel via fluvial bank erosion. Floodplain function is somewhat restored in the Lower Reach, located from reach mile 10.0 to the Bay, as the valley widens or disappears and the creek has more room for lateral movement."

Land use

Undeveloped forest (49%) and rangeland (13%) covers the majority of the Stevens Creek watershed, most of which is in the upper watershed above Stevens Creek Reservoir (Table 2-1). Much of this land is legally protected by agencies, easements, and special districts providing the general public access to multi-use trails and park facilities. Vegetation above the reservoir is dominated by broadleaved upland forest that covers almost 50% of the watershed, with smaller areas of chaparral and nonnative grassland. Riparian vegetation also grows along a majority of Stevens Creek and its tributaries (SCBWMI 2001). Despite the early prevalence of orchards throughout much

of the area, development and land conversion have reduced the current extent of agriculture to less than 1% of the watershed area.

High-density residential neighborhoods cover most of the area below the reservoir, comprising 24% of the total watershed area. Here, housing is interspersed with commercial uses, public developments and concentrated industrial centers, collectively covering 7% of the watershed. Transportation and utilities account for under 3%, and urban recreation accounts for another 3%. Only 0.2% of the watershed is vacant, undeveloped land, while 1% consists of freshwater. Gravel quarrying in the watershed has continued since the 1950s and still covers 0.3% of the total area (SCBWMI 2001).

Table 2.1. Areal extent of land use/land cover types in the Stevens Creek watershed.

Land Use/Cover Type	Acres	Mi^2	Km^2	Total (%)
Residential (4 or more DU/acre)	4,474	7.0	18.1	23.9
Residential (1-3 DU/acre)	102	0.2	0.4	0.6
Commercial	393	0.6	1.6	2.1
Public/Quasi-Public	202	0.3	0.8	1.1
Industry- Heavy	732	1.1	3.0	3.9
Transportation/ Communication	180	0.3	0.7	1.0
Utilities	121	0.2	0.5	0.7
Mines, Quarries	62	0.1	0.3	0.3
Agriculture	92	0.1	0.4	0.5
Forest	9,202	14.4	37.2	49.2
Rangeland	2,333	3.7	9.4	12.5
Urban Recreation	566	0.9	2.3	3.0
Vacant, Undeveloped	44	< 0.1	0.2	0.2
Freshwater	183	0.3	0.7	1.0
Totals[1]	**18,686**	**29.2**	**75.6**	**100**

Source: Santa Clara Basin Watershed Management Initiative (2001), land use in 1995.

2.3.2 Municipal and agency jurisdictional areas

Stevens Creek watershed is managed by a number of different jurisdictions which regulate land use and development. The watershed lies within the Santa Clara County and incorporates the cities of Cupertino, Los Altos, Mountain View, Sunnyvale and Palo Alto (Table 2.2). Those cities as well as the SCVWD and the Santa Clara County are Co-permittees with the SCVURPPP which are subject to the NPDES requirements discussed in Section 1. A large portion of the upper watershed (above Stevens Creek Dam) is made up of the Upper Stevens Creek County Park, managed by Santa Clara County, and open space preserves managed by the Mid-peninsula Regional Open Space District (MROSD). Cupertino manages Blackberry Farm and McClellan Ranch, two large park areas within the city.

Table 2.2: Total Area in the Stevens Creek Watersheds Area for Different Jurisdictions

Jurisdiction	Acres	Mi^2	Total (%)	Below Dam (%)	Above Dam (%)
Cupertino	2186	3.4	11.6	93	7
Los Altos	1168	1.8	6.2	100	0
Mountain View	2937	4.6	15.6	100	0
Sunnyvale	1117	1.7	5.9	100	0
Santa Clara County	9210	14.4	48.8	6	94
Palo Alto	2243	3.5	11.9	0	100
Total[1]	18,861	29.4	100	na	na

[1] Total area does not match those in land use table due to differences in data sources.

3.0 Previous Watershed Assessment Studies

3.1 The Fisheries and Aquatic Habitat Collaborative Effort (FAHCE)

FAHCE is a multi-agency endeavor convened by the SCVWD and the Department of Fish and Game to develop an interim fisheries and aquatic habitat management plan. FAHCE participants include the SCVWD, the Department of Fish and Game, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Natural Heritage Institute, the Guadalupe-Coyote Resource Conservation District and the City of San Jose. The goals for FAHCE include: 1) identify the contribution of SCVWD facilities and operations to existing fishery habitat conditions within the context of the variety of factors impacting salmon and steelhead populations; and 2) identify reasonable flow and non-flow measures that will improve habitat conditions for such fish populations within the context of competing water and land use demands.

The study objectives were to identify and evaluate alternative management actions based in part on the above studies and on the following:

- Improve habitat conditions to maintain fish populations in good condition;
- Protect, maintain, and improve habitat conditions for species listed under the State and Federal Endangered Species Acts or identified as California Species of Special Concern; and
- Improve the availability and suitability of stream corridor and channel habitat for a diversity of species of fish and wildlife.

The FAHCE study area included Coyote Creek (below reservoir), Upper Penitencia Creek, Stevens Creek below reservoir, and Guadalupe River and its major tributaries (Los Gatos, Guadalupe Creek, Alamitos, and Arroyo Calero Creeks). The FAHCE project quantified the following factors: 1) diversity, abundance, and condition of existing salmon and steelhead resources; 2) habitat quantity and quality that may limit these target fish populations; 3) types and locations of non-flow measures that could change existing conditions; and 4) alternative flow regimes that could change the conditions that limit the target fish populations.

The FAHCE Summary Report summarizes specific issues and actions within the watersheds listed above (SCVWD 2003). In Stevens Creek Watershed, Phase I work objectives including creating a suitable spawning and rearing habitat for four miles below

Stevens Creek Dam by, 1) releasing reservoir flows for fish; 2) work on fish barriers; 3) restoring spawning and rearing areas; and, 4) stabilization of banks. Also recommended is the installation of a "gravity-fed, multi-port outlet" for releases from the cold areas in the reservoir and aeration at the outlet to restore oxygen to the water from the hypolimnion. Phase 2 and 3 include extending the steelhead habitat further upstream, downstream, and eventually into the tributaries as necessary. In addition, the study created a system of reservoir rules for which the coldwater management zone is designated and the reservoir releases are regulated.

3.2 Surface Water Ambient Monitoring and Assessment Program (SWAMP)

The San Francisco Bay Regional Water Quality Control Board (RWQCB) initiated the SWAMP in FY 00-01. The goal of the SWAMP program is to monitor and assess all waterbodies of the San Francisco Bay Region in order to identify reference sites and waterbodies or sites that are impaired, based on data and information that provide a weight-of-evidence assessment of water quality. Objectives of the program include:

- Assess the physical, chemical, and biological condition of waterbodies in the region in order to determine if waterbodies are impaired and beneficial uses are being protected;
- Measure environmental indicators of stressors (e.g., pollutants or other water quality parameters), laboratory exposure/effects measurements (e.g., toxicity tests), and ecological response (e.g., benthic macroinvertebrate community analyses) from the same location and/or season;
- Generate data and information during different seasonal conditions;
- Generate data and information that is somewhat evenly distributed across a waterbody to provide a screening level of assessment;
- Determine if impacts are associated with specific stressors or land uses; and
- Evaluate monitoring tools in the watershed in order to develop a program that uses the best environmental indicators to achieve the purposes of the program.

The SWAMP monitored both Stevens and Permanente Creek watersheds in FY 01-02. Results of the data are scheduled to be published in 2004.

4.0 Anthropogenic Activities Potentially Affecting Sediment Production to Streams

Sediment production is a natural watershed process, however the rate of erosion, transport and deposition of sediment can be greatly affected by anthropogenic activities. Land use conversion and urban development can affect erosion and sediment transport and deposition in many ways. The following sections provide a general description of erosion and sediment transport processes and the types of anthropogenic activities that could potentially affect sediment production.

4.1 Erosion

A brief description for three types of erosion processes and human activities likely to occur in watersheds that affect erosion are discussed in this section. These include landslides or slope failures, stream and surface erosion.

4.1.1 Landslide Erosion

The Northern California Landslide Working Group (NCLWG) identifies the three most common types of landslide erosion as deep-seated landslides, rock-fall and debris flows (NHC 2004). Deep-seated landslides are primarily earthflows and slumps that are grouped by their ability to transport sediment intermittently over periods of months to centuries (Reid *et al* 1996) and generally move in pulses occurring during or following wet periods and are dormant during dry periods.

Debris flows, rockslides, and rockfalls are rapid failures that usually move only once (Reid *et al*. 1996). Debris slides and flows occur episodically and are typically triggered by intense storms that follow seasonal precipitation adequate to saturate the soil profile (NHC 2004). Landslides were identified as the dominant erosion process in the Santa Cruz Mountains (NHC 2004). Abundant landslides occur about every five to ten years, usually during severe storms or infrequent large earthquakes.

Human activities can significantly affect landslide erosion processes. "Vegetation removal and soil disturbance directly affect rates of shallow landsliding……road construction, use and maintenance are particular significant activities, as they may cause shallow or deep-seated landslides through failure of the road prism, contribute to downslope instability by re-distributing surface and groundwater flows…." (NHC 2004).

4.1.2 Stream Erosion

The natural process that creates stream channels is erosion, and the rate at which it occurs is determined by the slope of the channel and the resistance of the streambed material. Obstructions in the channel can increase erosion by accelerating and redirecting the flow of water (CDFG 2004). Bank erosion typically occurs during high flows and is greatest on river bends where high flows are directed at a bank (NHC 2004). Erosion of the streambed, or incision, refers to removal of sediment on the bottom of the channel resulting in a lowering of streambed elevation (NHC 2004). Bed incision is often indicated by "knickpoints" or steps in the channel profile representing the upstream limit of streambed lowering.

Urban developments that increase impervious surface area will typically increase the frequency, velocity and erosion potential of the small and moderate peak flows (i.e., hydromodification) that can result in channel incision and bank erosion. Vegetation removal, road construction and soil compaction can also increase peak flows. Stream erosion can also be affected by human impacts that occur directly in the stream, including development in the riparian zone, straightening and hardening of the channel, and the construction of instream structures. Many of these channel alterations may cause higher stream velocities and increased sheer stress and bank erosion in reaches below the modified section. Removal of vegetation and large woody debris in the stream channels can also result in bank erosion due to reduced vegetative bank protection and absence of instream structures (e.g., log jams) that help dissipate flow velocity and trap sediment.

Large dams and reservoirs trap bedload sediment, releasing sediment-starved water to downstream reaches (Kondolf 1995). This "hungry water" can cause bed and bank erosion and channel incision. Instream gravel mining also disrupts geomorphic processes. Instream gravel extraction reduces sediment transport to downstream reaches and changes channel slope resulting in channel incision, both above and below gravel pits.

4.1.3 Surface Erosion

Sheetwash or surface erosion occurs from overland flow, which is common in areas where infiltrations rates are lower than the maximum rain intensities (e.g. roads and other compacted surfaces). Another type of overland flow occurs when the soil is saturated and cannot absorb any more water (Reid *et al* 1996). Surface erosion is a chronic sediment source that is accelerated with storm events (CDFG 2004). The California Department of Fish and Game Upslope Assessment (2004) "has determined that the majority, in some case as much as 70 percent, or eroded sediment is caused by watershed road systems." Also surface erosion is intensified in areas of heavy grazing, fire or other surface disturbances and also with increased overland flows from urban development (CDFG 2004).

Anthropogenic sources of surface erosion can be seen where there is no or little vegetation to cover and hold together soils. Locations where this is likely to occur are at roads and trails, construction or development sites, farms and fields, landslide scars or bank erosion sites and sites where fire has occurred (NHC 2004).

Surface erosion from roads and trails can be a significant issue, resulting "in chronic delivery of fine-grain sediment into creeks… typically caused by lack of effective drainage structures, poor outsloping, steep gradient, and/or close proximity to a stream" (Best 2002). The most significant sources are often from native or gravel surfaced roads and their yield depends on road slope, road and drainage design road maintenance practices and traffic volumes. Road and trail erosion in open space preserves and other parks can be intensified in areas with heavy recreational traffic, especially mountain bicycling. Road drainage is a significant problem with road erosion because many drainage structures are undersized or inadequate (Best 2002).

Construction sites have potential for contributing large quantities of sediment from the grading and exposure of the soil. However, erosion control management practices appear to have greatly reduced sediment supply from developments (NHC 2004). Agricultural lands can also contribute fine sediment to streams. Erosion from croplands depends on the rainfall characteristics, topography, soil characteristics, vegetation, and surface armoring of the field (Reid *et al* 1996). Landslides and fire scars leave behind areas of exposed soil that can provide "a small but consistent volume of sediment to streams each year" (NHC 2004).

4.2 Transport

Sediment can be transported two ways in a stream channel; either as suspended or bed load. Suspended sediment usually consists of clay and silt, and includes sand during high flows when turbulence is greatest. Bed load consists of coarser sediment that is transported by rolling, sliding, or saltating. The particle size for sediment that is moved

in suspension versus bed load varies by flow magnitude; the larger flows will cause coarser sediment to be transported and suspended by turbulence (NHC 2004).

The bed material load consists of particles that are present in significant quantities in the streambed and exchanged with the bed material during transport. The fine sediments, usually clay and silt that are constantly suspended by turbulent flow are considered the wash load (NHC 2004). Transport of bed material is variable based on the hydraulic aspects related to water discharge. The upstream supply of bed material determines the wash load, which may be independent of the hydraulic characteristics and is usually is calculated as part of a suspended-sediment gauging program (NHC 2004).

The sediment transport process can be significantly affected by anthropogenic activities such as channel modifications and hydromodification, both factors typically associated with urbanization. Dams effectively blocks all coarse sediment supply from the upper watershed drainage area. The lack of recruitment of coarse sediment to the downstream reaches of the creek can significantly affect channel stability of the stream. In addition, dam releases that include suspended sediments from lower portion of the reservoir may potentially increase suspended sediment concentrations in the stream below the dam.

4.3 Deposition

Sedimentation or sediment deposition is the process where the suspended or bed load is deposited in the stream bed, floodplain, lakes, reservoirs or the bay. When the sediment transport capacity is less than the volume of material supplied, deposition occurs. Temporary sediment storage occurs along the streambed between floods and long-term deposition occurs in lakes or reservoirs. (NHC 2004)

Anthropogenic activities affecting deposition in the stream channel include construction of road crossings (e.g., bridges and culverts) and other grade control structures, and widening of the channel to increase flood conveyance capacities. These actions result in lowering the stream gradient and reducing stream velocities, which result in sediment deposition on the stream bed. Other structures can effectively block sediment transport, such as dams, weirs and fish ladders.

5.0 Sediment Management Policies and Practices

This section documents management practices and policies implemented by SCVURPPP municipalities and agencies that provide erosion control and channel protection in the Stevens Creek watershed. Table 5-1 indicates lead agencies, relevant regulatory and/or management driver, purpose and scope and applicable areas for each management practice that was identified as relevant to sediment production and bank protection. The existing management practices pertinent to new and existing development are discussed in greater detail below.

Existing information on the development policies relevant to sedimentation of streams was compiled and summarized from the SCVURPPP Municipal Development Policies Comparison Report (SCVURPPP 2003). Information from the municipalities of Cupertino, Los Altos, Mountain View and Sunnyvale, as well as the Santa Clara County and the Santa Clara Valley Water District, were compiled for this assessment. City of

Palo Alto was not included in the assessment because their jurisdictional areas within Stevens Creek watershed primarily occur in an Open Space preserve above the dam, and therefore, developmental policies were assumed to not be applicable.

Information relevant to municipal maintenance activities was compiled from SCVURPPP Annual Reports. Information relevant to channel maintenance and bank protection was compiled and summarized from the SCVWD's Stream Maintenance Program (SMP). Information relevant to rural public works maintenance activities was compiled from the SCVURPPP and Santa Clara County (SCVURPPP 2002c). Other information relevant to management practices in rural areas was obtained from management plans developed for Santa Clara County Parks and Open Space Preserves.

5.1 New Development

5.1.1 Stream Buffers

Stream buffer ordinances, regulations and guidelines for restricting development in sensitive areas were reported for all municipalities within in the Stevens Creek watershed (SCVURPPP 2003). In Cupertino, sensitive areas include riparian and wildlife habitat corridors, public open space preserves and ridgelines. These areas limit public access to include only those activities that are compatible with preserving natural vegetation, such as hiking, horseback riding and camping. The City of Los Altos General Plan establishes buffers from adjoining land uses to protect the natural state of all creekside areas. Mountain View requires natural areas, creeks, and shorelines to only be developed for low intensity uses such as walking, jogging, and environmental education. Sunnyvale has a formal policy in the Surface Runoff Sub Element of their General Plan (1993) that states "assure the reasonable protection of beneficial uses in creeks.... and protect environmentally sensitive areas."

Municipalities reported a wide range of set back distances that were required for new development in areas adjacent to creeks or sensitive areas. Set back requirements on development projects vary for both Los Altos and Mountain View depending on project size. Cupertino requires setback distances of at least 100 feet from edge of riparian zone. The SCVWD's Ordinance 83-2 requires a review process for any construction work (e.g., construction of any structure, excavation, grading or filling) within 50 feet from top of creek bank (SCVURPPP 2003). Santa Clara County also has a rural resource conservation aspect to their General Plan in which stream buffers should minimize new development impacts in the buffer area (NHC 2004).

The SCVWD and municipal agencies are in the process of developing guidelines and standards for land use near streams as part of the Water Resource Protection Collaborative (Collaborative). The Collaborative recently designated a Streamside Review Area (Ratified on June 24, 2004) to establish a permit review process when land use changes are considered near streams. The designated Streamside Protection Area includes "all properties abutting or in proximity to a stream, including all properties located within 50 ft. from top of bank." The Collaborative has also developed objectives to guide the development of specific guidelines and standards to assist cities and County establish measures for improving riparian habitat.

5.1.2 Stormwater Runoff

In an effort to reduce the potential impacts of hydromodification to creeks and waterways, all municipalities in the Stevens Creek watershed, including the County, have existing policies that limit site impervious area for development projects. Existing policies related to site design typically address establishing setbacks, building footprints and sidewalk design, as well as use of structures to discharge roof runoff to pervious areas rather than stormdrain systems. Examples for stormwater treatment devices are provided in the California Storm Water Quality Association Best Management Practices Handbook and other sources. Municipalities also have existing policies to minimize paved areas and encourage the use infiltration systems such as grassy swales and infiltration basins to reduce site runoff. These policies were developed under Provision C.3 of the SCVURPPP's permit (reissued in February 2001).

All SCVURPPP municipalities are now required, also under Provision C.3, to manage increases in peak runoff flow and increased runoff volume from certain new development and redevelopment projects. The permit requires that post-project runoff does not exceed pre-project rates and durations where the increased runoff from the project will result in increased potential for erosion or other adverse impacts to beneficial uses, attributable to changes in the amount and timing of runoff. The provision requires SCVURPPP to develop a Hydromodification Management Plan (HMP) to govern where and how runoff controls should be implemented. The HMP will be completed in fall 2004.

5.1.3 Construction

The statewide General Permit for construction activities disturbing one acre or more requires the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP must specify Best Management Practices (BMPs) that prevent grading and other construction activities from releasing sediment and other contaminants offsite primarily from runoff. In addition, most municipalities restrict grading on construction sites during the rainy season.

5.2 Existing Development

5.2.1 Municipal Maintenance

Municipal maintenance activities related to sediment control include street sweeping, storm drain facility maintenance, road and bridge repair, stream restoration and vegetation and fire management. All agencies and municipalities within the Stevens Creek watershed conduct street sweeping activities. Activities occur at different frequencies, dependent on land use type and jurisdictional area. Additionally, SCVURPPP agencies regularly conduct storm drain facility maintenance, which includes the removal of sediment from the municipal storm drain inlets.

Under federal Clean Water Act (CWA) section 404, municipalities and contractors performing streambank alterations (e.g., bridge repairs, culvert replacement, flood control, etc.) must obtain a permit from the United States Army Corp of Engineers (USACE), which is the primary federal agency with regulatory control over stream alterations. Section 404 permits regulate and strive to minimize disturbances and the amount of erosion as a result of alterations to streambanks. California Department of

Fish and Game also regulates activities in stream channels through the requirement for Streambed Alteration Agreements.

In addition to 404 permits, under federal CWA section 401 every applicant applying for a federal permit or license for any activity which may result in a discharge to a water body must obtain State Water Quality Certification (Certification). The Certification insures that the proposed activity will comply with state water quality standards. Most Certifications are issued in connection with USACE section 404 permits for dredge and fill discharges.

5.2.2 Stream Maintenance

The SCVWD performs routine stream and channel maintenance on streams and channels under their jurisdiction as part of the SCVWD Stream Management Program (SMP) (SCVWD 2001). The SMP identifies procedures for maintenance design, field operations and BMPs, and includes a regional program to mitigate cumulative impacts to wetland and riparian areas (NHC 2004). The activities addressed in the SMP include sediment removal projects, vegetation management and bank protection.

Sediment removal activities conducted under the SMP typically occur in areas where sediment deposition has reduced flood conveyance capacity, impeded function of facilities and impeded fish passage. Vegetation management activities include removal of vegetation within the riparian zone to maintain flood conveyance capacity, maintain water conveyance for supply purposes, reduce fuel loads on stream banks for fire protection, and control invasive nonnative vegetation (e.g., mowing, hand clearing or herbicide application).

Bank protection activities performed by the SCVWD, where SCVWD has right of way, fee title or easement, include repair of eroding stream banks in areas where erosion could cause property damage, create a public safety concern, and/or negatively affect transportation, beneficial uses, or riparian habitat. Bank protection measures used by the SCVWD may include hard structures (e.g., rock), as well as soft structures (e.g., brush mattresses, root wads, or crib walls)

5.2.3 SCVWD Water Supply Operations

The Stevens Creek Reservoir was constructed in 1935 for the purpose of storing winter runoff for the recharge of the Santa Clara Groundwater Basin during the summer months (SCBWMI 2001). The reservoir is managed by the SCVWD and has a current capacity of 3,465 acre-feet of water (SCBWMI 2001). The discharge below Stevens Creek Reservoir for the period of record (1930-1990) averaged between 13–14 cubic feet per second (cfs) (Stillwater 2004).

Stillwater (2004) reports “Although management of Stevens Creek Reservoir has decreased the frequency and magnitude of winter storm flows, it does not appear to have drastically altered the seasonality of surface flow in Stevens Creek. Dry stream channels continue to develop in the mid-reaches of Stevens Creek, but management of the reservoir is thought to have extended the area of wetted channel approximately five miles further downstream (Abel 2001). Typical summer flow into the reservoir is 0.4 cfs compared to releases of 4–5 cfs below the dam. Under current management, approximately 5.7 miles downstream of the reservoir (to Fremont Avenue) are typically wetted to allow for groundwater recharge during the summer (Abel 2001). The typical

dryback zone extends about 3.25 miles downstream of this area (Abel 2001). Maintaining summer surface flows along this length of stream nearly depletes the reservoir volume each year (Abel 2001).

The SCVWD manages the Stevens Creek Reservoir as part of the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). Based on results of preliminary studies, FAHCE recommended future operations of Stevens Dam to include controlling the dam flow with the following schedule: 1) Winter based flow (Nov. 1 - Apr. 30) to support steelhead trout (16 cfs), 2) Pulse flows (Feb 1. - April 30) when storage in the reservoir exceeds the pulse flow rule curve (50 cfs) and, 3) Summer coldwater flow (May 1 - Oct. 31) will maintain coldwater management zone as available coldwater storage allows (19 degrees C on average or less, max 22 degrees). These actions were recommended to improve rearing and spawning habitat conditions for steelhead.

5.2.4 Rural Roads and Trails

Santa Clara County is responsible for much of the maintenance of county and rural roads and trails in the Stevens Creek watershed. As part of their Performance Standards, the County has established model BMPs for: 1) management and/or removal of large woody debris and live vegetation from stream channels; 2) streambank stabilization projects; 3) rural road construction, maintenance, and repairs to prevent and control road-related erosion; 4) environmental permitting for rural public works activities; and, 5) road planning and design. These model management practices are designed to help define the level of implementation that each Co-permittee in the SCVURPPP will attain to demonstrate that water quality is protected to the maximum extent practicable (MEP). (SCVURPPP 2002c)

The Stevens Creek and Upper Stevens Creek County Park is managed by the County of Santa Clara Department of Parks and Recreation, which produced a Strategic Plan for the Santa Clara County Parks and Recreation System (SCCPRD 2003). One of the visions of this plan is that there will be resource protection “that balances resource conservation, recreation opportunities, and park management to assure the existence of vibrant quality parks for future generations.” This plan is important in managing growth and uses of county parks and to ensure maintenance of the park system. This will help prevent erosion and sediment via controlling populations in parks and maintaining trails.

5.2.5 Open Space Preserves

The Midpeninsula Regional Opens Space District (MROSD) manages much of the land above the Stevens Creek Reservoir and a portion just downstream of the dam. Fremont, Older, Picchetti Ranch Open Spaces surround the reservoir, while Monte Bello and Rancho San Antonio Open Spaces encompass the upper creek subwatershed area. MROSD maintains roads and trails within these open space preserves. Most of the work is done when acquiring new land, and generally consists of repairing roads and culverts that are failing or not functioning properly. Although there are no formal policies that the MROSD follows when completing maintenance activities, each site is analyzed before work is performed and a workplan is created which includes the implementation of BMPs. MROSD uses Pacific Watersheds Associates’ “Handbook for Forest and Ranch Roads” (1994) as guidelines for road work within the open space preserves (personal correspondence Matt Freeman, 2004). The MROSD also follows the policies in their

Resource Management Five-Year Strategic Plan in which their overall policies are to protect natural ecosystems and restore disturbed or degraded sites (NHC 2004).

5.2.6 Stevens Creek Quarry

The Stevens Creek Quarry is located above the reservoir on Stevens Canyon Road in Cupertino. As part of the Waste Discharge Requirements (WDR) issued by the Regional Board, the quarry is required to submit an Annual Report that demonstrates (i.e., through water quality monitoring data) the site is in compliance with WDRs and their on-site Stormwater Protection Plan (SWPP). The WDRs have been enforced at this site since the 1993-1994 fiscal year.

Water quality samples are typically collected at a specified outfall during storm events to characterize water quality. The most recent Annual Report (FY 2002-2003) indicates that the levels of Specific Conductance (SC) at the site were elevated. SC can be an indicator of mineralization, salinity, or the total dissolved solids concentration of a water sample. One of the potential causes of elevated SC may be runoff from limestone (calcium) and greenstone (chloride) materials found at the facility. Waters coming out of springs from undisturbed areas were tested and also had high SC levels. It is our understanding that in the near future there will be an investigation to determine the source(s) of elevated SC, as required by the Regional Board. (Stevens Creek Quarry Inc. 2003)

5.2.7 Other Activities

The Hanson Permanente Cement Company (formerly Kaiser Permanente) operates a quarry and a cement-plant on Permanente Creek. A study conducted by the USGS determined that the quarry and cement plant was a significant sediment source to the creek (USGS 1989). Erosion and sediment controls, including stabilizing disturbed slopes and intercepting runoff in sedimentation basins, were implemented due to a history of sediment releases, culminating with a significant release in 1998 that carried sediment miles downstream into Permanente Creek (SFRWQCB 2002). The quarry and cement operations may potentially deliver fine sediment to Stevens Creek via the Permanente Diversion; however, no study has been conducted to verify that sediment is delivered through the diversion.

6.0 Evaluation of Existing Policies and Practices

Based on the best available information, this section of the report identifies the types of anthropogenic activities that may potentially be important sources of sediment production in the Stevens Creek watershed. Additionally, a preliminary qualitative evaluation of effectiveness of those management practices and/or policies described in Section 5.0 that are relevant to these activities is also provided in this section. Since there is a lack of existing data to indicate the extent and relative contribution of sediment caused by anthropogenic activities versus natural sources in Stevens Creek, it is not possible to conduct a thorough evaluation of existing management practices at this time[1]. Data that would be needed to conduct a more rigorous evaluation of effectiveness are identified.

[1] An evaluation of effectiveness would be better conducted once it has been determined if excessive sediment is adversely impacting stream function and beneficial uses in a watershed. This conclusion could

Table 6-1 lists the anthropogenic activities that may potentially be affecting erosion processes in the Stevens Creek watershed and the key issues related to existing conditions of the watershed with respect to sediment. The table also identifies the existing management practices and policies that may be relevant to each anthropogenic activity and data needs and information gaps. The information provided in Table 6-1 is described in greater detail below. Additionally, summaries of previous efforts in other areas in the Bay area (i.e., San Francisquito Creek watershed and for San Mateo County) are included to provide context to this assessment.

6.1 Summary of Additional Bay Area Sediment Management Practice Assessments

6.1.1 San Francisquito Assessment

The San Francisquito Creek Watershed Assessment of Existing Management Practices focused on anthropogenic sources of erosion from landslides, and stream and surface erosion (NHC 2004). As a result of this study, it was determined that "while new development can be a component of the human-related sediment contribution to streams, existing developments are usually more important or significant" (NHC 2004). Additionally, results indicated that San Francisquito Creek watershed could benefit from a watershed-wide agency focused on sediment management. This agency would work with the numerous jurisdictions responsible for areas within the watershed on: developing common standards to manage sediment from stream erosion; rehabilitation of roads and trails; and developing better design standards and replacement program for crossings such as bridges, culverts and encroachments that create fish passage barriers. In addition "a coordinated study is required to assess existing priority erosion areas and rehabilitate them" and "development of common standards for trail construction and erosion control best management practices" (NHC 2004).

6.1.2 San Mateo County Assessment

Existing management practices were assessed in five Central California Coastal Counties, including San Mateo, as part of the Fishnet 4C Program, to evaluate county land management practices and policies relative to protecting salmonid populations, and to make recommendations for improving those practices and policies (Harris et al 2001). Existing management of erosion and bank protection was one component of the assessment.

The summary findings of the assessment included that there was a lack of riparian buffer policies or floodplain setback requirements in place in San Mateo County to protect streams (NHC 2004). In addition, implementation and effectiveness of erosion controls used for development projects and bank protections structures were inconsistent, particularly during the rainy season. Another limitation identified in the assessment was a lack of standards for rural road and culvert maintenance (NHC 2004).

---

be formed through the limiting factors analysis (LFA) that is currently being conducted in Stevens Creek. Identification of limiting factors that are specifically related to excessive sediment can direct attention towards potential sources of excessive sediment, which leads to a more focused assessment as to what currently implemented practices are effective or need to be revisited. However, as required by the SCVURPPP's NPDES Permit, the evaluation of sediment management practices is required to be conducted concurrently with the LFA, rather than after the LFA conclusions have been developed.

Important sediment sources identified in the study were from persistent road failures and landslides at certain locations and erosion from stored landslide debris, road spoils and other stored materials (NHC 2004). Sheetwash erosion from unpaved roads and trails and ditch erosion on paved roads were identified as important sediment sources that were not directly addressed in existing policies (NHC 2004).

Channel maintenance and levee maintenance, including woody debris removal from streams, was identified as an important concern for salmonid habitat quality. The study also identified stream crossings, including culvert replacements and repairs, and bank stabilization structures, especially where construction occurs along unstable banks near stream banks, as areas of concern for sediment impacts to salmonid habitat (NHC 2004).

6.2 Identification and Evaluation of Relevant Sediment Management Practices in Stevens Creek Watershed

The types of anthropogenic activities that may potentially be important sources of sediment production in the Stevens Creek watershed are discussed in more detail below. The discussion is organized by major types of erosion processes that were presented in Section 4.0. In addition, preliminary evaluations of existing management practices and policies that are assumed to be relevant to each sediment sources are presented, and information gaps needed to further evaluate these practices are discussed.

6.2.1 Landslide Erosion

Existing information

The Monte Bello Ridge Landslide Complex is a large landslide that occurs just west of Stevens Creek Reservoir and provides a continuous source of sediment to the reservoir (Stillwater 2004). Stillwater (2004) reports “Numerous local shallow landslides indicate that the slide complex is still active”. Although the Monte Bello Ridge Landslide Complex is the only landslide within the watershed that has been scientifically analyzed and documented, this observation of deep-seated, active shallow landsliding indicates that surface sediments and the underlying lithology are composed of erodible sediments that are likely to act as a continuous source of sediment to the channel of Stevens Creek.“

According to Pamela Chu, Santa Clara County Planning Department, (personal communication 2004) there is currently a minimal amount of development occurring in the drainage area above Stevens Creek reservoir, which includes low density houses, vineyards, horse stables and a rock quarry. There are no future major develop projects that are planned for the unincorporated area in the upper watershed. Existing paved and unpaved roads also occur in the Monte Bello and Swiss Creek subwatershed areas, both of which contain landslide areas from the Monte Bello Ridge Complex.

Based on existing information, erosion from landslides may be an important source of sediment in the Stevens Creek watershed. It is assumed, however, that most of this sediment is deposited and trapped in the Stevens Creek Reservoir, with the exception of

suspended sediment that can be transported to downstream reaches of the creek via water released by the dam (see discussion on surface erosion).

Relevant Management Practices

Existing management measures that are assumed to be relevant to landslide erosion are shown in Table 6-1. These measures include road and trail maintenance that occur primarily in the unincorporated areas, including County Parks and Open Space Preserves. In addition, existing and planned developments, including agricultural and livestock practices that have disturbed soil and altered drainage patterns may affect landslide erosion. For any future development projects, existing policies (i.e., new development runoff controls) are assumed to be adequate to prevent construction in geotechnical unstable areas or within riparian and protected areas, and limit hydromodification by encouraging onsite control measures.

Data Gaps

Future studies to understand the location and extent of potential sediment sources from landslides in the Stevens Creek watershed may be warranted if excessive sediment is determined to be a major issue. This includes an analysis of the extent, magnitude and frequency of landslides in the upper watershed drainage areas, especially for the Monte Bello Landslide Complex.

6.2.2 Stream Erosion

Existing Information

Stillwater (2004) observed stream erosion throughout the twelve mile section of Stevens Creek below the dam. In several locations within the Upper Reach of their creek reconnaissance (see description of geomorphic reaches in Background section of this report), bank erosion was reported to occur where the creek flowed at the toe of the steep bluff that borders the valley. In the Transition Reach, channel incision was documented as consistent and prominent, with 3-4 foot cut banks in some locations. Several unstable collapsing banks were also observed in this reach. The Middle Reach was described as heavily incised and containing exposed bluffs along the creek that exhibited both historic and recent bank erosion scars. The SCVWD has completed numerous bank erosion repair projects at several locations along Stevens Creek (Table 6-2).

Relevant Management Practices

Management practices associated with existing development are assumed to be most relevant to potential stream erosion in Stevens Creek, as opposed to other erosional processes (e.g., landslides). Some of the existing management practices that may have the greatest effect on stream erosion may include the construction and maintenance of bank protection structures and road crossings. In some areas of the channel, however, the existing grade control structures may actually prevent the channel from becoming more incised (Chris Jacquet, Stillwater Sciences, personal communication, 2004).

It is not known to what extent the stream channel may still be adjusting to stormwater runoff from existing development. It is assumed that any management practice that results in lowering frequency and duration of peak flows from existing impervious surfaces may be effective in reducing the potential for stream erosion. The potential to

reduce these peak flows in Stevens Creek through stormwater retrofit management (e.g., detention) is unknown. Management of flow diversions through the Permanente Diversion Channel may also affect bank erosion in Stevens Creek; however no study has been conducted to verify impacts of the diversion to Stevens Creek. Stillwater observed bank erosion in areas of Stevens Creek above and below the diversion outfall.

Trapping of coarse sediment behind Stevens Creek Dam may also have significant affects on stream erosion. FAHCE study identified gravel augmentation as a potential solution option for Stevens Creek to enhance steelhead habitat quality. It is unknown how this management action would affect erosion process in the channel.

It is uncertain what affects future development projects will have on stream erosion caused by hydromodification; however, there is limited availability of undeveloped areas in the Stevens Creek watershed below the dam that can be developed. Some proposals for development in the City of Mountain View (Eric Anderson, City of Mountain View, personal communication, 2004) may be subject to the new requirements under the C.3 Provision; however, a complete analysis of areas that are subject to HMP controls is pending upon completion of the final HMP report. A significant amount of the undeveloped areas in the Stevens Creek riparian corridor are protected (e.g., Stevens County Park and City Parks in Cupertino). In addition, the guidelines and standards being developed through the Collaborative process are likely to improve existing measures that protect riparian areas from development.

Data Gaps

Future studies that aid in the identification of potential sediment sources from instream erosion, including conducting an inventory of bank erosion, bank structures and road crossings would be useful to better understand the locations and extent of bank erosion. In addition, if resources were available, conducting a longitudinal profile of the creek would help identify areas of incision. Collecting baseline information and monitoring over time would also be useful to understand rates of bank erosion and bed incision and help identify causes for erosion processes. In addition, future studies which analyze the effect of management changes on capacity and flood insurance for homeowners would be useful in finding a correlation between the design capacity and FEMA requirements that allow homeowners to be outside the flooding limits.

6.2.3 Surface Erosion

Existing Information

Most of the anthropogenic activities discussed in Section 4.0 that affect surface erosion are most applicable to watershed areas above the Stevens Creek Reservoir. Unpaved roads and trails, landslide scars, agricultural land uses, and rock quarries are examples of potential human impacts that may contribute fine sediment from surface erosion. It is unknown to what extent these sources of fine sediment are transported as suspended sediment to the Stevens Creek below the dam. Additionally, surface erosion caused by construction and grading activities is assumed to be minimal due to existing policies and regulations.

Stillwater (2004) reported high turbidity from visual observations in the upper reaches of the Stevens Creek, which appeared to diminish with distance downstream of the dam. The turbidity was observed in the spring season approximately two weeks following the

prior storm event. Additionally, elevated turbidity was also observed during field reconnaissance at a tributary to Stevens Reservoir that receives discharges from the Stevens Creek Quarry.

Relevant Management Practices

Management practices associated with maintenance of roads and trails are assumed to be the most relevant to surface erosion in the upper watershed areas of Stevens Creek. Practices to reduce suspended sediment in discharges from the Stevens Creek Quarry are assumed to be relevant to managing suspended sediment in the watershed.

Data Gaps

Future studies designed to better understand potential sediment sources from surface erosion, especially in areas above the reservoir would be helpful. Additionally, it maybe important to understand the mechanism for the transport of suspended sediment below the dam.

6.2.4 Sediment Transport

Existing Condition

Field observations by Stillwater (2004) indicate that bed mobility in Stevens Creek is high and increases rapidly downstream from the reservoir. The Transition and Middle Reaches were characterized as narrow and straight channel that had debris jams with flattened vegetation high on the channel banks. Furthermore, Stillwater observed “many of the mid-channel and lateral bar deposits had fresh grain surfaces and were well mixed, relatively thin, and unconsolidated, suggesting that they were recently deposited and only temporary features. Cumulative evidence suggests that flows and transport capacity within the channel in these reaches are high. Incision has destabilized the channel banks and steep valley walls that run the length of the channel, causing them to collapse, and increase sediment supply. In some cases, flow scours to the underlying clay bedrock. Incision also confines flows within the incised banks, which reduces roughness, thereby increasing the likelihood of bed mobility.”

Another significant impact to sediment transport in the Stevens Creek watershed occurred after the construction of the Stevens Creek Dam. The dam likely blocks all coarse sediment supply from the upper watershed drainage area. The lack of recruitment of coarse sediment to the downstream reaches of the creek can significantly affect channel stability of the stream. As previous discussed, Stillwater (2004) also observed elevated turbidity in the stream below the dam that decreased in a downstream direction.

Relevant Management Practices

Management practices associated with reducing peak flows and duration caused by urban runoff are relevant to preventing future channel incision and loss of flood plain access. These channel conditions appear to facilitate high bed mobility in the middle reach of Stevens Creek. Potential management actions suggested in the FAHCE study, such as augmentation of gravel substrate in Stevens Creek, may affect sediment transport and instream erosion processes. It is not clear at this time how dam operations may affect suspended sediment concentrations below the dam.

Data Gaps

Monitoring the transport of bedload and suspended sediment at sites below the dam would help to better understand sediment transport processes and potential source areas.

6.2.5 Sediment Deposition

Existing Conditions

Sediment deposition in the low gradient areas near Highway 101 has required the SCVWD to conduct repeated sediment removal projects to maintain flood conveyance capacity of the Stevens Creek channel. The exact source(s) of this sediment has not been documented, but may include landslide, stream and/or surface erosion. Additionally, there are a number of grade control structures currently in place on Stevens Creek that may increase the deposition of sediment in particular locations

Relevant Management Practices

Sediment removal practices performed by the SCVWD as part of the SMP and the existence of grade control structures are the primary management practices in the Stevens Creek watershed that are relevant to sediment deposition. Currently, the SCVWD inspects and removes sediment when necessary at the low gradient reaches of the creek in the lower watershed. Additionally, the SCVWD removes sediment in areas where deposition will impeded the function of facilities and fish passage, including sites where in-channel structures such as flow diversion weirs, fish ladders and grade control structures are located.

Data Gaps

Identify the amount of sediment supply from the middle and transitional reaches of Stevens Creek watershed and the total amount of sediment removed downstream of Highway 101.

7.0 Summary and Conclusions

This report provides a summary of the anthropogenic activities that may be important sources of sediment production in the Stevens Creek watershed. The report also identifies existing management practices and/or policies that may be relevant to these activities and provides a preliminary evaluation of effectiveness. In addition, this report identifies the data gaps and information needs for further evaluation of effectiveness of existing management practices in controlling sediment production from anthropogenic activities.

Conclusions from the assessment of existing sediment management practices in the Stevens Creek watershed are based on the best available information and should be considered preliminary. Excessive sediment from anthropogenic activities has not been identified as a factor that is negatively affecting aquatic life uses. Therefore, the following conclusions should only be considered working hypotheses based on the best available information, rather than finalized conclusions:

1. A variety of policies and best management practices are currently being implemented in the upper watershed areas that are designed to reduce the impacts of anthropogenic activities on landslide, surface and stream erosion. However, limited information is currently available to determine the effectiveness of these practices. Based on existing information, erosion from landslides may be an important source of sediment in the Stevens Creek watershed. It is assumed, however, that most of this sediment is deposited and trapped in the Stevens Creek Reservoir, with the exception of suspended sediment that can be transported to downstream reaches of the creek via water released by the dam.
2. Anthropogenic activities may be affecting stream erosion and may be a relatively large source of sediment to Stevens Creek reaches below the dam. Activities that are hypothesized to be potentially causing stream erosion include, dam influences on downstream bank stability, hydromodification, channel modifications and urban encroachment. There are limited opportunities for new development and/or significant redevelopment in the watershed below the dam. It is also unclear whether the stream channel has fully adjusted to changes in frequencies and intensities of runoff from existing development. Efforts by the Collaborative to develop guidelines and standards for land use near streams will assist the cities and County in making land use planning decisions that will likely enhance the protection of riparian habitat. The extent that these actions will have on reducing stream erosion is not known. Additional data are needed to more fully understand the location and extent of stream erosion and additional management actions that will reduce this process.
3. Surface erosion is believed to be minimal in the Stevens Creek watershed. However, based on preliminary observations, it appears that the Stevens Creek Quarry may be contributing to the release of fine sediment to the lower watershed via the dam. More quantifiable information is needed to examine this issue more completely.
4. The dam likely blocks all coarse sediment supply from the upper watershed drainage area. The lack of coarse sediment migrating from the upper watershed creates sediment starved water that typically increases shear stress to the bed and banks of the channel below the dam. Additional information is needed to determine the effects of limiting the supply of coarse substrate to the lower watershed.
5. Sediment removal in the lower watershed continues to be an effective way to reduce impediments to fish migration in the lower watershed. Additionally, existing grade control structures are likely reducing stream erosion by creating depositional areas throughout the creek through the reduction of flow. However, these structures may also be impediments to fish. Additional information is needed to provide more detailed assessment of the effectiveness of existing grade control structures in controlling excessive stream erosion and the transport of sediment to the Lower San Francisco Bay.

8.0 References

Abel, J. 2001. Description of fish passage impediments on Stevens Creek. SCVWD. Unpublished notes with photographs.

Best, Timothy C., 2002. Road and Trail Erosion Inventory: El Corte De Madera Creek Open Space Preserve Draft Report. Prepared for Midpeninsula Regional Open Space District. November 27, 2002.

California Department of Fish and Game 2004. California Salmonid Stream Habitat Restoration Manual. 3rd edition; Section "Part X Upslope Assessment and Restoration Practices" added to manual April 2004.

Carter, James L and Steven V. Fend. 2000. The Dististribution and Abundance of Lotic Macroinvertebrates during Spring 1997 in Seven Streams of the Western Santa Clara Valley Area, California. U.S. Geological Survey. Open File Report 00-346.

Kondolf, G.M. and M. Larson. 1995. Historical channel analysis and its application to riparian habitat restoration. Aquatic Conservation: Marine and Freshwater Ecosystems, Vol. 5, 109-126.

Northwest Hydraulic Consultants 2004. San Francisquito Creek Watershed Analysis and Sediment Reduction Plan Final Report. May 2004.

Pacific Watershed Associates. 1994. Handbook for forest and ranch roads. Prepared for the Mendocino County Resource Conservation District in cooperation with the California Dept. of Forestry and the U.S. Soil Conservation Service. Mendocino Resource Conservation District, Ukiah, California.

Reid, Leslie M. and Thomas Dunne 1996. Rapid Evaluation of Sediment Budgets. Catena Verlag GMBH Geoecology Paperback. Germany. 164 p.

San Francisco Bay Regional Water Quality Control Board (SFRWQCB). 2001. Surface Water Ambient Monitoring Program (SWAMP) Final Workplan 2001-2002. August 2001 (Revised August 2002).

Santa Clara Basin Watershed Management Initiative (SCBWMI). 2001 Watershed Management Plan, Volume One Unabridged, Watershed Characteristics Report. February 2001.

Santa Clara County Parks & Recreation Department (SCCPRD). 2003. Co-authors include 2M Associates, Harison & Associates, Terrell Watt, AICP; and Jones & Stokes Associates. Strategic Plan Santa Clara County Parks and Recreation System Santa Clara County Parks and Recreation Department. August 5, 2003.

Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). 2002a. Potentially Sediment Impaired Creek Report. March 1, 2002.

Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). 2002b. Workplan for Conducting Watershed Analysis and Management Practice Assessment in Other Creeks Potentially Impaired by Sediment from Anthropogenic Activities. August 30, 2002.

Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). 2002c. Performance Standard and Supporting Documents for Rural Public Works Maintenance and Support Activities. December 19, 2002.

Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). 2003. Santa Clara Basin Municipal Development Policies Comparison Project, Final. April 2003.

Santa Clara Valley Water District (SCVWD) 2003. FAHCE. Fisheries and Aquatic Habitat Collaborative Effort – Summary Report – February 26, 2003.

Stevens Creek Quarry Inc. 2002-2003 Annual Report for Storm Water Discharges Associated with Industrial Activities. June 24, 2003.

Stillwater Sciences Inc. 2004. Stevens Creek Limiting Factors Analysis Draft Technical Report. July 13, 2004.

United States Geological Survey (USGS). 1989. Effects of Limestone Quarrying and Cement-Plant Operations on Runoff and Sediment Yields in the Upper Permanente Creek Basin, Santa Clara County, California. U.S. Geological Survey Open-File Report 89-4130.

9.0 Figures and Tables

Figure 1. Land use type in the Stevens Creek watershed.

Figure 2. Jurisdictional boundaries and protected open spaces in the Stevens Creek watershed.

Table 5-1. Existing sediment-related management policies and practices for municipalities and agencies within Stevens Creek watershed.

Table 6-1. Anthropogenic activities and associated existing management practices that may be relevant to Stevens Creek.

Table 6-2. SCVWD bank repair records in the Stevens Creek watershed.

FIGURES AND TABLES

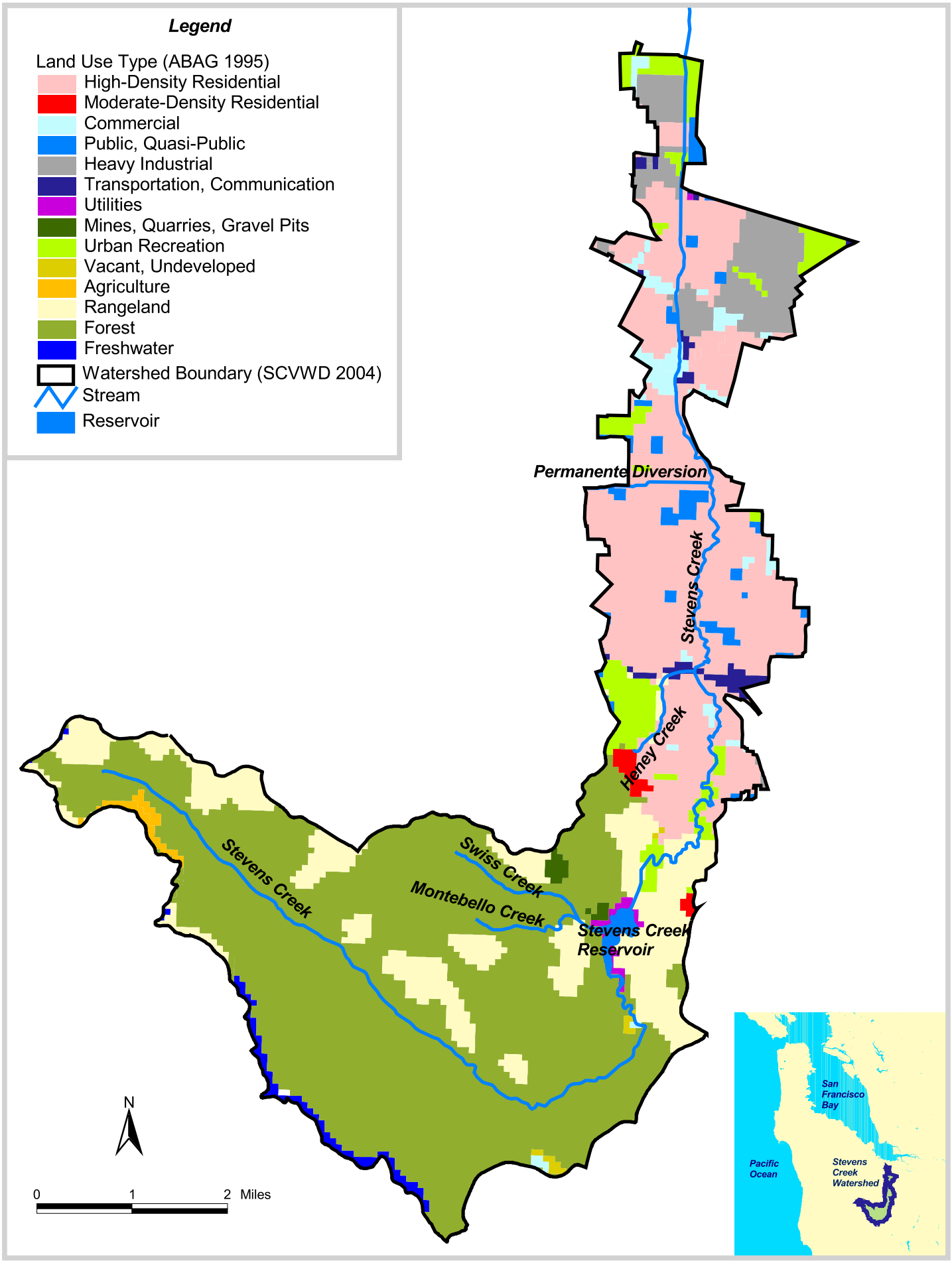


Figure 1. Land use type in the Stevens Creek watershed.

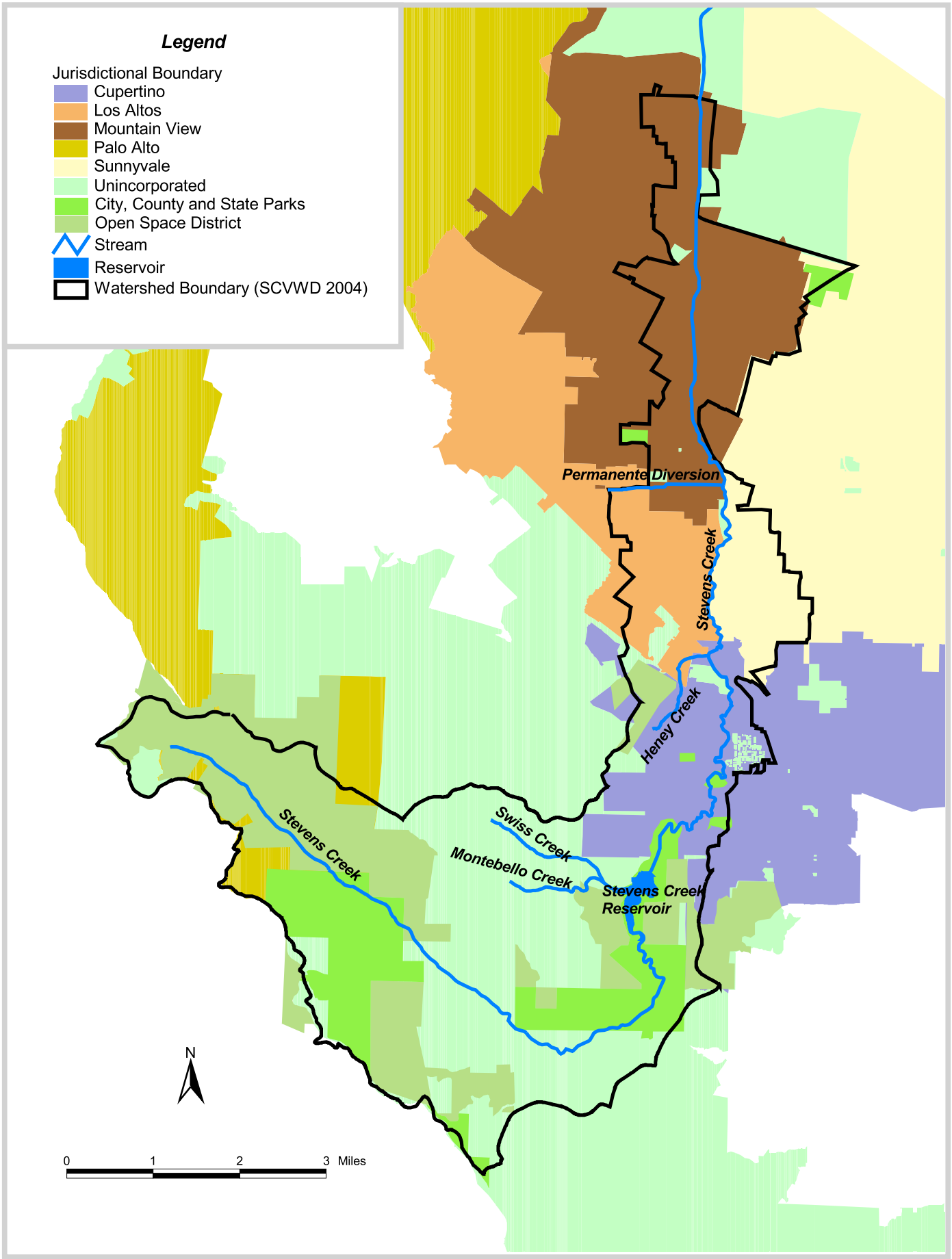


Figure 2. Jurisdictional boundaries and protected open spaces in the Stevens Creek watershed.

Table 5-1. Existing sediment-related management policies and practices for municipalities and agencies within Stevens Creek watershed.

Type of Management Practice	Lead Agency	Regulatory/ Management Driver	Purpose and Scope	Location and Extent	Time Period of Projects	Reference
NEW DEVELOPMENT						
Stream Buffers and Setbacks						
Stream Buffers	Cupertino, Los Altos, Mountain View and Sunnyvale	Appropriate plans, policies or ordinances	Restrict the development in sensitive areas that include riparian and wildlife habitat corridors, public open space preserves and ridgelines. These areas limit public access to include only those activities that are compatible with preserving natural vegetation, such as hiking, horseback riding and camping.	Sensitive areas	Ongoing	Santa Clara Basin Municipal Development Policies Comparison Project
Rural Resource Conservation	Santa Clara County	General Plan	Within areas immediately adjacent to stream buffer area, new development should minimize environmental impacts on the protected buffer area, and screening of obtrusive or unsightly aspects of a project should be considered as a mean of preserving the scenic value of riparian areas	Stream buffer area	Ongoing	San Francisquito - Existing Conditions (2003)
Stormwater Runoff						
Site Designs to Reduce Impervious Area	Cupertino, Los Altos, Mountain View and Sunnyvale	Appropriate plans, policies or ordinances	Policies to reduce the amount of maximum impervious surface area on a lot for example including one or more of the following treatment systems allowed by Mountain View: a) infiltration trenches or wells; b) grassy swales; c) sand filters; d) bioretention filters; or e) other alternatives approved by the City. These and other examples storm water treatment devices can be found in the California Storm Water Quality Association: Best Management Practices Handbook and other resources.	New and Redevelopment	Ongoing	Santa Clara Basin Municipal Development Policies Comparison Project
Site Designs to Reduce Impervious Area	Santa Clara County	Appropriate plans, policies or ordinances	Policies to limit the amount of maximum impervious surface area on a lot with examples including sidewalks draining to adjacent park strips; using turf block; and requiring a minimum percentage of landscaping in parking lots .	New and Redevelopment	Ongoing	Santa Clara Basin Municipal Development Policies Comparison Project
Other Hydromodification	SCVURPPP	SCVURPPP NPDES Permit regulated by SFRWQCB	This requires that hydrograph modification management plan be created to mange the impacts from changes to the volume and velocity of stormwater runoff from new development and significant redevelopment projects, where these changes can cause excessive erosion damage to downstream watercourses.	All Santa Clara Valley Watersheds	To be implemented	SCVURPPP NPDES Permit 2003
Construction						
Grading	Cupertino, Los Altos, Mountain View and Sunnyvale	Appropriate plans, policies or ordinances	Cities typically restrict grading during the rainy season. BMPs typically include a) silt fences around the site perimeter; b) gravel bags surrounding catch basins; c) filter fabric over catch basins; d) covering of exposed stockpiles; e) concrete washout areas; f) stabilized rock/gravel driveways at points of egress from the site and g) vegetation hydroseeding or other soil stabilization methods for high erosion areas.	Construction during rainy season	Ongoing	Santa Clara Basin Municipal Development Policies Comparison Project
Grading	Santa Clara County	Appropriate plans, policies or ordinances	Dikes, swales and ditches, when required, shall be designed and constructed to control runoff and erosion from graded areas. Where concentrated drainage discharges onto natural ground, effective measures shall be taken to dissipate the energy and, where practical release the accumulated waters as sheet flow unless the discharge is into a storm sewer or natural water course.	Construction	Ongoing	Santa Clara Basin Municipal Development Policies Comparison Project
Other Erosion Controls	Cupertino, Los Altos, Mountain View and Sunnyvale	Appropriate plans, policies or ordinances	All Cities have an ordinance, policy, or guideline that requires more stringent erosion and sediment controls for developments near sensitive areas (e.g., riparian or hillside areas).	Riparian or hillside areas	Ongoing	Santa Clara Basin Municipal Development Policies Comparison Project

Table 5-1. Existing sediment-related management policies and practices for municipalities and agencies within Stevens Creek watershed.

Type of Management Practice	Lead Agency	Regulatory/ Management Driver	Purpose and Scope	Location and Extent	Time Period of Projects	Reference
EXISTING DEVELOPMENT						
Municipal Maintenance						
Street Sweeping	Cupertino, Loa Altos, Mountain View, County, Sunnyvale	Stormwater Management Plan required by SFRWQCB.	Street sweeping to remove as much material as possible and dispose of it properly. This allows wash down of streets only if runoff is controlled or contained.	Countywide streets	Ongoing	SCVURPPP Annual Reports
Storm Drain Facility Maintenance	Cupertino, Loa Altos, Mountain View, County, Sunnyvale	Stormwater Management Plan required by SFRWQCB.	Storm drain facility maintenance to remove as much material/sediment as possible and dispose of it properly.	Storm Drain Facility	Ongoing	SCVURPPP Urban Runoff Management Plan
Modify Channels	USACE	Section 404 of Clean Water Act	Requires any streambank alteration work (e.g., bridge repairs, culvert replacement, flood control, etc.) to obtain a Section 404 permit.	Any "waters of the United States"	Ongoing	www.epa.gov/owow
Road Removal	SCVWD	CDFG	There are three drive through roads in Stevens Creek on Blackberry Farm which pose as potential fish barriers in the creek and the City of Cupertino and SCVWD (which is taking the lead) are planning to remove it.	Blackberry Farm (owned and operated by the City of Cupertino)	August 2005 (tentative)	Mike O'Dowd, onsite manager of Blackberry Farm - phone 4/26/04
Stream Restoration	Santa Clara County	General Plan	Encourages restoration of stream channels and riparian areas wherever feasible. Multiple users, such as for recreational trails, should be considered so long as habitat and other ecological values are preserved	Countywide	Ongoing	San Francisquito - Existing Conditions (2003)
Stream Restoration	Cupertino	Cupertino	Stream restoration at McClellan Ranch has mostly been removal of nonnative vegetation and replacement of indigenous species. Most of this work is done at the top of the stream banks, not on the slopes, so erosion is minimal.	McClellan Ranch	Ongoing	Barbara Banfield, City of Cupertino, McClellan Ranch - phone 5/4/04
Vegetation/Fire Management	Cupertino	Cupertino	McClellan Ranch has stopped the practice of disking to create fire breaks, which created a lot of dust. They are mowing now and a species of quail has returned to the area, however the costs are much more and they are considering resorting back to disking.	McClellan Ranch	Ongoing	Barbara Banfield, City of Cupertino, McClellan Ranch - phone 5/4/04
SCVWD Stream Maintenance						
Erosion and Sediment Controls	SCVWD	Stream Maintenance Program	The District shall prevent erosion on steep slopes by using erosion control material according to the manufacturer's specifications during all phases of routine maintenance projects to control sediment and minimize water quality impacts.	Streambanks		SMP
Sediment Removal	SCVWD	Stream Maintenance Program	The District typically removes sediment in areas where sediment deposition has: 1) reduced flood conveyance capacity; 2) impeded function of facilities and/or structures (e.g., flap gates, culverts); or 3) impede fish passage and/or access to fish passage structures.	Stevens Creek -14,000 cubic yards of the removed on the average of every other year between Moffett Boulevard and L'Avenida Ave.	10/00 (project dropped in 2003)	San Francisquito - Existing Conditions (2003), Sediment Removal Reports (2000, 2003)
Vegetation Management	SCVWD	Stream Maintenance Program	The District typically removes vegetation in and adjacent to streams and canals to: 1) maintain flood conveyance capacity; 2) maintain water conveyance for supply purposes; 3) reduce fuel loads on adjacent banks to meet local fire code requirements; and 4) control invasive nonnative vegetation. Specific vegetation management activities generally include mowing, disking, hand clearing, or herbicide application.	Streambanks		San Francisquito - Existing Conditions (2003)

Table 5-1. Existing sediment-related management policies and practices for municipalities and agencies within Stevens Creek watershed.

Type of Management Practice	Lead Agency	Regulatory/ Management Driver	Purpose and Scope	Location and Extent	Time Period of Projects	Reference
Bank Protection	SCVWD	Stream Maintenance Program	Bank protection activities are typically conducted by the District to repair eroding stream banks or to implement preventative erosion protection. Bank protection measures implemented by the District are based on site-specific conditions and range from the installation of "hard" structures (e.g., rock, concrete, sack concrete, gabion baskets) to the use of "soft" structures (e.g., brush mattresses, root wads, crib walls).	Streambanks	Ongoing	San Francisquito - Existing Conditions (2003)
Dam Operations	SCVWD	FAHCE	The watershed rules include controlling the dam flow with the following schedule: 1) Winter based flow (Nov. 1 - Apr. 30) to support steelhead trout (16 cfs), 2) Pulse flows (Feb 1. - April 30) when storage in the reservoir exceeds the pulse flow rule curve (50 cfs) and 3) Summer coldwater flow (May 1 - Oct. 31) will maintain coldwater management zone as available coldwater storage allows (19 degrees C avg or less, max 22 degrees).	Stevens Creek, below the Reservoir	Year round	FAHCE 2003
Modify Channels	SCVWD		Attempts to reduce flooding and transfer water have resulted in over 25% of Stevens Creek Watershed modification.	Stevens Creek and tributaries		SWAMP 2001-2002
County Rural Road[1] and Trails						
Road Construction and Maintenance	SCVURPPP Co-Permittees	SCVURPPP Performance Standards	This includes scheduling construction and maintenance activities for dry weather and protecting downslope drainage courses, stream and stormdrains with wattles, sand bags, earth dikes, or temporary drainage swales to divert or trap and filter runoff.	Rural roads and trails	Ongoing	SCVURPPP FY 2003-2004 Work Plan
Road Embankment and Median Maintenance	SCVURPPP Co-Permittees	SCVURPPP Performance Standards	Erosion and sediment controls including maintaining vegetative cover to prevent soil erosion, trap pollutants and slow the rate of storm water runoff and using measures that break the slopes to reduce the problems associated with concentrated flow volumes and runoff velocities.	Rural roads and trails	Ongoing	SCVURPPP FY 2003-2004 Work Plan
Riparian Buffer Area	Santa Clara County	General Plan	Where trails and other recreational uses are proposed by adopted plans to be located in the vicinity of streams and riparian areas or reservoirs, trail alignments and other facilities should be placed on the fringe of the riparian buffer area or at an appropriate distance to avoid disturbance of the stream or vegetation.	Recreational trails	Ongoing	San Francisquito - Existing Conditions (2003)
Open Space Preserves						
Road and Trail Maintenance	MROSD	Depends on location (e.g. CDFG, SFRWQCB, ACOE, etc)	MROSD repairs roads and culverts generally after acquiring new property in which staff practices follow The Handbook for Forest and Ranch Roads (by Pacific Watershed Associates in 1994) when restoring roads and trails.	Open Space Preserves	ongoing	Matt Freeman, contact for MSROD - phone 4/27/04
Stevens Creek Quarry						
Waste discharge requirements	SFRWQCB	Clean Water Act	The Stevens Creek Quarry produces crushed rock for building industry and is not exempt from waste discharge requirements. They have a SWPP onsite and have submitted annual reports to the Regional Board since 1994. Part of waste discharge requirements is to sample the first two major storm events a year and to make visual observations of storm events.	At Base of Stevens Creek Reservoir on Stevens Canyon Road (since 1932)	Ongoing	Stevens Creek Quarry (WDID No. 243S006687) Annual Report June 2002-July 2003
Hanson Permanente Cement Company (formerly Kaiser Permanente)						
Erosion and Sediment Controls	Hanson Permanente Cement Company	SFRWQCB	Stabilizing disturbed slopes and intercepting runoff in sedimentation basins.	Permanente Creek	since issued violation in 9/98.	SWAMP 2001-2002

1. A public paved or unpaved road that is: a) in an area having average lot sizes of 1 acre net or greater or zoned as open space under Co-permittee jurisdiction; and b) not served by an integrated municipal storm drain system; c) not served by curbs and gutters; and d) intended to be passable to a maintenance vehicle. This definition does not include hiking and equestrian trails, unless they are intended to be passable to a maintenance vehicle.

Table 6-1. Anthropogenic activities and associated existing management practices that may be relevant to Stevens Creek. Key issues are shown, as well as data needs and information gaps to evaluate effectiveness of existing practices.

Anthropogenic activities potentially affecting erosion processes		Relevant issues	Existing Management Practices that may be relevant to impacts in Stevens Creek	Data needs and information gaps
General	**Specific activities that may be relevant to Stevens Creek**			
Landslide Erosion				
Road construction, vegetation removal and soil disturbance changing drainage patterns	• Potential development and construction of new roads in upper watershed area • Maintenance and use of existing roads, culverts or other structures	• Unstable geology; some watershed areas subject to frequent landslides (e.g., Monte Bello Landslide Complex) • Stevens Reservoir capacity affected; dam prevents downstream transport of coarse sediment	• Road and trail maintenance in unincorporated area, including parks and Open Space Districts • Existing development policies relating site designs to reduce imperviousness	• Landslide analysis to determine extent and magnitude of sediment sources from existing development, paved and unpaved roads and trails.
Stream Erosion				
Hydromodification	• Potential new development projects • Existing development • Water imports	• Limited area available for new development below dam; • Watershed area below dam is highly urban (44% cumulative watershed imperviousness) • Additional winter streamflow (~1500 cfs) from the Permanente Diversion Channel	• HMP controls may apply to some future projects • Existing development policies relating site designs to reduce imperviousness; • Potential stream restoration projects that increase channel capacity or floodplain access	• Hydrologic modeling to evaluate magnitude and significance of altered flows to bank erosion; • Sediment source analysis from stream erosion
Channel alteration	• Construction and maintenance of bank protection structures, roads, bridges, culverts and fish ladders	• Steven Creek channel (below dam) has been significantly modified; 10% channel length has been hardened; 50% levied, excavated or modified flood plain.	• Bank erosion repairs • Bridge and culvert replacement and maintenance • Fish ladder maintenance	• Sediment source analysis from stream erosion • Inventory structures causing bank erosion • Inventory of significant changes in bed elevation to identify areas of channel incision

Anthropogenic activities potentially affecting erosion processes		Relevant issues	Existing Management Practices that may be relevant to impacts in Stevens Creek	Data needs and information gaps
General	**Specific activities that may be relevant to Stevens Creek**			
Floodplain encroachment	• Existing development and redevelopment in stream corridor	• Existing development near stream banks; channel has limited access to floodplain in middle reaches; • Channel incision resulting in high bed mobility	• Existing development policies protecting riparian corridor	• Review and document existing and potential flood plain areas for bankfull or dominant discharge events.
Removal of vegetation and woody debris	• Vegetation and Large woody debris (LWD) removal for flood control	• Lack of woody debris in channel reduces structures to trap large sediment and limits available overwintering habitat for steelhead	• Channel maintenance activities by SCVWD • Potential management actions to improve fish habitat (e.g., add LWD structures)	• Inventory of large woody debris • Information on the effect of management changes on capacity and flood insurance for homeowners.
Trapping or removing coarse sediment	• Stevens Creek Dam (built in 1935)	• Lack of coarse substrate in channel limits available overwintering habitat for steelhead	• Potential management actions to improve fish habitat (e.g., augment coarse substrate)	
Surface Erosion				
Roads and trails	• Maintenance and use of existing roads, road ditches, culverts or other structures	• Existing unpaved roads and trails contribute sediment to streams from sheetflow erosion	• Road and trail maintenance as well as closures as necessary	• Road and trail inventories in areas not studied
Construction	• Construction could potentially be a large source of erosion and sediment, if controls are not used	• Construction sites that do not have the proper controls can release both wet and dry season surface erosion flows	• Existing construction and inspection programs must be in place to ensure that proper erosion controls are used, especially during the wet season	

Table 6-2. Bank erosion repairs conducted by the SCVWD on Steven Creek from 1987 – 1999.

REACH	TYPE	TYPE OF MISC	FY	DESCRIPTION	LENGTH (FEET)
902	MISC	Shotcrete	87	STEVENS CK U/S OF 101 EROSION REPAIR	30
902	ROCK		89	STEVENS CRK U/S MOFFETT BLVD ROCK PLACEMT P	200
902	MISC	Shotcrete	89	STEVENS CRK U/S 85 EROSION REPAIR @ STREAM GAGE	40
902	SCSP		90	STEVENS CRK D/S EVELYN S.C.S.P. F&G	20
902	MISC	Shotcrete	90	STEVENS CRK U/S MOFFETT BLVD. MISC EROSION	100
902	MISC	Shotcrete	93	STEVENS CRK-U/S 101 &MOFFETT-FIX DISSIPATER(MOU)1N	10
902	MISC	Shotcrete	93	STEVENS CRK-U/S 101 &MOFFETT-FIX DISSIPATER(MOU)1N	10
902	ROCK		93	STEVENS CRK D/S 101 - ROCK PLACEMENT (MOU)1-N	190
902	MISC	Soil	94	STEVENS CRK D/S MOFFETT BLVD-COMPACT TOP OF BANK.	400
903	SCSP		87	STEVENS CK-FAILED SACK RIPRAP U/S OF EVELYN AVE.	65
903	ROCK		87	STEVENS CRK - REAR OF 1221 BLACKBERRY TERRACE	55
903	MISC	Shotcrete	87	STEVENS CRK D/S RFREMONT AVE. FISH LADDER	100
903	ROCK		87	STEVENS CRK D/S FREMONT AVE EROSION REPAIR	100
903	ROCK		88	STEVENS CRK D/S EL CAMINO EROSION CONTROL P	100
903	ROCK		88	STEVENS CRK D/S EL CAMINO EROSION CONTROL P	100
903	ROCK		89	STEVENS CK. U/S HOMESTEAD ROCK PLACEMENT F&G	100
903	ROCK		91	STEVENS CRK/PERM DIV CONFLUENCE-ROCK PLACEMT.F&G	100
903	ROCK		91	STEVENS CRK D/S HOMESTEAD-ROCK PLACEMENT F&G	110
903	ROCK		91	STEVENS CRK U/S EVELYN AVE.-ROCK PLCMT. F&G	20
903	ROCK		94	STEVENS CRK D/S 85 (FISH LADR)ROCK PLCMT(F&G)	70
904	MISC	Soil	96	STEVENS CRK - 22157 CLEAR CRK CT - EROSION REPAIR (M)	20
951	MISC	Vegetation & Fabric	99	STEVENS CK - U/S FREEMONT AVE - PLANT TO STABILIZE EROSION	40