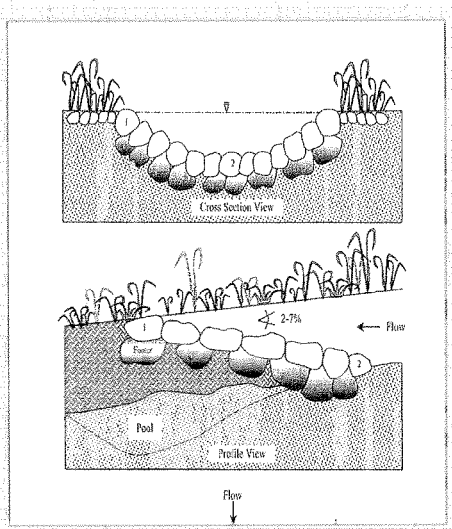
CHANNEL DESIGN RECOMMENDATIONS

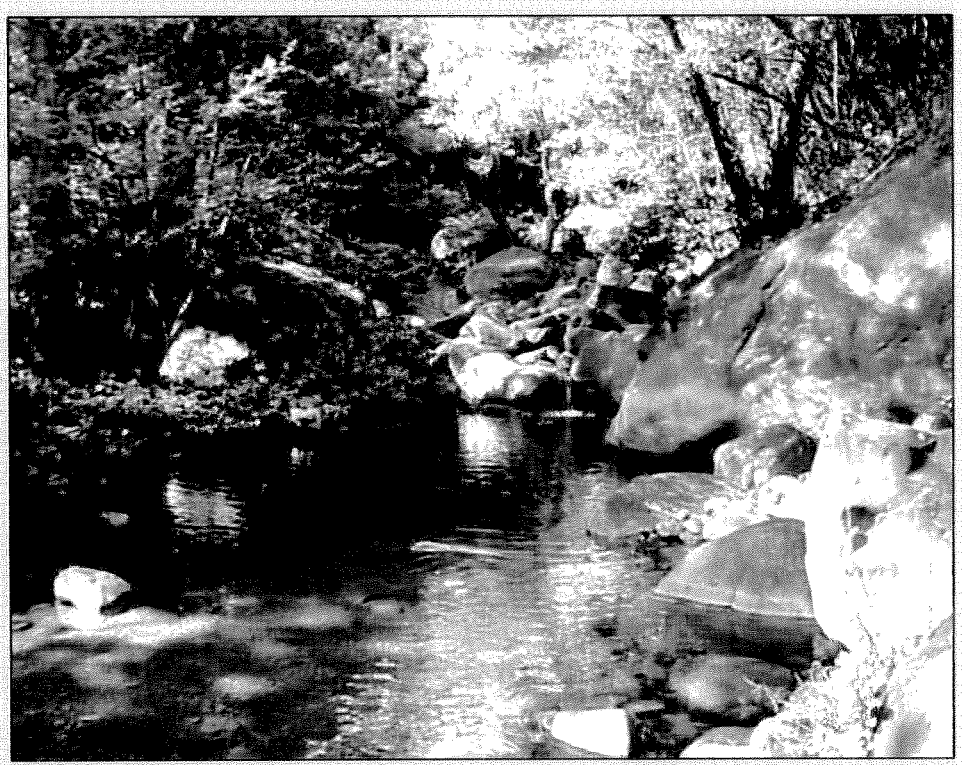
LOWER MISSION CREEK FLOOD CONTROL PROJECT



June 2005

Prepared for:

City of Santa Barbara
County of Santa Barbara
Corps of Engineers



Prepared by:

URS Corporation
Goleta, California

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1. INTRODUCTION

The Lower Mission Creek Flood Control Project (Project) consists of various channel and bridge improvements along Mission Creek from Canon Perdido Street to Cabrillo Boulevard. The Corps of Engineers (Corps) is funding most of the design and construction. The local sponsors are the City of Santa Barbara (City), and Santa Barbara County Flood Control District (County). The objective of the Project is to reduce flooding by increasing the channel capacity from its current capacity of 1,500 cfs to 3,400 cfs (a 20-year event). The improvements described in the Lower Mission Creek Flood Control Feasibility Study (Corps, 2000) include the following elements: widening the existing channel; replacing and widening of four bridges; constructing vertical wall channels with the upper slope and adjacent buffer zone to be planted with riparian trees and understory plants; constructing a by-pass weir and parallel culvert to convey high flows under Highway 101; and constructing various channel features to improve habitat conditions for fish.

In November 2001, the California Coastal Commission (CCC) issued a preliminary Coastal Zone federal consistency certification for the Project. Condition 3 requested that the Corps consult with specific individuals with interest and knowledge of the project for recommendations on a final design of the proposed "pilot channel" as it was described in the Corps' feasibility report. Condition 3 reads as follows:

> *"The Corps shall develop a new pilot channel configuration for the Lower Mission Creek Flood Control Project. The Corps shall consider, as design alternatives, all feasible suggestions and recommendations on the pilot channel's physical characteristics (e.g., dimensions, morphology, sinuosity, substrate, etc.) received from the Environmental Defense Center, Dr. Ann Riley, Dr. Ed Keller, Dr. Scott Cooper, Dr. Camm Swift, Dr. Kevin Lafferty, National Marine Fisheries Service, and the City and County of Santa Barbara. The new configuration shall be developed with the goal of promoting effective and efficient transport of sediment through the creek, minimizing streambed erosion and sedimentation impacts and related creek maintenance impacts associated with the project, and protecting aquatic habitat. The pilot channel design shall be submitted to the Commission as part of the consistency determination for the design phase review of the Lower Mission Creek Flood Control Project."*

The Corps proposed the "pilot channel" to promote sediment transport, reduce maintenance requirements, and enhance aquatic habitat and fish passage conditions, particularly for the endangered southern steelhead which travels through the lower creek to rearing habitat in the upper watershed. The pilot channel was included in the project evaluated by National Marine Fisheries Service (now called NOAA Fisheries) in its Biological Opinion regarding impacts of the project on the steelhead. Condition 2D of the Biological Opinion requires that the Corps construct a "low flow channel" that reflects what would be formed through natural fluvial processes. Condition 2E requires that the low flow channel be restored after routine channel maintenance activities.

In early 2002, the City, with concurrence by the Corps, convened a working group to address the channel design issue. The group includes technical experts from the City, Corps, and County; experts in channel design and river geomorphology - Dr. Ed Keller of U.C. Santa Barbara and Dr. Anne Riley; Mr. Stan Glowacki of NOAA Fisheries; and Dr. Scott Cooper of U.C. Santa Barbara. The group also includes Mr. Brian Trautwein of the Environmental Defense Center and representatives from Santa Barbara Channel Keeper. The City conducted a meeting of the working group in May 2002 to identify the objectives of the group, discuss terminology, and begin technical discussions. Subsequent meetings were conducted on February 20, 2003 and February 17, 2005 to discuss design channel recommendations based on a draft version of this report.

This report provides an overview of the issues being addressed by the working group and a recommendation to the Corps concerning the final design of the channel for the Lower Mission Creek Flood Control Project. This report will be submitted to the CCC for review and approval in compliance with Condition 3 of the preliminary Coastal Zone federal consistency certification for the project.

The report also contains a summary of the proposed channel maintenance plan, prepared by the County in consideration of the recommendations of this report (see Appendix C).

Please note that the channel from Highway 101 to the ocean is not considered in this study because channel conditions along this reach are not suitable for establishing and maintaining a "pilot channel." In addition, most of this reach is tidally influenced, and as such, is flooded most of the year.

2. OVERVIEW OF THE PROPOSED CHANNEL DESIGN

2.1 SUMMARY OF CHANNEL DESIGN

The Lower Mission Creek Flood Control Project involves widening the existing channel and several key bridges from Canon Perdido Street to State Street to increase the channel capacity and reduce flood hazards. The new channel would be designed for a capacity of 3,400 cfs, which is a 20-year event. The existing channel capacity is about 1,900 cfs, which is about an 8-year event. The proposed channel will have a combined rectangular and trapezoidal shape with: (1) vertical walls at the base of the banks; and (2) vertical walls with vegetated rip-rap on the upper banks at a 1.5:1 (H:V) slope (see Figure 1, Appendix A).

The channel will be unlined, except at two bridges (De la Guerra and Gutierrez). Four bridges will be replaced with wider openings to match the new wider channel - Ortega, Cota, Haley, and Mason streets. An overview of the new channel improvements and widened bridges upstream of Highway 101 is presented on Figures 2a and 2b.

The new channel and bridges will be wider than current conditions (see Table 1 below). Existing concrete bottom will be removed except between Highway 101 and Yanonali Street in order to preserve the sandstone channel associated with the historic railroad depot.

TABLE 1
PROPOSED CHANNEL WIDTHS

Reach to be Widened	Approx. Length (Feet)	Channel Width (feet)	
		Existing (typical)	Proposed (approx)
Canon Perdido to Haley St	2,200	25	42
Haley St to Highway 101	1,000	25	50
Yanonali St to Beach	1,100	27	60

A rip-rap channel bottom will be installed 150 feet upstream and 150 feet downstream of the existing bridges at De la Guerra Street and Gutierrez Street (Figures 2a and 2b). The rip-rap lining would prevent channel bed scour at these bridges once the project is completed due to anticipated higher velocities. The rip-rap on the channel bottom will contain clusters of 6-7 boulders of 3-4 foot width and 18-24 inches above the channel invert. These features are called "boulder clusters" or "rock energy dissipaters" in the project plans. They would be similar in size and material as the "fish baffles" described below, but would be extended across the entire creek bed.

2.2 PROPOSED FISH HABITAT ENHANCEMENTS

The Corps has proposed to install 50-foot long fish ledges on alternating sides of new channel – two feet wide and about 10-20 inches above channel invert. The ledges would be installed on the concrete vertical walls. The purpose of the ledges is to provide cover and protection from

predators for fish, particularly steelhead, during low flow conditions. A total of six ledges are proposed for the project reach (Figures 2a and 2b).

The Corps has also proposed to install rock "fish baffles" at periodic locations along the project reach, consisting of two rows of rocks in a 5-foot wide zone along the outer edge of the channel, 5-8 feet apart. The rocks would protrude 18-24 inches about the channel invert. The individual rows of rock would be about 150 feet long at each location. They would be placed on the inside curves of the creek where water velocities would be lower, and would be placed in between the fish ledges. The purpose of the baffles is to provide habitat for fish amongst the rocks on the channel bottom and to improve hydraulic conditions in the channel for fish migration by providing backwater areas for resting. A total of 6 rows of baffles would be installed along the project reach, as shown on Figures 2a and 2b.

3. ORIGINALLY PROPOSED PILOT CHANNEL

In their Feasibility Study and Environmental Impact Statement/Report, the Corps proposed establishing a "pilot channel" at the end of construction that would provide a permanent low flow path and prevent a uniform flat channel bottom along the reach above Highway 101. The precise alignment of the pilot channel would be determined based on hydraulic analyses conducted during final design. It would be situated in relation to the fish ledges, which would be placed on the outside bends of the channel to facilitate the formation of pools beneath the fish ledges. Hence, the pilot channel would be constructed to direct flows to the outside bends.

The Corps proposed to size the pilot channel to accommodate 50 cfs. It would likely be 8 to 10 feet wide and 1 to 2 feet deep. The bottom of the channel would be lined with gravels and cobbles. The overall intent of the pilot channel is to concentrate low flows, particularly near the fish ledges, that will provide year-round aquatic habitat. It would prevent the formation of broad shallow flows across the channel bottom that would be too shallow and too warm for many fish and aquatic organisms.

Cross sections of the proposed channel immediately after construction, and after the installation of the pilot channel and other fish enhancements, are shown on Figure 1.

4. RELATIONSHIP BETWEEN BANKFUL & PILOT CHANNELS

4.1 BANKFUL CHANNEL ALONG MISSION CREEK

The "morphology" or shape of a channel depends on the discharge, the nature and amount of sediment moving through the system, and the composition of the bed and bank materials. The slope of the channel bed is also an important factor in shaping the creek due to its influence on flow velocity and sediment transport. The shape of a channel can vary greatly from year to year, particularly when there are years with extreme events (e.g., floods or droughts). However, over time and in between these events, a typical channel morphology is present in a creek which is strongly linked to the channel forming flow, or "bankful discharge." In southern California, this flow typically has an average recurrence interval of 1.5 to 2.0 years. The bankful discharge is the increment of discharge that transports the largest fraction of the sediment load over a long period of time. It is a function of the magnitude of the event and its frequency of occurrence. This discharge is considered to have morphological significance because it represents the breakpoint between the processes of channel formation and floodplain formation.

Dr. Ed Keller of UC Santa Barbara has estimated the bankful discharge along lower Mission Creek to be about 350 cfs using a flow frequency of 1.5 years. [Note: The return events used to calculate the bankful discharge varies from 1.5 to 2.0 years, depending upon watershed conditions]. The "bankful channel" associated with this discharge would have a width and depth of 33 and 2 feet, respectively.

The proposed 40 to 50-foot wide channel along the project reach would provide enough space to accommodate this bankful channel. Over time, a 30-35 foot wide channel is expected to naturally form within the proposed rectangular channel. The alignment, width, and depth of the bankful channel along Mission Creek are expected to be relatively stable over time except after extreme flooding events. The bankful channel will become re-established after floods, although the number of years required to reform the channel will depend on the types of flow. The channel bottom will remain the same as today – a mixture of coarse sediments, cobbles, and occasional large boulders.

The thalweg in the bankful channel would convey low flows throughout the year, as there are year-round flows in Lower Mission Creek. A small, "low flow channel" is expected to form in the bankful channel. The dimensions of this low flow channel cannot be predicted. However, it is likely to exhibit similar characteristics of the current low flow channel in Mission Creek, which is 5 to 10 feet wide and 2 to 3 feet deep.

It should be emphasized that the pilot channel proposed in the Feasibility Study and EIS/EIR for the project is different from the bankful channel. The pilot channel would have smaller dimensions and would convey less flow. The pilot channel described in the Feasibility Study and EIS/EIR is equivalent to the low flow channel described above.

4.2 COMPARISON TO THEORETICAL CHANNEL MORPHOLOGY

The proposed channel will provide a more natural hydraulic condition compared to current conditions due to the wider channel bottom where the bankful channel can form. However, it should be recognized that the current and proposed channel is separated from the floodplain, and therefore, it will not fully function as a natural creek with a dynamic interaction with the floodplain (e.g., channel migration, sediment deposition, etc).

To assess the level of natural hydraulic function of the new channel, the geomorphologic characteristic of the new channel was assessed using the following indices:

- Channel sinuosity = ratio of the valley slope divided by the channel slope. Natural creeks that are unconfined by flood control improvements will develop a unique sinuosity value. A high ratio indicates a stream with many meanders and a very long flowline compared to the channel centerline.
- Meander sinuosity = ratio of the flowline distance divided by the channel centerline. This index indicates the degree to which meanders are present in the channel. A high value indicates a meandering thalweg within the channel.
- Meander length = 11 times the bankful width
- Meander width - 2.7 times bankful width

The channel and meander sinuosity values for the existing and future channel conditions are presented below in Table 2. The channel sinuosity is not expected to change because the elevations of the creek channel from the top to the bottom of the project reach will not be altered. The stream gradient and associated stream energy will not be altered. However, the channel will be wider, which will allow more natural meanders to form. Wider and longer meanders are predicted under the new channel conditions, as shown below.

TABLE 2
CHANNEL GEOMORPHIC CHARACTERISTICS

Index	Existing	Future	Comments
Channel sinuosity	1.30 (Calculated)	1.30	No change because the valley and channel slopes will not be modified by the project
Meander sinuosity	1.03 (Measured)	1.06 (Estimated)	Will increase due to wider channel bottom
Average future meander length (feet)	200 (Measured)	363 (Calculated)	Meander length will be longer
Average future meander width (feet)	NA	40-50	Theoretical width if the creek was not separate from the floodplain is 89 feet. Due to channel constraints, actual width will be based on width of channel bottom

5. CURRENT POOL AND THALWEG CONDITIONS

To provide more information about the geomorphology of Lower Mission Creek that could be used in the channel design, URS Corporation conducted a pool and thalweg survey of the creek from near Canon Perdido Street to Gutierrez Street. Two investigators walked this reach, measuring water depth along the lowest part of the channel. They mapped the alignment of the thalweg, as well as major cobble bars. Maps of the thalweg and pools are attached (Figures 3a and 3b). In addition, a plot of pool depths is shown on attached Chart 1 (Appendix B).

Thirteen distinct pools occur along the reach. The lengths of the pools range from 25 to 215 feet. The depths range from 10 to 48 inches. Surface water was present along the entire reach. The distribution, size, and depth of the pools do not exhibit any obvious patterns related to bridges or channel alignment. Significant cobble bars with dense vegetation are present throughout the reach, typically narrowing the width of the low flow channel to 8 to 10 feet. The sinuosity of the thalweg was very low – the linear distance of the thalweg alignment was only 8 percent longer than the centerline of the channel.

A best-fit trendline is plotted on Chart 1 to provide another approach to identifying the number of pools. Depths below this line can be viewed as pools. Using this method, there are 12 pools along the project reach.

6. RECOMMENDATIONS

Recommendation for the final channel design are presented below that would: (1) enhance the effectiveness of the originally proposed pilot channel; and (2) meet the objectives of CCC Condition 3 – that is, promote sediment transport, minimize channel bed erosion, reduce maintenance requirement, and protect aquatic habitat and fish passage conditions. These design modifications were developed based on input from Dr. Ed Keller, and from the Channel Design Working Group. They are designed to contribute to the "naturalization" of Mission Creek channel. Naturalization occurs when highly altered channels are modified to allow natural geomorphologic processes to operate, which will form and maintain a series of pools and riffles.

The new and wider channel will have sufficient width (40-50 feet) to allow a bankful channel to form over time and create the low-flow channel (within the bankful channel) that follows a natural hydraulic flow line unique to this reach of Mission Creek based on the substrate, overall channel alignment, bridge locations, and slope. Hence, the objective of the channel modifications would be to enhance the creation of the bankful channel and the attendant low flow channel – that is, facilitate the rapid formation of these channel features as soon as possible after construction and ensure that they will be as stable as possible over time (in the context of the natural creek geomorphology).

To accomplish this goal, the channel should be "initialized" at the end of construction to begin the natural geomorphological processes as follows. Cross sections of the proposed channel initialization and the resulting channel morphology are shown on Figure 4. The following design modifications would contribute to this initialization process. They would enhance migration and rearing opportunities for the southern steelhead by facilitating the formation and maintenance of a low flow channel and deep pools within the larger channel.

Recommendation No. 1- Establish Pools

Pools should be established at the locations of the existing pools at the time of construction by excavating the channel below the design elevation for the channel bottom. Hence, if the project were constructed next year, a total of 13 pools would be created. The depths of the new pools would be 75 percent of the depths of the existing pools. A shallower depth is proposed in order to retain some channel bed material for scouring and redeposition during the first several years after construction. The lateral locations of the pools within the channel should generally match the locations of the existing pools (Figures 3a and 3b).

To maintain these pools, a "cross-vane rock weirs" should be installed at the head of each new pool (Rosgen, 2003). These weirs are grade control structures that narrow the width of the base flow channel and create scour pools downstream. The weir consists of a rock sill perpendicular to the stream flow located at the invert elevation of the creek. Two arms of the sill extend downstream along the banks, rising in elevation to the bankful height as they extend downstream, as shown on Figure 5. The stone is trenched into the stream bank at sharp angles in a general "V" shape pointing upstream. Two lines of rock are utilized to create a stable structure, utilizing the principle that water will

flow off of immovable objects at right angles (90° angles). The downstream line of rock is trenched into the stream bottom so that the tops of the rock are approximately level with the stream bottom. The size of the rock for the weir and sills will be determined during final design. The length of the weir arms is the distance measured from the bankful bank to the intercept with the invert elevation of the creek at 1/3 the bankful channel width.

The cross-vane weir reduces bank erosion, creates a stable width-depth ratio, maintains channel capacity, and maintains sediment transport capacity. It decreases near-bank shear stress and increases energy in the center of the channel where it forms and maintains pools. The cross-vane is used to improve fish habitat because it creates pools for holding and refuge, develops feeding zones by creating flow separation areas along the margins of the weir, and creates potential spawning habitat in the tail-out portion of the pool (Rosgen, 2003).

In curved portions of the creek, a "J-hook vane rock weir" would be installed, as shown on Figure 6.

To the extent feasible, boulders encountered during construction of the project should be used to create the rock weirs. Similarly, cobbles that are excavated during the construction of the channel should be used for fill activities in the channel, particularly in areas between pools where they can be used to form riffles.

Recommendation No. 2- Initialize the Formation of a Low Flow Channel

The channel between pools should be graded with a slight cross slope that reflects the location of the existing thalweg prior to construction (Figure 4). Hence, if the thalweg is located along the west bank, the new and wider channel would be graded with a slight grade (one foot or less over the width of the channel) towards the west bank. This action will enhance the formation of the low flow channel within the larger bankful channel.

A low flow channel should not be graded, as it will form naturally after the first winter with average or above average runoff. Any attempt to create and maintain a specific low flow channel would likely be a futile effort.

Recommendation No. 3 - Relocate Fish Baffles to Center of Channel

As noted earlier, the Corps proposes to install rock fish baffles at periodic locations along the outer edge of the channel. The rocks would protrude 18-24 inches about the channel invert. The purpose of the baffles is to provide habitat for fish amongst the rocks on the channel bottom and to improve hydraulic conditions in the channel for fish migration by providing backwater areas for resting. It is recommended that the rock be reconfigured as more numerous "rock clusters" in the center of the channel, placed at 100 – 150 foot spacing between pools. Placement of the rocks in the center of the bankful channel at the end of construction would maximize the potential for the rocks to occur in year-round flows, in contrast to the proposed locations at the edges of the channel bottom. The rock cluster would consist of 3 to 5 individual rocks placed in close proximity, as shown on Figure 7. The size of the rocks will be determined during final design. They must be of sufficient size to remain in place during flood flows.

Recommendation No. 4 - Remove Fish Ledges

The Working Group engaged in several lengthy discussions about the proposed fish ledges. It was concluded that they would not be effective and should be removed from the design. The primary reason was that the ledges could become stranded over time if the low flow channel migrates to the other side of the larger channel, or the channel becomes lower. In these cases, the fish ledges would no longer be effective. The Working Group believed that the establishment of pools using the rock weirs would provide a greater amount of pool habitat that would be self-sustaining. Riparian and wetland plants are likely to persist or regularly colonize the channel bottom along the outside of the rock weir "arms" that extend downstream and form the pool, thereby creating cover for fish. The proposed fish ledges would have created 300 feet of cover for fish. The proposed 13 pools to be re-created during construction of the project would provide significantly habitat than would be created by the fish ledges, as the size of the pools below the rock weirs would range from 50 to 100 feet.

Recommendation No. 5 - Reduce or Modify Rock Energy Dissipators at Two Bridges

As noted earlier, a rip-rap channel bottom will be installed 150 feet upstream and 150 feet downstream of the existing bridges at De la Guerra Street and Gutierrez Street (Figures 2a and 2b). The rip-rap lining would prevent channel bed scour at these bridges once the project is completed due to anticipated higher velocities. The rip-rap on the channel bottom will contain clusters of 6-7 boulders of 3-4 foot width and 18-24 inches above the channel invert.

The Working Group expressed concerns about the overall lengths of the rock lining, and about the potential for this rock channel bottom to become a fish migration barrier. Two recommendations were developed to address these issues as follows: (1) During final design, the Corps and local sponsors should consider other design features to address the potential scour problems at these bridges that would reduce the length of the rip-rap channel lining. Examples include extending the abutments of the existing bridges to reduce the need or size of the energy dissipater structures, or using point stabilizers instead of continuous rock surfaces. (2) Any rock or concrete structure on the channel bottom at these bridges should be notched for a low flow channel to allow fish passage.

Recommendation No. 6 - Implement Adaptive Management for Design Modifications

The above design modifications are designed to be consistent with, and maintained by, the natural fluvial processes that will return to Mission Creek once the channel has been widened. The use of engineered structures to enhance habitat conditions in the creek is minimized, however, the rock weirs are necessary to maximize the formation of self-sustaining pools.

If, after several winters, a persistent low flow channel and series of pools are not forming or exhibiting persistence, then the City and the Corps, in consultation with NOAA Fisheries, the California Department of Fish and Game, and members of the Channel Design Working Group,

would review the performance of the proposed channel enhancements and consider modifications to the design, including but not limited to adding or removing weirs, modifying the size of instream boulders, and placement of additional boulders to encourage formation of a more stable and deeper low flow channel and series of pools.

In many locations, obstructive vegetation will be removed by hand brushing, using a crew of four with loppers and chainsaws. Branches of trees and shrubs that overhang into the creek will be hand cut to a height of approximately six feet from the channel bottom.

Brushed vegetation will be either cut up into small pieces and left on the channel bottom, or will be chipped in place or bundled and removed from the creek channel with a winch truck. Dense clumps of non-native vegetation such as giant reed, ironweed, german ivy, and fennel will be removed during routine brushing as an environmental enhancement measure.

The County will apply herbicides to control vegetation under limited circumstances. The herbicide AquaMaster™ will be applied using backpack sprayers to ensure the minimum amount of herbicide is used to achieve the vegetation control. Some areas that have been hand brushed may also be sprayed to inhibit the regeneration of the obstructive vegetation. Herbicides will also be used for eradication of non-native species during channel maintenance.

Desilting will be necessary in channel reaches where sedimentation has significantly reduced the cross-section of the creek (i.e., more than 15 percent), and there is a need to remove the sediment from the channel bottom. Desilting will be typically accomplished with a dozer or loader working in the bottom of the channel, pushing the accumulated sediment to an area where the material can be loaded directly into trucks driving on the channel bottom or to an area where a crane can access the material which is then loaded into trucks and hauled to a suitable disposal site. It is possible that lesser amounts of sediment will be temporarily placed on the banks where the County has an easement.

After a section has been desilted, a pilot channel will be re-created through that section per the design guidance in this report. If a pool was affected by the de-silting, a replacement pool will also be re-created. The channel will be reshaped with a dozer working on the channel bottom. The dozer will create a 10-15 foot wide pilot channel with material windrowed along the sides to a height of approximately two feet.

All rock weirs and rock clusters in the channel bottom, installed per this report will be avoided during channel desilting and shaping.

8. CONSISTENCY WITH "VE" ALTERNATIVE CHANNEL

In July 2003, the Corps conducted a Value Engineering (VE) workshop for the proposed Project. The VE process is used to review the project in an organized manner by engineers not associated with the Project in order to identify alternative ways to meet the Project objectives with the lowest cost. The results of the VE workshop are presented in a report (Corps, 2003), and will be considered by the Corps during the final design of the Project.

One of the major alternatives identified during the VE process was an alternative channel configuration that would significantly reduce project costs and provide many environmental and aesthetic benefits. Under this alternative, called Recommendation C-01, the proposed vertical walls would be replaced with an earthen, vegetated bank (1.5:1 H:V) with boulders or rock rip-rap at the toe of the slope in areas with potential bank erosion. Vertical concrete walls would be constructed on the top of the earthen banks as necessary to meet the design capacity of 3,400 cfs. The average vertical wall height would be 2.5 feet. The proposed ungrouted rock rip-rap slope with tree plantings would not be included in this alternative. A sketch of the alternative channel configuration is shown on Figure 8.

The recommendations presented in Section 6 would be consistent with the alternative channel design. That is, the low flow channel, cross-vane weirs, and pools can be established on the channel bottom of the alternative channel design in the same manner. The size of the rock and cross-vane weirs may differ under this design, but their functions would be the same as for the proposed project.

9. REFERENCES

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Corps of Engineers, 2000. Lower Mission Creek Flood Control Project Feasibility Study and Final EIR/EIS. September 2000.

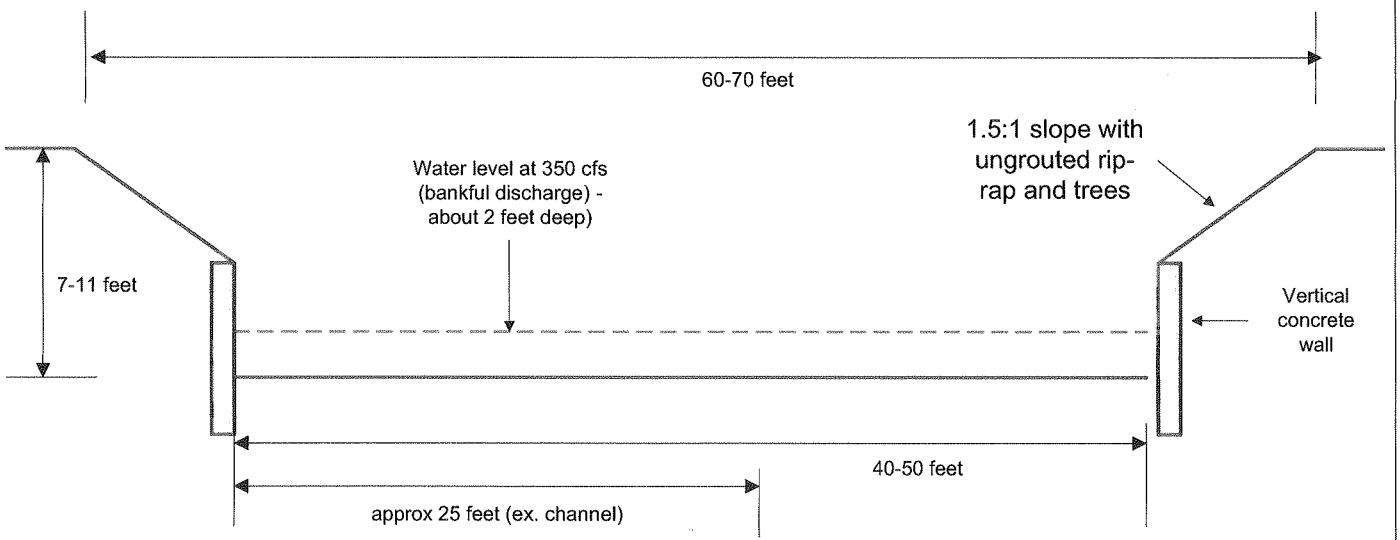
Corps of Engineers, 2000. Revised Biological Assessment - Steelhead. Lower Mission Creek Flood Control Project (June 2000).

National Marine Fisheries Service, 2000. Biological Opinion for the Lower Mission Creek Project. Lower Mission Creek Flood Control Project (August 2000).

Rosgen, D.L., 2003. The cross vane, w-weir, and j-hook structures. Their description, design, and application for stream stabilization and river restoration.

APPENDIX A

Channel Configuration Immediately after Construction Before Any Channel Enhancements



Channel Configuration Immediately after Construction with Original Proposed Channel Enhancements

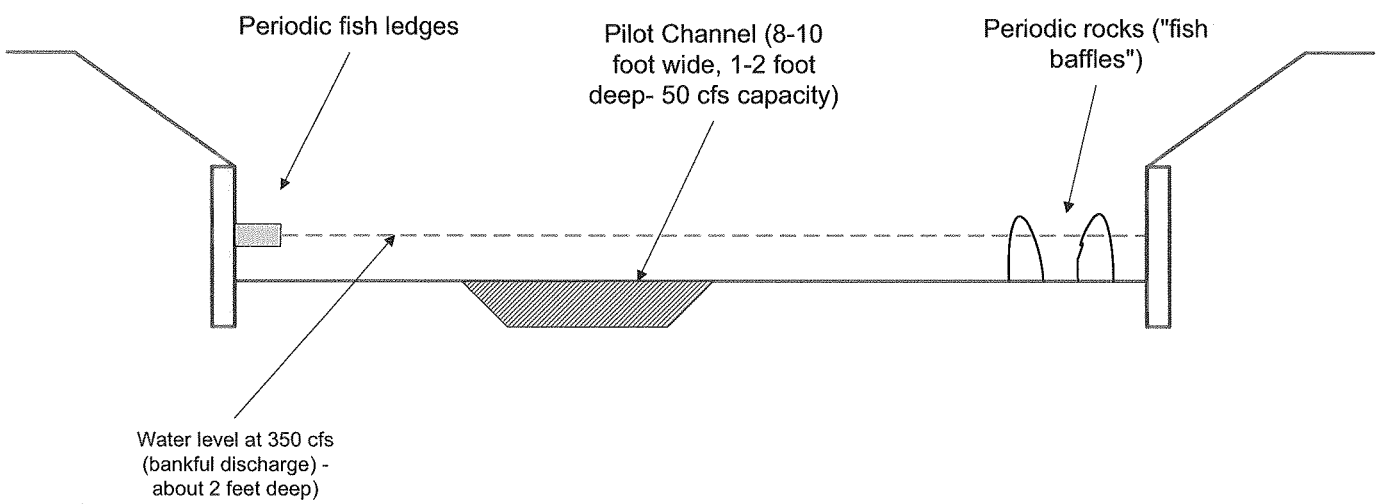


Figure 1. Channel Cross Section for the Lower Mission Creek Project - Original Project

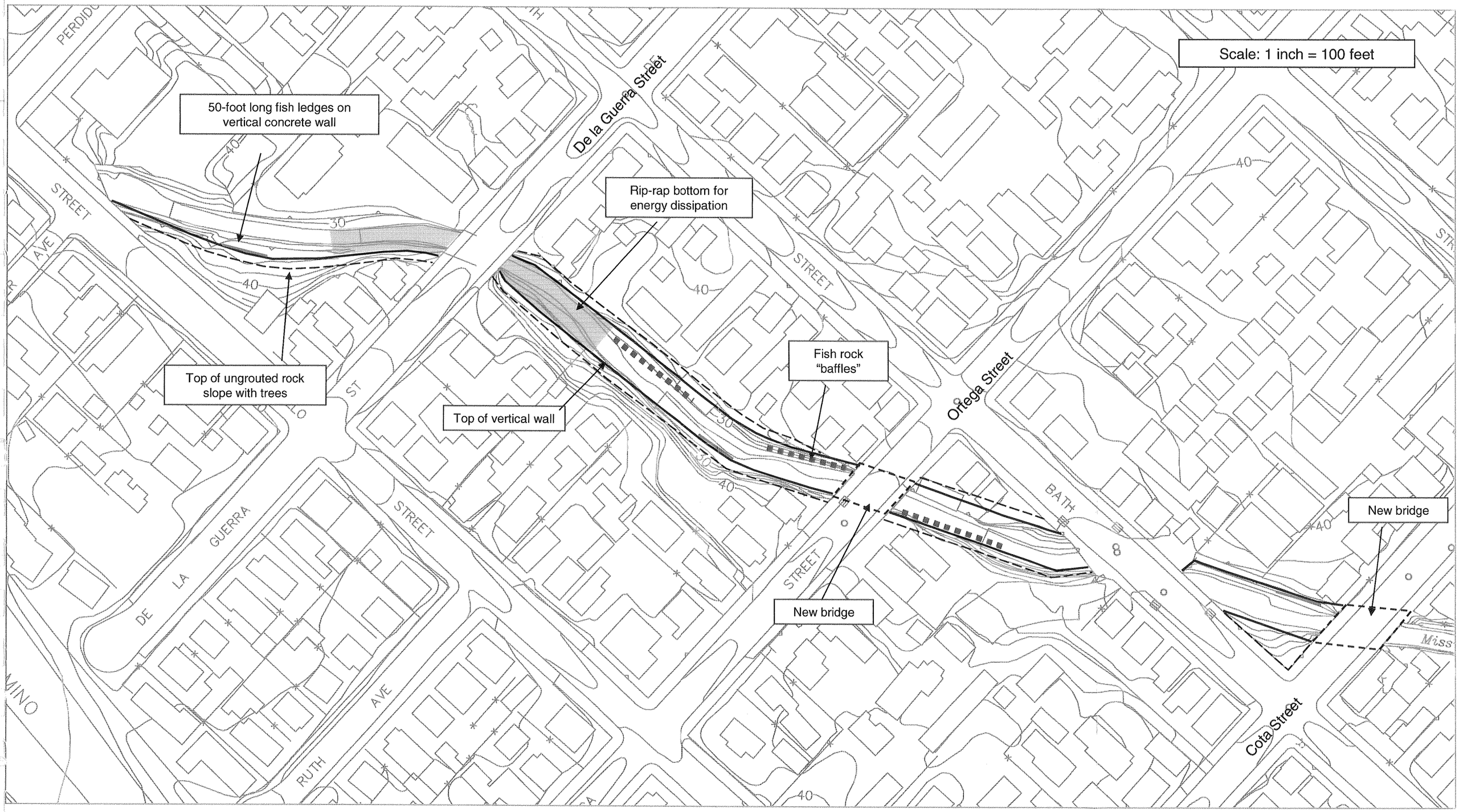


Figure 2a. Overview of New Channel Upstream of Highway 101

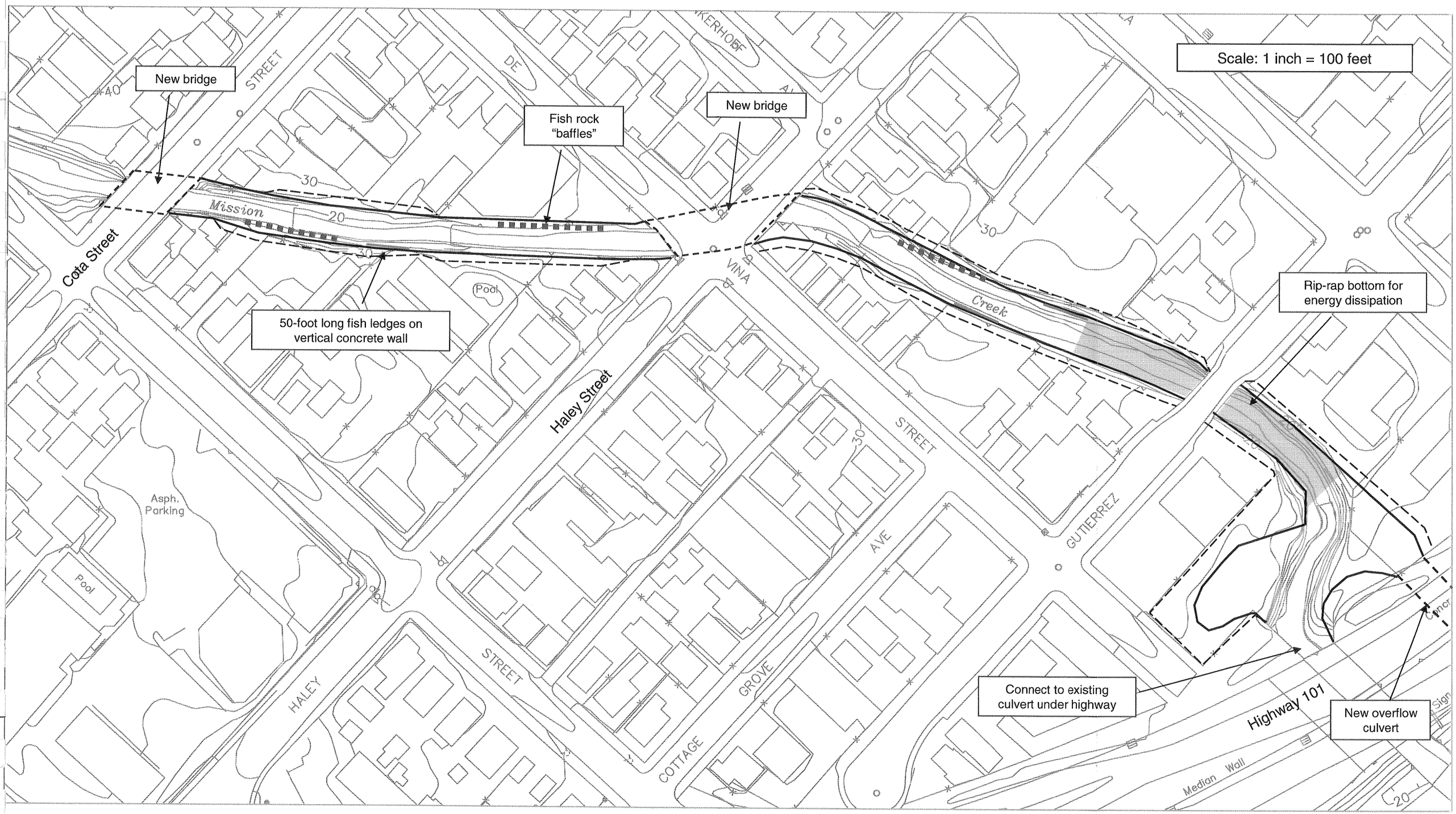


Figure 2b. Overview of New Channel Upstream of Highway 101

Data collected in August 2002

Scale: 1 inch = 100 feet

De la Guerra Street

Ortega Street

Cota Street

1

2

3

4

5

6

Thalweg

Cobble bar with vegetation

Cobble bar without vegetation

Pool

Figure 3a. Thalweg Alignment and Pools along Lower Mission Creek

Data collected in August 2002

Scale: 1 inch = 100 feet

Cota Street

Haley Street

Rock barrier

Pool

Asph. Parking

7

8

9

10

11

12

13

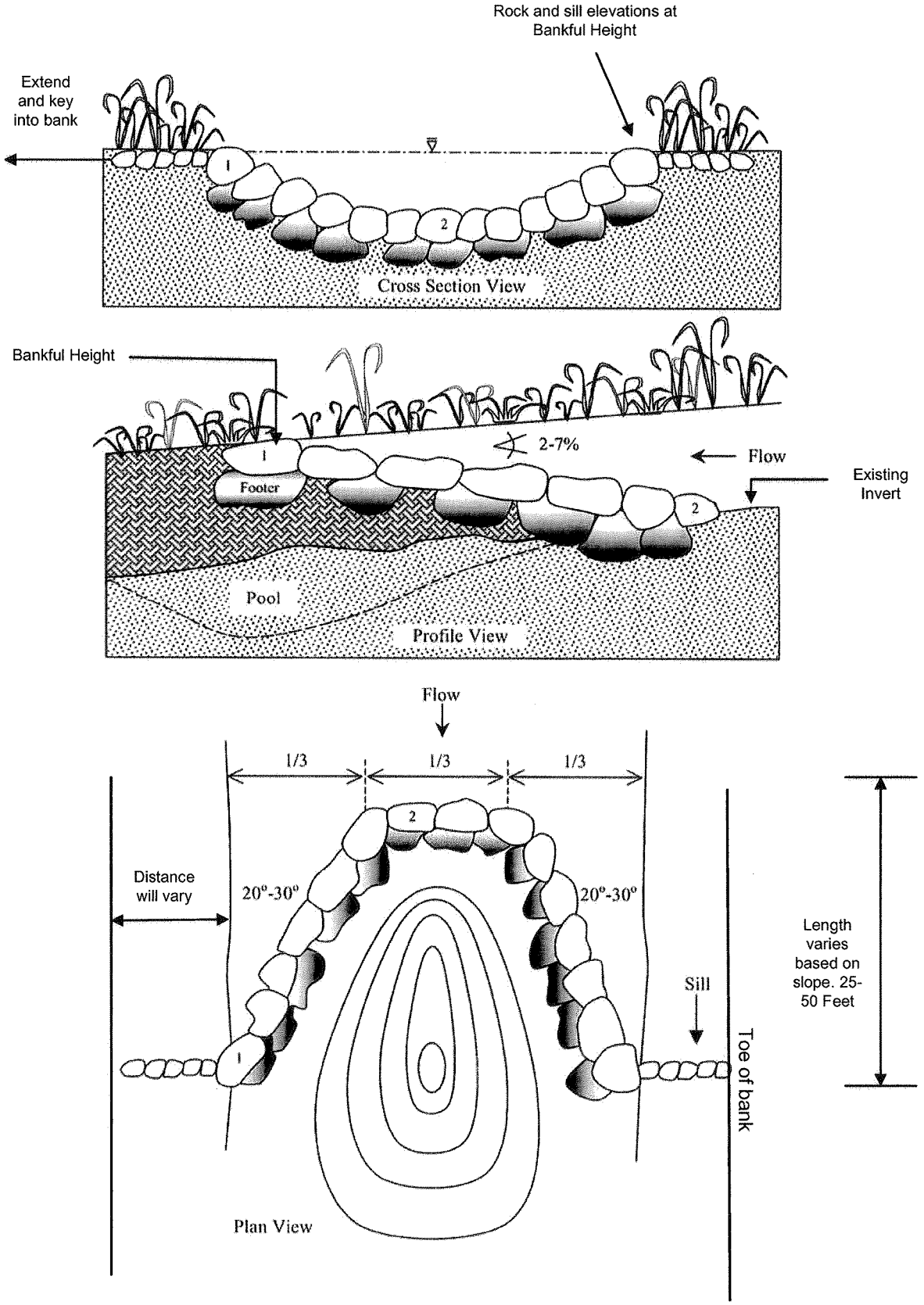
Thalweg

Cobble bar with vegetation

Cobble bar without vegetation

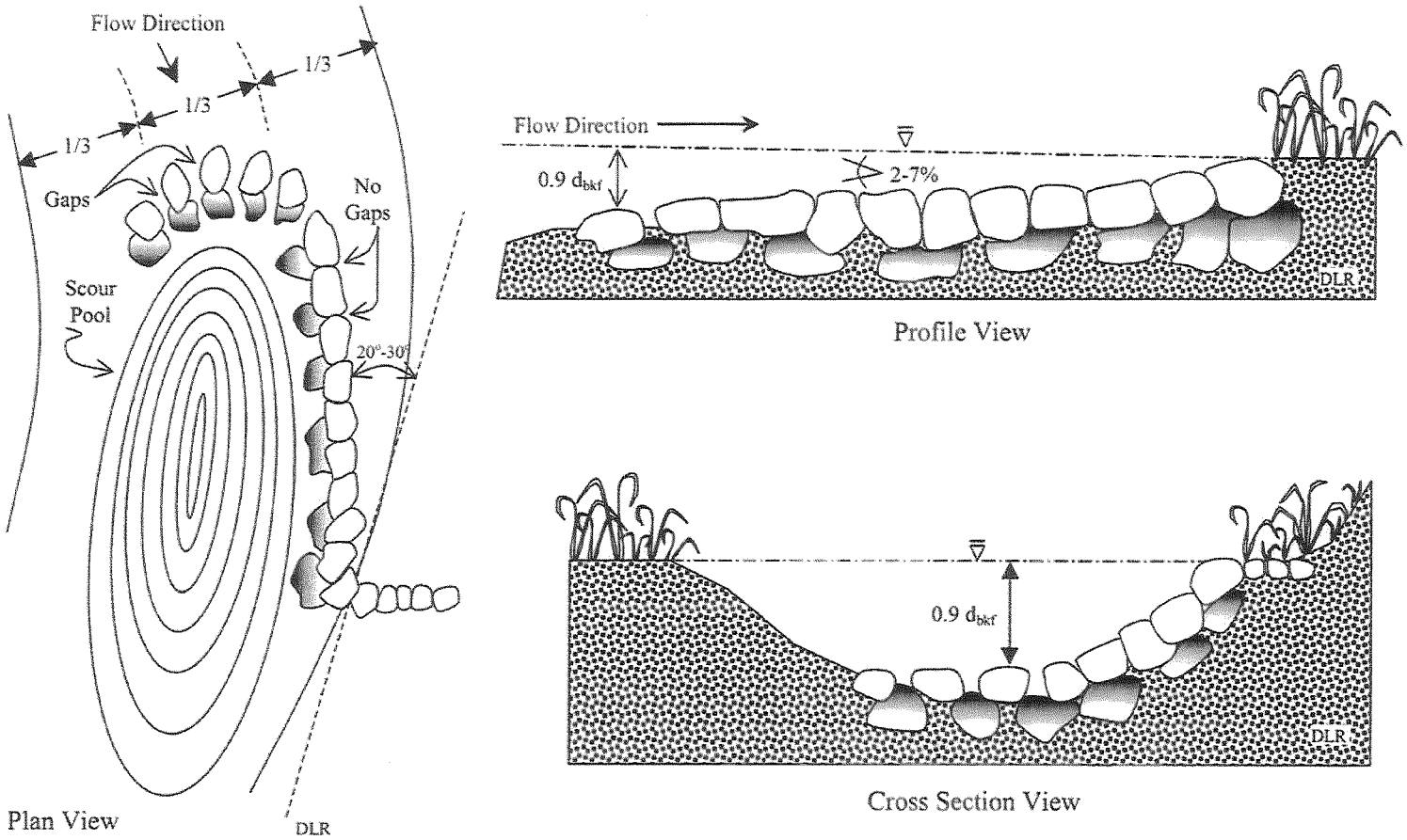
Pool

Figure 3b. Thalweg Alignment and Pools along Lower Mission Creek



From Rosgen (2003)

Figure 5. Rock Cross-Vane Weirs



From Rosgen (2003)

Figure 6. J-Hook Cross Vane Rock Weir

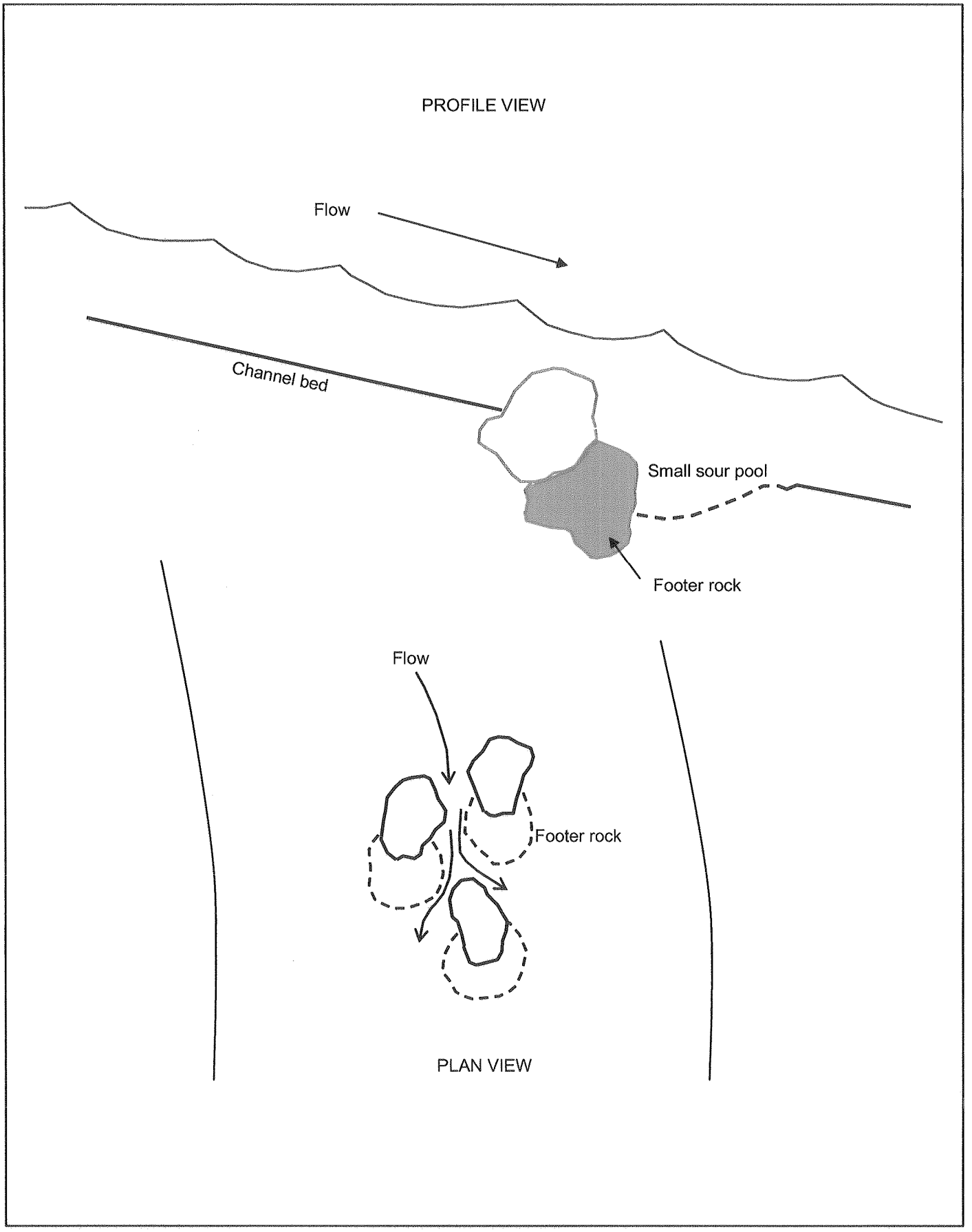
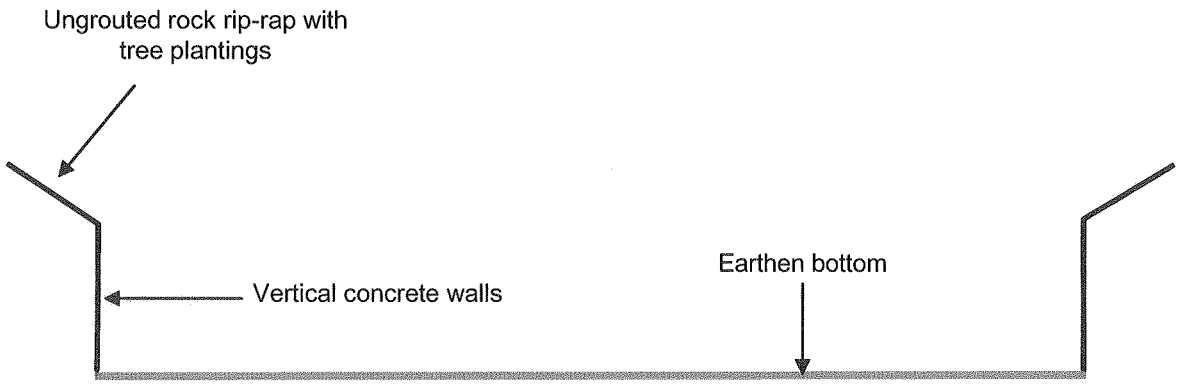
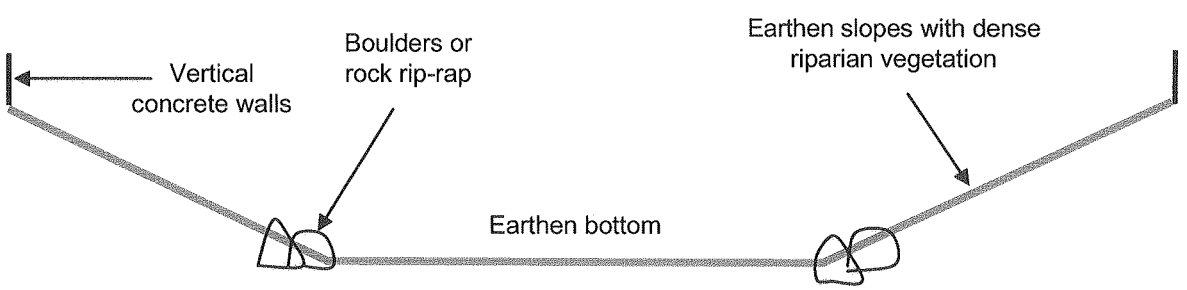


Figure 7. Recommended Rock Clusters



PROPOSED CHANNEL DESIGN

Not to scale



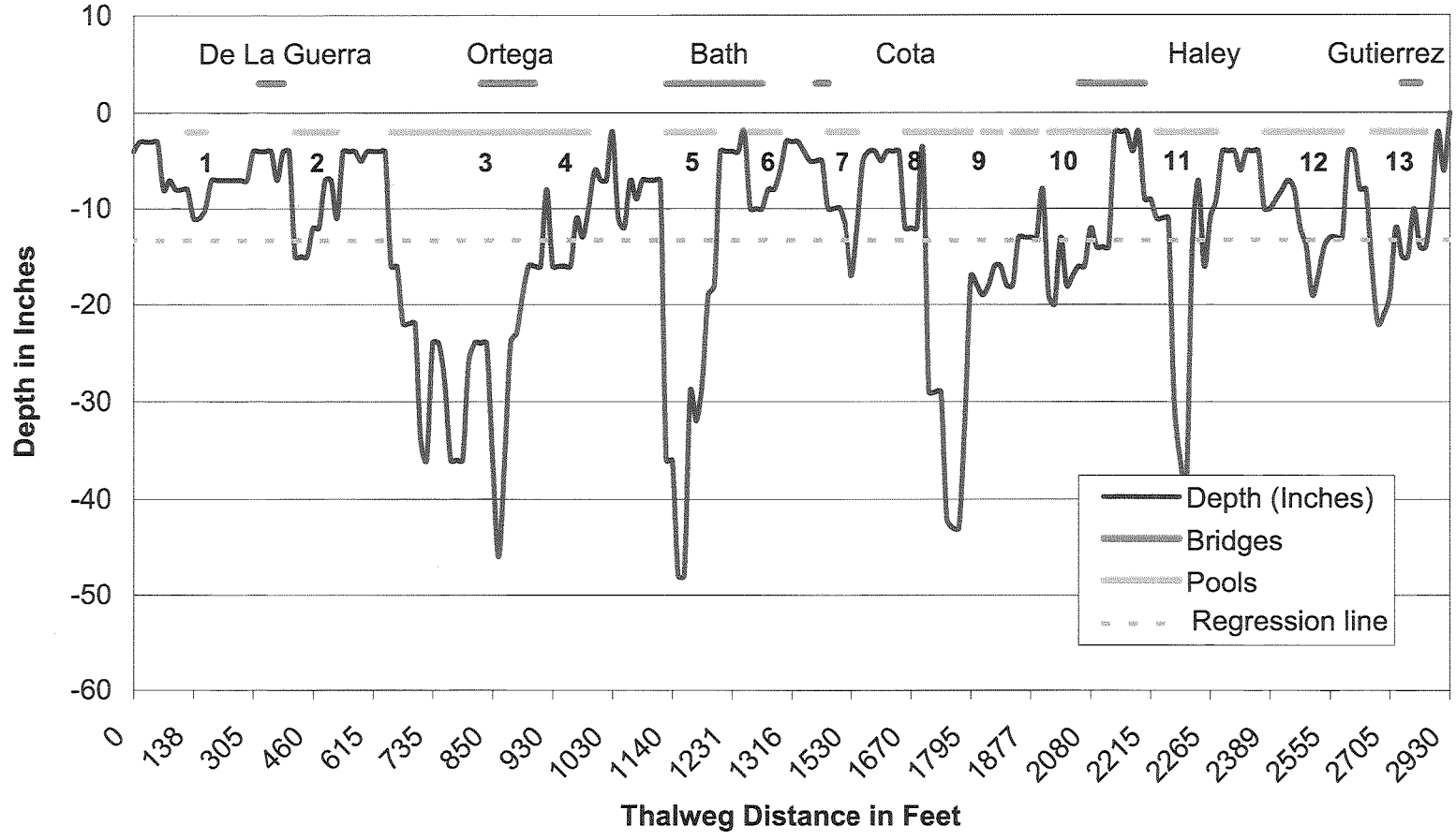
VE ALTERNATIVE CHANNEL DESIGN

Not to scale

Figure 8. VE Alternative Channel Design

APPENDIX B

Chart 1. Lower Mission Creek
Thalweg and Pool Survey - August 2002



APPENDIX C

LOWER MISSION CREEK FLOOD CONTROL PROJECT
ADAPTIVE CHANNEL MAINTENANCE PLAN

Santa Barbara County Flood Control District
June 2005

I. INTRODUCTION

The Santa Barbara County Flood Control District (District), in cooperation with the City of Santa Barbara and the Corps of Engineers, will conduct maintenance of the Lower Mission Creek Project (LMC) improvements. As described in the Final Feasibility Study Report (FFSR) and Environmental Impact Statement/Environmental Impact Report (EIS/EIR) prepared by the Corps of Engineers, the LMC improvements are proposed to increase flood protection for the residents and businesses along Mission Creek and to enhance riparian habitat. The LMC improvements extend from Canon Perdido Street to Cabrillo Boulevard in the City of Santa Barbara.

The purpose of this Adaptive Channel Maintenance Plan (Plan) is to establish criteria to be followed by the District when conducting maintenance of the channel along the project reach in order to reduce environmental impacts of channel maintenance while maintaining the design capacity of the LMC improvements. The plan identifies methods to maintain the channel and protect the fish habitat enhancements installed as part of the project, such as rock weirs, pools, and low flow channels. The adaptive maintenance plan also defines an approach to use in adapting the planned maintenance to changes in the channel conditions that will occur over time due to natural fluvial processes, flood events, and changed environmental requirements.

Maintenance of the following LMC improvements are addressed in this Plan:

1. Earthen channel bottom
2. Vertical channel walls
3. Box culvert (Highway 101)
4. Channel banks above the vertical walls
5. Interior drainage
6. Habitat expansion zones

In addition, the Plan includes a description of channel inspection and the reporting associated channel maintenance activities.

The channel maintenance described in this Plan will supplement the channel maintenance and environmental protection practices in the District's County-wide routine channel maintenance program, adopted in 2001. The environmental mitigation measures developed for the program will be applied, as appropriate, to the LMC channel maintenance. These measures are included as an attachment to the Plan. All of these measures apply except for Measure B-1, habitat compensatory mitigation. This measure would not apply because habitat impacts of the project from construction and ongoing maintenance are mitigated through the planned riparian landscaping on the banks of the widened creek.

The LMC maintenance will be conducted under the provisions of the District's current permits for channel maintenance from the California Department of Fish and Game, Corps of Engineers, and Regional Water Quality Control Board. In addition, the work will be performed in compliance

with endangered species protection measures specified by the US Fish and Wildlife Service and NOAA Fisheries for the District's routine maintenance program.

The Plan was first described in the Corps of Engineers' FFSR and EIS/EIR. Operations and maintenance are discussed in the FFSR on pages 129 through 134. The EIS/EIR addresses operation and maintenance on pages 3-46 through 3-55. Additional text references are noted throughout this document. This Plan represents a refinement and elaboration of the maintenance activities described in the FFSR and EIS/EIR. It specifically incorporates the design recommendations in the Channel Design Recommendations report (URS, 2005) prepared by the District, City of Santa Barbara, and Corps of Engineers.

2. DEFINITIONS

The Plan makes reference to several terms from the Corps of Engineers' FFSR and EIS/EIR, and from the Channel Design Recommendations report. These terms are used throughout this document and are intended to have the same meaning as that used by the Corps of Engineers. Definitions are provided below.

- Low flow channel: The channel maintained by natural fluvial processes that has a recognizable bank and bed and conveys the summer and fall flows (typically less than 25 cfs). The invert of the channel is the thalweg. The size, geometry, and alignment of the channel will vary seasonally and annually.

- Pilot channel: An artificial low flow channel created at the initiation of the project. It has since been replaced with the term "low flow channel."

- Bankful channel: The channel formed by natural fluvial processes associated with the bankful discharge (estimated to be about 350 cfs at a 1.5 year return interval). The "bankful channel" associated with this discharge will have a width of 33 feet and depth of 2 feet,

- Thalweg: The flow line in the channel; the lowest elevation in the channel.

3. EARTHEN CHANNEL MAINTENANCE (FFSR PAGE 130, EIS/EIR PAGES 24-1 TO 24-3)

The channel bottom will be earthen from stations 10+37 to 22+00 and stations 31+00 to 61+36. The extent of channel maintenance to be conducted will be established by regular inspections as described in Section 9. The objective of the channel maintenance is to remove sediment deposition and/or dense vegetation which reduce channel capacity by 15 percent or more, and to remove dense vegetation which could create a flow obstruction at bridges or in other downstream areas, or which could capture sediment and cause a local sediment buildup that could affect flows.

The District will conduct the maintenance activities described below to restore the design capacity in the LMC reaches. Channel maintenance will be accomplished through the use of both hand crews and mechanical equipment, as described below. These channel maintenance will not occur downstream of Yanonali Street Bridge, as this portion of Lower Mission Creek is a year-round estuary with impounded water, and obstructive vegetation does not typically develop under these conditions.

Brushing (EIS/EIR page 7-19, 10-63)

As described in Section 9, the District will inspect vegetation conditions in the channel each spring. If obstructive vegetation such as willows, cottonwoods, and sycamores colonize the streambed to the extent that it reduces the capacity of the channel by more than 15 percent, brushing will be required. Vegetation that is more than three feet in height as observed in the spring will be removed across approximately half of the channel. Efforts will be made to align the clearing with any established low-flow channels. An application of herbicide may be applied to the cut vegetation to inhibit regeneration. The half of the channel width where vegetation is left in place will be cleared during the following year if it is not removed by high flows the following winter. Herbaceous vegetation known to trap sediment such as cattails and rushes will also be cleared along half the channel one year at a time. Low growing herbaceous vegetation such as watercress will be left in place. If necessary, all vegetation will be removed if inspections indicate more than 15% reduction in capacity as a result of sedimentation.

In many locations, obstructive vegetation will be removed by hand brushing, using a crew of four with loppers and chainsaws. Branches of trees and shrubs that overhang into the creek will be hand cut to a height of approximately six feet from the channel bottom. If necessary, mechanical brushing would be used in certain areas with dense woody growth. This would involve a brush hog tractor or a large brush mower attached to an excavator.

Brushed native vegetation (e.g., willows) will be either cut up into small pieces and left on the channel bottom, or will be chipped in place or bundled and removed from the creek channel with a winch truck. Dense clumps of non-native vegetation such as giant reed, ironweed, german ivy, and fennel will be removed during routine brushing.

Significant impacts on water quality and aquatic species, including southern steelhead, due to hand or mechanical brushing would be avoided by pre-construction biological surveys, avoidance measures, seasonal restrictions on work, and construction monitoring (see attached standard mitigation measures).

Spraying (EIS/EIR page 10-63)

The District will apply herbicides to control vegetation under the following circumstances when the application of herbicides would be more efficient than hand brushing. Some areas that have been hand brushed may also be sprayed to inhibit the regeneration of the obstructive vegetation. Herbicides will also be used for eradication of non-native species during channel maintenance. In general, herbicide application can reduce the frequency of more disruptive brushing or mechanized desilting.

The herbicide AquaMaster™ will be used, and applied using backpack sprayers to ensure the minimum amount of herbicide is used to achieve the vegetation control. The District will observe the herbicide best management practices described in the attached mitigation measures when applying herbicides along Lower Mission Creek in order to avoid impacts to water quality and aquatic species, including southern steelhead.

Shaping/Desilting (EIS/EIR page 3-48, 3-49, 7-18, 10-40, 10-42)

Desilting will be necessary in channel reaches where sedimentation has significantly reduced the cross-section of the creek (i.e., more than 15 percent), and there is a need to remove the sediment from the channel bottom. Desilting will be typically accomplished with a dozer or

loader working in the bottom of the channel, pushing the accumulated sediment to an area where the material can be loaded directly into trucks driving on the channel bottom or to an area where a crane can access the material which is then loaded into trucks and hauled to a suitable disposal site. It is possible that lesser amounts of sediment will be temporarily placed on the banks where the District has an easement.

After a section has been desilted, a pilot channel will be re-created through that section per the design guidance in the Channel Design Recommendations report (URS, 2005). If a pool was affected by the de-silting, a replacement pool will also be re-created. The channel will be reshaped with a dozer working on the channel bottom. The dozer will create a 10-15 foot wide pilot channel with material windrowed along the sides to a height of approximately two feet.

All rock weirs and rock clusters in the channel bottom, installed per the Channel Design Recommendations report (URS, 2005), will be avoided during channel desilting and shaping.

Significant impacts on water quality and aquatic species, including southern steelhead, due to desilting and channel shaping would be avoided by pre-construction biological surveys, avoidance measures, seasonal restrictions on work, and construction monitoring (see attached standard mitigation measures).

4. CHANNEL WALL MAINTENANCE (FFSR PAGE 130 TO 131, EIS/EIR PAGES 3-49, 10-64, 13-6, 13-11, 24-5, 24-8)

Concrete surfaces in the channel include variable height concrete walls along most of the project reach, at approaches to bridges, and in the cut stone channel between Yanonali and Montecito streets. The District will Inspect these wall per Section 9, looking for cracking, chipping or breaking of the concrete to an extent which might affect the stability of the wall or its watertightness. Maintenance will consist of the following activities:

1. Eroded concrete will be repaired when reinforcing steel is exposed or erosion approaches two inches in depth. Normally, eroded concrete will be repaired by sandblasting the eroded area and matching the decorative treatment with the appropriate material. Evidence of settlement, uplift, scour or failure of concrete structures will be given special attention during inspections.

2. Any material present on the top of the vertical walls that could deteriorate the wall will be removed.

3. The District will remove any unauthorized backfill placed on the ungrouted rock rip-rap slope or the vertical walls from adjacent property.

4. Any protective fencing placed on the vertical wall or on the top of the ungrouted rock rip-rap slope will be repaired or replaced as required. Gates will be kept in good working order, and padlocks or other means will be maintained for proper security measures.

5. Weep holes will be cleaned on a regular basis. Accumulated debris will be removed from the front of any weep holes.

6. Woody debris and large trash items piled against bridge piers and splitter walls will be removed.

7. Staff gages will be painted on the channel walls in strategic locations. The staff gages will be re-painted if they become difficult to read.

Significant impacts on water quality and aquatic species, including southern steelhead, due to channel wall maintenance would be avoided by pre-construction biological surveys, avoidance measures, seasonal restrictions on work, and construction monitoring (see attached standard mitigation measures).

5. BOX CULVERT MAINTENANCE (EIS/EIR PAGES 3-23 TO 3-24, 13-11)

A box culvert to bypass high flows around the Mission Creek oxbow will be constructed under Highway101 (station 25+09 to 30+40). The culvert will be approximately 35 feet wide with a divider wall down the center. A weir will be constructed at the upstream end of the culvert (station 31+00). The weir will direct lower flows into the constructed wetlands and the historic alignment. Higher flows will go over the weir and into the culvert. The culvert will be inspected and maintained as follows:

1. Maintenance will occur if there is cracking, chipping or breaking of the concrete to an extent which might affect the stability of the culvert or its watertightness.

2. Eroded concrete will be repaired when reinforcing steel is exposed or erosion approaches 2 inches in depth. Normally, eroded concrete will be repaired by sandblasting the eroded area and filling with Portland Cement mortar. Evidence of settlement, uplift, scour or failure of concrete structures will be given special attention.

3. Any material that may deteriorate the culvert will be removed.

4. Weep holes will be cleaned on a regular basis. Accumulated debris will be removed from the front of any weep holes.

5. Sediment deposited within the culvert will be removed. Sediment removal will be conducted by pushing the accumulated sediment to the inlet and/or outlet where the material can be removed with a crane or excavator.

Significant impacts on water quality and aquatic species, including southern steelhead, due to culvert repair would be avoided by pre-construction biological surveys, avoidance measures, seasonal restrictions on work, and construction monitoring (see attached standard mitigation measures).

6. CHANNEL BANKS ABOVE VERTICAL WALLS (FFSR 132, EIS/EIR PAGES 3-20 – 3-23, 10-48, 13-6, 13-11, 24-5)

The channel banks above the vertical concrete walls will be constructed of ungrouted rip-rap on 1.5:1 slopes with six inches of fill over the rip-rap. Planting pockets will be included for various trees and shrubs to provide habitat and ultimately develop a canopy which will shade the channel bottom. The ungrouted rock around the trees will be seeded with native plants. The District will plant, weed, and irrigate these areas.

The District will monitor the growth rates of the trees and shrubs for 3-5 years. If the plants do not meet growth rates described in the FFSR and EIS/EIR, the District will take remedial action will to improve growing conditions such as replanting or increased irrigation. Trees and shrubs

that do not survive will be replaced as soon as possible with native plants collected within the Mission Creek watershed.

The rip-rap will be periodically inspected. Areas of the ungrouted rock rip rap slope encompassing more that 250 square feet that are severely damaged by flooding or rainfall will be replaced.

The layer of fill over the rip-rap will be maintained to encourage understory growth. Periodical soil augmentation on the banks may be necessary by using deposited streambed sediment or imported soil. The District will organize and coordinate periodic trash removal efforts for the banks using local residents and volunteer groups.

7. HABITAT EXPANSION ZONE MAINTENANCE (FFSR PAGE 133, EIS/EIR PAGES 3-51, 10-51 TO 10-52, 10-81, 13-8, 24-5 TO 24-8)

Habitat Expansion Zones will be created in the vicinity of stations 16+00, 19+00, 38+50, 51+50, and 59+00. Parcels ranging in size from 0.03 to 0.52 acres will be planted with native vegetation. The Habitat Expansion Zones will provide riparian habitat along the creek and also provide recreational areas for local residents. The District will plant, weed, and irrigate these areas.

The District will monitor the growth rates of the trees and shrubs for 3-5 years. If the plants do not meet growth rates described in the FFSR and EIS/EIR, the District will take remedial action will to improve growing conditions such as replanting or increased irrigation. Trees and shrubs that do not survive will be replaced as soon as possible with native plants collected within the Mission Creek watershed.

The District will organize and coordinate periodic trash removal efforts using local residents and volunteer groups.

8. INTERIOR DRAINAGE (FFSR PAGE 133)

Drainage structures, such as stormdrains, will be installed through the concrete channel walls and channel banks at strategic locations to pass interior drainage into the channel. The drainage structure outlets will be maintained to preserve their function. Although these facilities are typically either private or City owned, the District will maintain the outlets open so that they can operate.

9. INSPECTIONS (FFSR PAGE 134)

District staff, in addition to representatives from regulatory agencies, the Corps of Engineers, and representatives from local public interest groups, will conduct periodic inspections of the project reach to ensure the LMC improvements are being maintained properly. The inspections will determine the condition of the various components of the project and disclose any areas that require repair, replacement, or maintenance. Inspections will occur in the spring after the rainy season; in the fall immediately prior to the rainy season; and, after major storms.

The spring inspections (typically in April) will be conducted in conjunction with the District's Annual Maintenance Plan inspections. Any maintenance needs identified in the spring inspections for the channel bottom and banks will be described in the District's Annual Maintenance Plan. Maintenance identified in the Annual Maintenance Plan is typically

conducted between July and December. Problems identified with the concrete channel or interior drainage structures will be repaired as soon as possible unless the repair will result in impacts to the earthen channel or banks. If impacts to the earthen channel or banks are anticipated, repair of the concrete channel or interior drainage will be postponed until the late summer or early fall.

Representative cross-sections within each city block will be monitored annually in the spring to determine sediment removal and/or vegetation or debris clearing requirements. Each cross-section will be monitored as follows:

- The District will survey representative cross-sections and compare to previous cross-sections as well as the as-built cross-sections. The District will determine the net area of sediment deposition from the as-built condition. If there is more than a 15% reduction in channel capacity due to sedimentation, channel desilting will be required.

- The District will make observations of the height and density of vegetation within each city block. If obstructive vegetation such as willows, cottonwoods, and sycamores colonize the streambed to the extent that it reduces the capacity of the channel by more than 15%, brushing will be required.

In an effort to better determine the reduction in channel capacity associated with vegetation, the District will make observations of the water surface elevation during peak flows within each city block in the project reach. These observations will then be compared to recorded gauged flows. A comparison of the stage of the creek within the project reach during peak flows to the gauged flows will be made to better determine roughness coeficients for channel vegetation. Thresholds for vegetation clearing as described in this Plan may be modified as a result of this comparison.

Fall inspections will be conducted immediately prior to the rainy season. Fall inspections will focus on the conditions of the concrete channel and interior drainage structure outfalls. Any necessary repairs will be completed as soon as possible.

All channel improvements will be inspected immediately after high flows. Any damage to the channel will be repaired as soon as possible if it is early in the rainy season and additional high flows are anticipated. If high flows occur later in the rainy season, damage to the channel may be repaired after flows have receded and conditions are more conducive to channel maintenance and repair.

Based on the results of the various inspections and project monitoring, performance standards will be developed to better determine conditions under which maintenance needs to be conducted. Performance standards for conveyance, maintenance, habitat functions and values, and aesthetics will be established. Future maintenance will consider pre-determined performance standards for these issues prior to development of annual maintenance plans.

10. REPORTS

Three annual reports will be prepared by the District in order to document the condition of the channel and to conduct appropriate maintenance and repairs. Channel bed and bank maintenance will be included in the District's Annual Maintenance Plan. Concrete channel and interior drainage repair and maintenance will be documented in a separate annual LMC maintenance report. Maintenance of channel bank vegetation and the Habitat Expansion Zone

vegetation will be documented in an Annual Revegetation Monitoring Report. All of these reports will be distributed to the Corps of Engineers, City of Santa Barbara, and regulatory agencies responsible for permitting the project and corresponding maintenance.

Based on the information provided in the reports, this Plan, and the Project Operations and Maintenance Manual will be modified every five years. Maintenance techniques and thresholds for triggering maintenance may be modified as appropriate.

11. RESPONDING TO FLOODS

When severe floods occur in Santa Barbara County, appropriate actions must be taken to ensure adequate channel capacity in the project reach. Sedimentation and storm debris deposition are the most likely consequences of severe flooding. Debris plugs and excessive sedimentation will be removed as soon as possible after flows begin to recede. Heavy equipment such as excavators and loader will access the creek at the established access ramps or if necessary, as close as possible to the areas where debris and sediment are to be removed. Sediment and debris will typically be cast up onto the banks where additional equipment can load it into trucks to be removed. Channel capacity will be restored to the maximum extent feasible as soon as possible.

In anticipation of high flows associated with a significant fire in the watershed, channel capacity will be restored to the as-built condition prior to the rainy season. All sediment and obstructive vegetation will be removed prior to the rainy season. This will ensure maximum conveyance when high flows are expected.

12. CONCLUSION

The District anticipates that the Corps of Engineers will incorporate this Adaptive Channel Maintenance Plan into an "Operations and Maintenance Manual" to be prepared by the Corps of Engineers during preparation of final plans for the Project.

ATTACHMENT

MITIGATION MEASURES
SANTA BARBARA COUNTY FLOOD CONTROL DISTRICT
UPDATED ROUTINE MAINTENANCE PROGRAM
OCTOBER 2001

BIOLOGICAL RESOURCES

B-1 - Compensatory Habitat Mitigation. The District shall provide compensatory habitat mitigation for the removal of riparian and wetland habitat associated with brushing, herbicide spraying, channel shaping, bank stabilization by placing fill or grading banks, pilot channel construction, bank protection installation, access ramp construction, and channel desilting. The mitigation shall be required for all vegetated habitat, with the exception of areas dominated by aggressive, noxious non-native weeds (e.g., giant reed). The restoration treatment shall occur either on-site (i.e., along suitable portions of the drainage and its tributaries where the project is located) or off-site (Los Carneros Mitigation Bank) in accordance with the updated restoration plan described in the updated Program EIR, using a 1:1 acreage replacement ratio. A 2:1 ratio shall be used for impacts due to new grade stabilizers and non-vegetated bank protection, as described in the updated Program EIR. Prior to the use of the Los Carneros Mitigation Bank, the District shall consult with other organizations with expertise in habitat restoration (e.g., Wetlands Recovery Project) to determine if they have any knowledge of any on-site opportunities. Mitigation for specific affected areas shall only occur once during the next ten years of the maintenance program. That is, once habitat mitigation has been achieved for a portion of a drainage, no further mitigation is required for future maintenance of that reach or site over the next ten years regardless of the type of maintenance activity, provided the previous habitat mitigation has been successfully implemented, and the District continues to minimize habitat impacts to the extent feasible. After ten years, the habitat mitigation requirement shall begin again, regardless of previous habitat mitigation. Native trees with a diameter at breast height of 6 inches or more that are removed shall be replaced at a 10:1 ratio at the restoration site, independent of the replacement of habitat based on acreage. To the extent feasible, habitat restoration opportunities shall be sought on the tops of banks and landward of the creek that could provide a bio-filtering benefit for overland stormwater runoff. In addition, the District will seek opportunities to use regionally rare plants in the restoration plans, as feasible.

B-2 – Minimize Vegetation Removal from Channel Bottom. The District shall minimize vegetation removal from the channel bottom to the least amount necessary to achieve the specific maintenance objectives for the reach (i.e., removing obstructive vegetation or silt-trapping vegetation). Brushing and herbicide application for vegetation control on the channel bottom shall be conducted in a non-continuous, mosaic-like manner, to the extent feasible, allowing small patches of in-channel native vegetation to persist

B-3 - Construction Monitoring During Maintenance Activities. The District Biologist shall monitor maintenance activities daily to ensure that the appropriate methods and limits are used. Results of the monitoring shall be documented in the annual post-maintenance report. These activities include brushing, herbicide application, channel shaping, desilting, bank stabilization by placing fill or grading banks, bank protection construction or repair, grade stabilizer construction or repair, pilot channel construction, and access ramp construction.

B-4 - Restore Temporarily Disturbed Areas. The District shall restore channel banks containing riparian or wetland vegetation that are temporarily disturbed by maintenance or construction activities associated with the following: channel shaping, placement of bank protection, ramp construction, and repair or

construction of bank protection and grade stabilizers. Restoration objectives, methods, plant species, maintenance, and monitoring shall follow the guidelines in the updated restoration plan described in the Program EIR. The restoration of channel bed habitats shall only occur if it would not conflict with the maintenance needs in the affected reach.

B-5 - Pre-Construction Biological Surveys and Avoidance Measures. A District biologist shall inspect all maintenance areas in creeks and basins during the annual spring field assessments (April and May) to determine if any sensitive plants, fish, or wildlife species are present, or habitats for these species are present. If the species are present, the District shall modify maintenance activities to avoid removal or substantial disturbance of the key habitat areas or features. Avoidance and impact minimization measures shall be described in the Annual Plan for each maintenance project. If a rare plant could be affected, the District shall relocate the plant by cultivation or seeding methods to a suitable nearby site. If a sensitive fish or wildlife species will be present at a maintenance site during the work period, the District shall schedule the work to avoid the species, if possible. If avoidance is not feasible, the District shall attempt to relocate the species or population with approval from the California Department of Fish and Game, US Fish and Wildlife Service or National Marine Fisheries Service, as appropriate. This measure applies to all currently known sensitive species that occur in maintained drainages and basins, as well as species that are determined to be sensitive in the future. Endangered species experts with handling permits shall be consulted during relocation efforts to provide additional assurances that relocation is effective. Such consultation shall include assistance in field efforts, as warranted.

B-6 - Construction Monitoring for Sensitive Species. The District Biologist shall monitor, on a daily basis, earth and vegetation disturbing maintenance activities located at and adjacent to locations where sensitive species are known to occur. The need for monitoring and the areas to be monitored shall be determined during the annual field assessment in the spring. The objective of the monitoring is to ensure that key habitat features or species locations are avoided.

B-7 – Post Maintenance Channel Bed Treatment. The District shall roughen the channel bed after channel desilting maintenance to create microtopography that will encourage re-establishment of aquatic habitats over time. Pools and riffles shall be recreated in the work area if they were removed during maintenance, to the extent feasible. Modifications of the creek bed shall be consistent with geomorphological considerations identified through mitigation measure H-1.

HYDRAULIC ISSUES

H-1 - Maintenance Need Analysis. The District shall evaluate relevant hydraulic factors when determining the need, type, and extent of channel maintenance for non-exempt watercourses where natural geomorphic processes are largely intact. Key factors that shall be included in the evaluation include: (1) hydraulic benefits of maintaining the bankful channel (if present) dimensions, natural sinuosity, and natural channel bed roughness; and (2) potential adverse hydraulic effects of excessive brushing, channel shaping, equipment activity in the channel, and bank hardening. Hydraulic principles of creating and maintaining channel stability and sediment transport equilibrium shall be applied, if applicable. The analyses and determinations relevant to this issue shall be documented in the Annual Plan. Clear maintenance objectives with attainable benefits for the protection of life, property, and habitat shall be established for each project and presented in the Annual Plan. A primary objective of this measure is to minimize maintenance activities to the extent feasible, consistent with District's program objectives.

H-2 - Extent of Desilting. The depth of channel desilting shall not cause bank undercutting or channel headcutting. The District shall make a field determination of the maximum depth of desilting based on channel capacity objectives, an evaluation of channel invert elevation and slope through the project reach,

and a consideration of the maximum allowable bank length and slope that would cause bank instability. To the extent feasible, banks and bank vegetation shall not be disturbed or reconstructed during desilting to avoid destabilizing the banks.

H-3 - Post Desilting Restoration. After desilting, the District shall restore the channel geometry at the desilting site to a more natural state, as feasible, based on the channel shape, dimension, and slope upstream and downstream of the project site. The channel geometry shall be designed to enhance post-maintenance sediment transport through the desilted reach. If banks are disturbed during desilting, they should be set at a slope that matches existing undisturbed banks and stabilized, to the extent feasible and taking into account available right of way.

H-4 - Pilot Channel Construction. If it is necessary to construct a pilot channel or substantially modify an existing low flow channel, the District shall attempt to maintain the low flow channel length, width, slope, substrate, and sinuosity that are characteristic of the project reach, as determined by field observations of undisturbed low flow channels upstream and downstream of the project reach.

H-5- Bank Protection Methods. The construction of bank protection shall be limited to situations where bank stabilization is necessary because the banks are vulnerable to continued erosion which could cause a threat to critical public infrastructure, valuable habitat, or otherwise in the public interest and it has been determined that natural slope settling would not achieve the necessary stability. The District shall evaluate different types of bank protection methods, then select one that is most suitable based on the following order of decreasing preference: (1) vegetation stabilization only; (2) bio-technical methods in which vegetation is incorporated with natural type structural components such as woody branches, natural rock, logs, natural fibers and geotextiles, and biodegradable temporary geotextiles; (3) ungrouted rip rap with vegetation; (4) pipe and wire revetment while retaining vegetation; (5) grouted rip rap; and (6) concrete sackwalls, gabion walls, soil cement, and gunite. Only native plants common to the region shall be used in all bank protection projects. Hard bank protection such as grouted and ungrouted rip-rap, pipe and wire revetment, gunite, concrete sackwalls, gabion walls, and soil cement shall only be used if the District has determined that the above methods will not achieve the desired results, are not cost effective, are logistically or technically infeasible, and/or would create greater incidental environmental impacts. Incorporation of plant material into bank protection, and maintenance and monitoring of such plantings, shall follow the guidelines in the updated Routine Maintenance Program Restoration Plan. The installation of new bank protection shall not adversely affect the stability of nearby banks. Bank protection projects that exceed 150 linear feet at any one single location would be considered a separate project, not included in the routine maintenance program.

H-6 – Removal of Giant Reed from Banks. If the District will remove a stand of mature giant reed from the bank for habitat restoration purposes, the following measures shall be implemented to ensure that the bank will remain stable after treatment. To the extent feasible, the least invasive method of giant reed removal shall be used, and the removal of native vegetation from the banks shall be minimized. The District shall stabilize the banks after giant reed removal using biotechnical methods that include native plants. This measure shall also apply if similarly large stands of other non-native plants are removed from banks.

H-7 – New or Repaired Grade Stabilizers. Prior to installing a new grade stabilizer to control channel bed degradation, the District shall conduct the hydraulic analysis described in H-1. In addition, the District shall first consider stabilizer designs that use native ungrouted rock. The new structure shall not create a passage impediment for fish. This measure also applies to the repair or reconstruction of existing stabilizers. Detailed plans for new and repaired grade stabilizers shall be presented in Annual Plans, including a consideration of alternative designs and justification for the selected design.

H-8 – Access Ramps. The distance between access ramps shall be determined by balancing the impacts of driving equipment on the channel bed versus creating extra access points. Access ramps shall be placed in areas with minimum potential for erosion. Access ways shall be sited, constructed, and maintained in a manner that minimizes disturbance to native vegetation, wildlife, and aquatic organisms. The width of all new ramps shall be minimized to the extent feasible. Unneeded access ramps shall be removed and restored to a natural condition. For ramps that will be used infrequently (e.g., every three years or more), the District shall seed or plant the ramp after each use with native species, compatible with adjacent vegetation and resistant to occasional vehicle use, to prevent infestations of noxious weeds. Permanent and frequently used ramps shall be stabilized with vegetation, as feasible, and designed to minimize unauthorized vehicle access.

WATER QUALITY

W-1 - Reduce Sedimentation. The District shall minimize the amount of surface disturbance and vegetation removal to the extent feasible during all maintenance activities in order to reduce the area of disturbed soils that could be eroded during winter runoff. No stockpiles or dewatering operations shall be established in the channel bed or basin bottom. All fill shall be compacted to reduce erosion. All disturbed banks and terraces above the low flow channel shall be seeded with appropriate riparian grasses and herbs and/or planted with willows, mulefat, or other woody plant species. The objectives of the seeding and/or planting are to stabilize these areas and reduce erosion. The selection of species to be used and the density of seeding or planting shall balance the need for maintaining channel capacity while meeting these objectives. If work must occur in a wetted channel that has continuous flow downstream of the work site, the District shall either temporarily divert streamflow around the work site, or provide temporary sediment containment downstream of the site. In addition, the District shall check silt fencing, diversions, and settling ponds twice a day.

W-2 – Responsible Herbicide Application. To the extent feasible, the primary herbicide application each year shall occur during the months of August through November, when stream flows are minimal. In some instances, a follow-up application will be made in the spring to reduce the frequency of maintenance. Herbicides shall be applied by hand-held sprayers rather than from truck mounted sprayers to the extent feasible. The dilution and application of herbicides shall be conducted in strict accordance with all label recommendations, including all restrictions related to public health, worker safety, and the protection of aquatic organisms. Herbicides shall not be applied when winds at the application site exceed 5 miles per hour, within 12 hours of a forecasted rain event, or when vegetation surfaces are covered with water from recent rainfall or dew. Herbicides shall be applied carefully to plant surfaces in minimal effective amounts, minimizing drift to non-target plants and overspray onto the ground or to open water. Signs shall be placed to warn the public if herbicides are applied within 50 feet of any public recreation location, such as a trail, picnic spot, or other site of regular human activity. The signs shall remain for 48 hours after the application of the herbicide. The District shall also notify residences and businesses located adjacent to drainages to be treated with herbicides. Notification shall occur by mail within 7 days of the planned maintenance work.

W-3 - Maintain Biofiltering by Reseeding Channel Bottom Areas. To the extent feasible and consistent with the maintenance objectives, the District shall avoid removal of emergent herbaceous wetland vegetation on the channel bottom that is rooted in or adjacent to the low flow channel or a pond. This same type of vegetation shall be protected, to the extent feasible, during the removal of taller obstructive woody vegetation on the channel bottom. In addition, the District shall re-seed desilted channel areas that formerly contained emergent vegetation, provided that suitable native seeds from plants that provide biofiltration are available and that the new vegetation will not significantly affect channel conveyance or significantly increase the need for future maintenance. Seeding shall occur after the major winter runoff has occurred and stream flows have receded to prevent loss of seeds.

W-4 - Prevent Accidental Spills and Leaks. The mixing and dispensing of herbicides and equipment fueling or maintenance shall not occur within a channel or a basin. Spill containment and clean-up procedures for herbicides and vehicle fuels and oils shall be developed by the District. All field personnel shall be trained and all field vehicles shall be equipped with appropriate materials.

W-5 - Water Quality Monitoring During Herbicide Application for Large Projects. The District shall monitor concentrations of glyphosate downstream of large maintenance projects that involve herbicide application. Large projects are defined as projects that involve continuous or near-continuous herbicide application along reaches of more than 250 feet where there is flowing water along the entire reach. Water samples shall be collected from the flowing water at the following locations: Site A - above the work site, representing the ambient water quality conditions; Site B - immediately downstream of the work site; and Site C - approximately 200 feet downstream of the work site. Samples shall be collected using the following protocol: (1) Prior to herbicide application – samples at Site A, and Sites B and C if there is a storm drain outlet or similar feature within the maintenance reach that may contribute off-site flow and possible herbicides to the water samples; (2) 24 and 96 hours after herbicide application – samples at Sites A, B, and C. If glyphosate concentrations exceed 15 mg/l in the 24-hour sample or 10 mg/l in the 96-hour sample, the District shall modify the spray program at all remaining maintenance sites to be sprayed. Modification may include reducing the rate of herbicide application and/or using hand removal techniques. The District shall continue to apply herbicides only if the glyphosate concentrations are consistently below the 24 and 96-hour thresholds. If the 24 and/or 96-hour thresholds are exceeded five times during the maintenance year, regardless of location, the District shall cease application of herbicides in aquatic situations until the program can be modified to reduce concentrations to the acceptable range.

W-6 – Public Education Regarding Creek Water Quality. The District shall prepare information brochures for residents located along maintained drainages that explain: (1) how the District applies herbicides in a responsible manner, and provides guidelines on how landowners can use herbicides for residential and commercial uses in a similarly responsible manner to minimize water quality impacts to the creeks; and (2) how landowners can reduce pollution to the creek from their activities by employing best management practices for landscape fertilization; disposal of household paints, hazardous materials and petroleum products; management of trash and landscaping debris; and handling of pet wastes. The brochure shall be prepared in coordination with Project Clean Water and mailed to affected areas on a 3-year rotating basis. It shall include the Project Clean Water phone numbers for technical assistance and for reporting illegal dumping. The brochure shall also include information on how landowners can make their land available for habitat restoration under the routine maintenance program.

W-7 – Reporting Water Quality Incidents. The District shall train its maintenance crews to identify and report incidents or materials observed in the creeks during routine maintenance work that could cause significant water quality impacts, including illegal dumping of trash, pet waste, and green waste; homeless encampments; and drain outlets with evidence of poor water quality. The staff shall contact appropriate authorities in the County or affected municipalities.

W-8 - Reduce Overall Herbicide Use. The District shall make every feasible effort to reduce the overall amount of herbicides used in the maintenance program over the next ten years through more restrictive and selective applications, greater use of manual clearing, actions to reduce in channel obstructive vegetation through shading by new canopy trees, and coordination with the the County's Integrated Pest Management Strategy to identify more environmentally friendly pesticides. The IPM Strategy was adopted by the Board of Supervisors to promote the maintenance of the County's landscapes in way that protects and enhances natural resources and public health, while providing a framework for evaluating pesticide use by County Departments in pursuit of their missions.