

March 1998

San Francisquito Creek
Coordinated Resource Management and Planning (CRMP)

Reconnaissance Investigation Report of San Francisquito Creek

EXECUTIVE SUMMARY

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Prepared by the CRMP Flood and Erosion Control Task Force

Reconnaissance Investigation Report of San Francisquito Creek

Preface

This report and its executive summary[1] were prepared by the Flood and Erosion Control Task Force and approved by the Steering Committee of the San Francisquito Creek Watershed Coordinated Resource Management and Planning (CRMP) Group. CRMP's membership includes representatives from:

- the five city and two county governments within the San Francisquito Creek watershed
- many state, federal and local government agencies, community groups, and Stanford University

CRMP manages a consensus-building process in which participants discuss watershed-related issues and develop creek management plans and strategies that address the diverse concerns of all watershed stakeholders, with the goal of maintaining an ecologically healthy creek environment.

Executive Summary

Goal of this Report

This report is a historical summary of floodplain management proposals that have been made for the San Francisquito Creek and its surrounding watershed. **It is not intended to provide a basis for selecting a flood and erosion control plan, but rather, it aims to give policy makers and the public information to begin a dialog on flood and erosion control measures. No specific plan is advocated.** As a 'reconnaissance' report, it briefly describes some previously considered alternatives, assesses their feasibility, and summarizes impacts and preliminary cost estimates for each.

Definition of the Problem

Nearly 5,000 homes, businesses, schools, and industrial sites lie within the flood plain of San Francisquito Creek. Many of these properties are within the Special Flood Hazard Area of the San Francisquito Creek, as defined by the Federal Emergency Management Agency (FEMA). Residents and businesses in this area not only risk devastating losses during floods, but they are collectively required to purchase flood insurance. In addition, they are subject to costly flood-related building requirements. Many more watershed residents are expected to be added to the Special Flood Hazard Area this year, as FEMA completes a major revision of its Flood Insurance Rate Maps (FIRMs).

Since the San Francisquito Creek overbanked in 1955, more than a half dozen floodplain management studies have been commissioned by the U.S. Army Corp of Engineers, the Santa Clara Valley Water District, and the San Mateo County Flood Control District. None of these comprehensive floodplain management proposals have gone beyond the study phase, primarily because of the complex jusidictional issues associated with the San Francisquito Creek, which flows through five cities and two counties. Instead, a few temporary flood control projects have been built, such as bank stabilization and low floodwalls.

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[1] Please note that the full "Reconnaissance" report was written before the February 3, 1998 flood, and the executive summary was written after this event.

Protection against a one-percent flood event is a generally accepted design standard for regional floodplain management projects, and this level of protection is required by FEMA in order for properties to be removed from the Special Flood Hazard Area. A one-percent flood event means that in any given year, there is a one percent chance that this magnitude of a flood will occur. A one-percent flood event is also sometimes referred to as a 100-year flood event.

According to information provided by FEMA and the Santa Clara Valley Water District, the areas of San Francisquito Creek expected to overbank during a one-percent flood event are:

- The channel between El Camino Real and Highway 101. The flow through this part of the creek is expected to exceed the current channel capacity between El Camino Real and Highway 101 of approximately 6,000 cubic feet per second (cfs). (Downstream of El Camino, flow is expected to reach 9,300 cfs during a one-percent flood, according to a 1977 study.) The Highway 101, University, Pope/Chaucer, and Middlefield bridges are additional constriction points along this reach. Even without the bridges, the channel is too small to contain a one-percent flood event. During high flow situations less severe than a one-percent event, the creek is expected to overtop its banks at various locations in Palo Alto, Menlo Park, and East Palo Alto.
- The channel downstream of Highway 101. This lower channel reach is able to safely carry only 2,900 cfs because of inadequate design capacity, tides, sedimentation within the channel, land subsidence, and erosion of berms.

An Overview of Alternatives

The floodplain management alternatives listed in the full report are organized into two geographic categories: those upstream of Highway 101 and those downstream of Highway 101. For the purposes of this executive summary, the alternatives are organized into two different categories—one-percent flood event alternatives and partial solution alternatives. Each alternative uses one of these approaches to watershed management:

1) A 'No Project' alternative
2) Storage of flow in a reservoir located in the creek's upper reaches. (Webb Ranch Flood Basin, Expand Searsville Lake)
3) Channel diversions, such as detention basins or auxiliary channels, that divert excess water out of the main channel. (Offstream Storage, Willow Road Diversion Conduit)
4) Instream improvements that enhance channel flow. (Concrete Channel Modification, Natural Channel Widening, Replace Bridges, Raise the Levees)

Possible solutions could consist of one or a combination of any of the alternatives or others not included here. New solutions may also arise from the public dialog we hope to establish. Each alternative described in the report has associated costs. Inaction in the matter of floodplain management also has related costs.

Explanation of Costs

Please note that the cost estimates have been calculated in 1996 dollars for comparison purposes. A detailed analysis that considers combinations and variations of alternatives, in addition to a detailed analysis of impacts, would be required to make sound recommendations as to the most effective plan in terms of social, economic, and environmental costs and benefits. All the alternatives meriting consideration would require extensive studies, environmental review, and public review before a solution could be selected. In the Executive Summary, the Estimated First

Costs have been expressed in ranges in order to reflect the variance inherent in these estimates. Examples of how costs might be calculated are in located in Appendix A of the full report. In the "Formal Comments" section of the report, information is also provided as an example of how these costs could change substantially with a more detailed analysis.

No Project Alternative

Under the No Project alternative, residences and businesses within the flood plain would continue to face potential hardships due to flooding, and Special Flood Hazard Area insurance would still be required. Properties adjacent to the creek would remain at risk of bank erosion and failure. Under the No Project alternative, "Estimated First Cost" is calculated as the present worth of an average "Annual Cost " over a 50-year period. "Estimated Annual Cost" includes average annual flood damages, flood emergency costs, flood insurance administration costs, and maintenance costs.

I. NO PROJECT UPSTREAM AND DOWNSTREAM OF HIGHWAY 101

Results in flooding upstream of Highway 101 on average every 18.5 years and more frequent flooding downstream of Highway 101. During one-percent floods, up to 4,850 residences would experience flooding.

- **Description:** Current practices would continue and no action would be taken to reduce the existing flood hazard.
- **Impact:** Flood insurance requirements would continue. During a one-percent flood, damages as high as $155 million would occur (in 1996 dollars). Areas downstream of El Camino Real would be subject to flooding (see attached San Francisquito Creek Flood Zone map). Emergency bank protection measures would be necessary.
- **Estimated First Cost:** Less than $100 million
- **Estimated Annual Cost:** $4.8 million upstream of Highway 101; $15,000 downstream of Highway 101 (includes maintenance costs only)

One-Percent Flood Event Alternatives

This section summarizes the five proposals in the report that adequately protect against a one-percent flood event. All Estimated First Costs are preliminary and include right-of-way acquisition, environmental reviews, geotechnical investigations, design, construction, and environmental mitigation expenses. Estimated Annual Maintenance Cost are the estimates for the yearly upkeep of each project.

I. WEBB RANCH FLOOD BASIN/HIGH DAM

Reduces instream flow to 4,000 cfs downstream of El Camino Real during a one-percent flood by creating a temporary upstream reservoir.

- **Description:** Construct a single-purpose, flow-through earth dam upstream of Highway 280. The earth dam would include a flow-through outlet large enough to allow unobstructed flow of San Francisquito Creek during most flow events. During very high flow events, the capacity of the dam's outlet would be exceeded, causing a temporary detention of flood waters behind the dam that would then be released when the high flows receded. The net downstream effect would be to reduce the magnitude of peak flows, while extending the duration of high flows.
- **Impact:** It would require the permanent easement of approximately 300 acres of land from Stanford University. It would impact instream and upland sensitive habitat and fish passage, but could include environmental enhancements upstream of the dam as a mitigation measure.
- **Estimated First Cost:** Between $100 and $250 million
- **Estimated Annual Maintenance Cost:** $100,000

II. UPSTREAM DIVERSIONS & OFFSTREAM STORAGE

Reduces instream flow to 4,000 cfs downstream of El Camino Real during a one-percent flood by diverting high flows into offstream storage.

- **Description:** Construct offstream facilities for storage of flood waters during peak events. High flows would be diverted from the natural channel into detention basins. As the high flows recede and the water in the creek channel lowers, the detention basin would drain back into the natural channel.
- **Impact:** It would require up to 1,400 acres of land that has not yet been identified. It could have significant social and environmental impacts, including riparian zone and fish passage issues.
- **Estimated First Cost:** Over $1,500 million
- **Estimated Annual Maintenance Cost:** $100,000

III. CONCRETE CHANNEL MODIFICATION

Conveys 9,400 cfs downstream of El Camino Real during a one-percent flood.

- **Description:** Deepen the channel between El Camino Real and Highway 101, and line it with concrete to improve conveyance for a one-percent flood event. It would also require the replacement of bridges at Middlefield Road and Pope/Chaucer Street.
- **Impact:** It would have significant environmental impacts requiring mitigation of more than 3 miles of instream habitat destruction, including fishery and special species habitats. It could have significant social and environmental impacts, including riparian zone and fish passage issues.
- **Costs:** This is not a feasible alternative because it would not be possible to mitigate for such extensive environmental impacts. No costs were estimated.

IV. NATURAL CHANNEL WIDENING & BRIDGE REPLACEMENT

Conveys 9,300 cfs downstream of El Camino Real during a one-percent flood.

- **Description:** Acquire sufficient creekside right-of-way to allow the creek channel to erode and seek its own stable configuration between Pope/Chaucer Street and Highway 101. Replace Middlefield Road and Pope/Chaucer Street bridges and construct levees or flood walls between Pope/Chaucer Street and Highway 101.
- **Impact:** It would require the acquisition of more than 107 creekside properties in Palo Alto and Menlo Park. This acquisition and relocation could take many years to complete and would have significant social impacts. It would have minimal environmental impact, and could provide public access to creek for recreational purposes. It would require permanent closure of sections of Woodland Avenue, and it could possibly impact local drainage systems.
- **Estimated First Cost:** Less than $100 million
- **Estimated Annual Maintenance Cost:** $100,000

V. WILLOW ROAD DIVERSION/LARGE CONDUIT

Reduces instream flow to 4,000 cfs downstream of El Camino Real during a one-percent flood by diverting high flows into a secondary conduit.

- **Description:** Divert floodwaters above 4,000 cfs from the channel upstream of Middlefield Road into an underground conduit (approx. 11- by 37-feet), which follows Willow Road, then delivers floodwater to an earth channel with levees downstream of Highway 101 to the Ravenswood Slough. The conduit would carry about 5,500 cfs during one-percent flood events.
- **Impact:** It would have major construction impacts along Willow Road. It would require acquisition of multi-unit residential structures and assisted relocation of low income residents in East Menlo Park, with significant social impacts. Environmental impacts could include fish passage issues and introduction of fresh water to the tidal slough during floods. It may impact local drainage systems.
- **Estimated First Cost:** Between $100 and $250 million
- **Estimated Annual Maintenance Cost:** $100,000

Partial Solution Alternatives

The Reconnaissance Report also presents several other floodplain management measures that will not adequately protect against a one-percent flood event, but that could be combined with other proposals to achieve this level of protection.

VI. EXPAND SEARSVILLE LAKE

Reduces instream flow to 6,600 cfs downstream of El Camino Real during a one-percent flood.

- **Description:** Replace the existing Searsville Dam with a new dam, 20 feet higher, to capture upstream flood waters during high flow events. This alternative would inundate approximately 250 acres during a one-percent flood event (about 215 acres additional land) and the new earth dam would cover about 300 feet of the riparian corridor. Searsville Lake would remain at its existing level and size most of the time.
- **Impact:** This dam would have to be combined with other solutions to fully address a one-percent flood event. A flood plain would remain downstream of Middlefield Road. The dam would inundate part of Jasper Ridge Biological Preserve during peak events, and it would require acquisition of numerous hillside properties.
- **Estimated First Cost:** Less than $100 million (For an alternative discussion on costs, see the "Formal Comments" section of the Reconnaissance Investigation Report.)
- **Estimated Annual Maintenance Cost:** $200,000

VII. REPLACE BRIDGES AT POPE/CHAUCER STREET & MIDDLEFIELD ROAD

Increases bridge flow-through, causing worse flooding further down the creek.

- **Description:** Replace bridges at Middlefield Road and Pope/Chaucer Street .
- **Impact:** This project would relocate flood-flow breakout points from Middlefield Road and Pope/Chaucer Street bridges, causing worse flooding downstream. This could create liability issues for Menlo Park, Palo Alto, and East Palo Alto. This effort would have to be combined with other solutions to fully address a one-percent flood event.
- **Estimated First Cost:** Not feasible as an individual project due to liability issues.

VIII. RAISE THE LEVEES DOWNSTREAM OF HIGHWAY 101

Conveys 9,300 cfs downstream of Highway 101 during a one-percent flood.
This is the only alternative presented in the report that would protect against a one-percent flood in this reach.

- **Description:** Raise levees on both sides of the channel by six feet to accommodate one-percent event flow. The existing levee's base width would increase.
- **Impact:** Tide-related flooding downstream of Highway 101 would continue until additional levee improvements occur along the bay. This solution would require additional right-of-way from three landowners. It would have environmental impacts associated with loss of bay habitat under widened levees, and would affect local drainage systems due to sediment accumulation.
- **Estimated First Cost:** Less than $100 million
- **Estimated Annual Maintenance Cost:** $10,000

A Postscript from CRMP

Looking beyond this Reconnaissance Report, it is worth mentioning the impacts of flooding on residents living in the San Francisquito Creek watershed. The San Francisquito Creek has overtopped its banks 11 times since 1907. The implications of these events are all too real, given the flood of February 3, 1998. This storm inflicted damage to an estimated 400 homes in Palo Alto, 10 homes in Menlo Park, 56 homes and 131 apartments in East Palo Alto, and Stanford University. In addition, there was extensive storm-related damage to roads and residential areas in the upper watershed areas of Portola Valley and Woodside.

Community collaboration is the key to preventing future disasters of this scale, and CRMP recommends that watershed policy makers work diligently to take the following steps:

- The flood control agencies of Santa Clara and San Mateo counties need to join forces and resolve watershed maintenance, funding, and administrative issues. (The San Mateo Flood Control District currently has no floodplain management budget, and much of the Santa Clara Valley Water District's primary funding source expires in the year 2000.)

- Using the information in this report, public discussions should be initiated to gain consensus on a direction for long-term flood and erosion control measures. Comprehensive studies need to be funded as an early step in this process.

- The municipalities of Palo Alto, Menlo Park, East Palo Alto, Portola Valley, Woodside, and Stanford should work with county, state, and federal agencies who have jusidiction over the creek, and assign people to expedite the timely implementation of floodplain management projects. Since collaboration among these entities is imperative, it is suggested that the CRMP process be used to facilitate the consensus-building process among San Francisquito Creek watershed stakeholders. Each city should apply for state and federal grants, such as the FEMA hazard mitigation fund, to help defray planning costs. (See page 82 of the full report for a list of funding sources.)

- Each city should establish emergency flood notification and response procedures.

By publishing this report, CRMP and its participants hope to facilitate public discussion on long-term flood and erosion control measures, while ensuring the continued vitality of the creek environment. To order the full report, "Reconnaissance Investigation Report of San Francisquito Creek," send $10 to The San Francisquito Creek Coordinated Resource Management and Planning (CRMP) Group, or download it for no charge from their web site: <http://www.pccf.org/crmp>.

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A Summary of Recent Flood Events

Date	Flow at USGS Station/Stanford	Flooding Events
December 1955 (25-year event)	5,560 cfs (cubic feet per second)	• At Middlefield, Pope/Chaucer, and Bayshore bridges • At Bayshore levees and downstream of Hwy 101 bridge, Palo Alto Airport and Golf Course flooded
April 1958	4,460 cfs	• At Bayshore levees, the PA Airport and Golf Course. The landfill flooded to 4 ft.
January 1982	5,220 cfs	• At Alpine Road, at University Ave, and downstream of Hwy 101
1995	3,320 cfs	• Near Hwy 101 due to drainage back-up
February 1998	7,100 cfs*	• Overflows in Palo Alto at Byron St, Everett Ave, Seneca Ave, Chaucer St, Palm St, Lincoln Ave, E. Bayshore, and Palo Alto Golf Course. In Menlo Park at Laurel Ave, Pope St, Emma Ln, and Oak Ct. In East Palo Alto at University Ave, upstream and downstream of Newell Rd, and West and East Bayshore.
One-Percent Flood Event (estimated)	7,860 cfs**	• Overflows expected are shown on FEMA Flood Insurance Rate Maps.

*Preliminary estimate from the USGS station at Stanford Golf Course.
**Downstream of El Camino, flow is expected to reach 9,300 cfs, according to a 1977 study.

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December 1997

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INTRODUCTION

This report presents the results of a reconnaissance level investigation of San Francisquito Creek's history, previous studies and construction, flooding and erosion problems, and maintenance concerns. Previously considered flood control alternatives are also discussed along with a schedule and cost estimate for a typical feasibility study and potential funding sources. The study area consists of the entire length of San Francisquito Creek and its watershed. The creek forms part of the boundary between Santa Clara and San Mateo Counties, is under the jurisdiction of two flood control districts (Santa Clara Valley Water District and San Mateo County Flood Control District), and flows through five cities and towns. It is slightly over 12.5 miles long extending from the base of Searsville Dam to the San Francisco Bay.

Representatives from government agencies, community groups, landowners, and the public have come together to form the Coordinated Resource Management and Planning (CRMP) group for the San Francisquito Creek watershed. The CRMP operates under the auspices of the Peninsula Conservation Center, a local non-profit organization. It consists of the CRMP group at large and six task forces, one of which is the Flood and Erosion Control (F&EC) task force. The objective of the F&EC task force is to facilitate ways to minimize damage and costs from flooding and erosion throughout the watershed while ensuring the continued vitality of the creek environment. Early on, this task force decided that a comprehensive watershed management plan and environmental impact assessment would be required to meet this objective. This reconnaissance report was written by the F&EC task force with the purpose of providing the San Francisquito Creek CRMP group with a source of information to use to pursue support for completing a larger scale study.

In this study, the alternative solutions examined consisted of updating previously considered flood protection alternatives as to their construction feasibility, impacts, and costs. In some cases, previously considered alternatives have been modified to accommodate constraints that did not exist when they were first proposed. Examination of additional alternatives and combinations thereof is beyond the scope of this reconnaissance level study. Although many more alternatives are possible, they will need to be examined as part of additional studies. In addition, this report makes no recommendations toward a preferred solution to the flooding problem. Additional comprehensive studies and the construction of a project itself will require funding. Several potential funding sources that are most appropriate for San Francisquito Creek have been identified in the report.

STUDY BACKGROUND

This section of the report discusses the San Francisquito Creek watershed, the study area, and previous studies and construction.

SAN FRANCISQUITO CREEK WATERSHED

San Francisquito Creek is located in the northernmost portion of Santa Clara County and the southernmost portion of San Mateo County (see Figure 1). It lies within the Santa Clara Valley Water District's Northwest Flood Control Zone and San Mateo County's San Francisquito Creek Flood Control Zone.

San Francisquito Creek begins at the outlet of Searsville Dam in the upper portion of the watershed. Tributary streams include West Union Creek, Corte Madera Creek, Bear Creek, and Los Trancos Creek. Downstream of the confluence with Los Trancos Creek, the creek forms the boundary between San Mateo and Santa Clara Counties.

The creek's drainage basin is approximately 45 square miles and covers an area extending from Skyline Boulevard on the ridge of the Santa Cruz Mountains to the San Francisco Bay. Bordering the creek on the south are the city of Palo Alto and Stanford University, and to the north are the cities of Menlo Park and East Palo Alto. The towns of Woodside and Portola Valley are also in the upper portion of the watershed. A general map of the watershed is shown in Figure 2.

Watershed elevations range from sea level to about 2,200 feet above sea level in the Santa Cruz Mountains. However, the creek exists in the foothills above Stanford University for only a few miles before it flattens to a gentler slope as it crosses the valley floor. The upland portion of the watershed consists of low density residential development and is characteristic of brushy woodlands. The relatively flat valley floor has been extensively developed and is typical of most urbanized areas.

STUDY AREA

The San Francisquito Creek study area extends from the San Francisco Bay near the Palo Alto Airport to Searsville Lake, in the foothills above Stanford University. The primary flood problem is downstream of El Camino Real. This stretch of San Francisquito Creek forms the boundary between East Palo Alto and Menlo Park, and Palo Alto. Likewise, it forms the boundary between San Mateo and Santa Clara Counties. The majority of residential development, as well as the majority of properties within the 1 percent flood boundary, exists along these reaches. Figure 3 shows the preliminary 1 percent flood boundary determined by studies that began in 1995 sponsored by the Federal Emergency Management Agency (FEMA). The preliminary 1 percent flood areas reflect depths up to 2 feet on the Santa Clara County side and depths up to 1 foot on the San Mateo County side. The primary study area between the Bay and El Camino Real has been subdivided into six separate reaches. These reaches are shown in Figure 4.

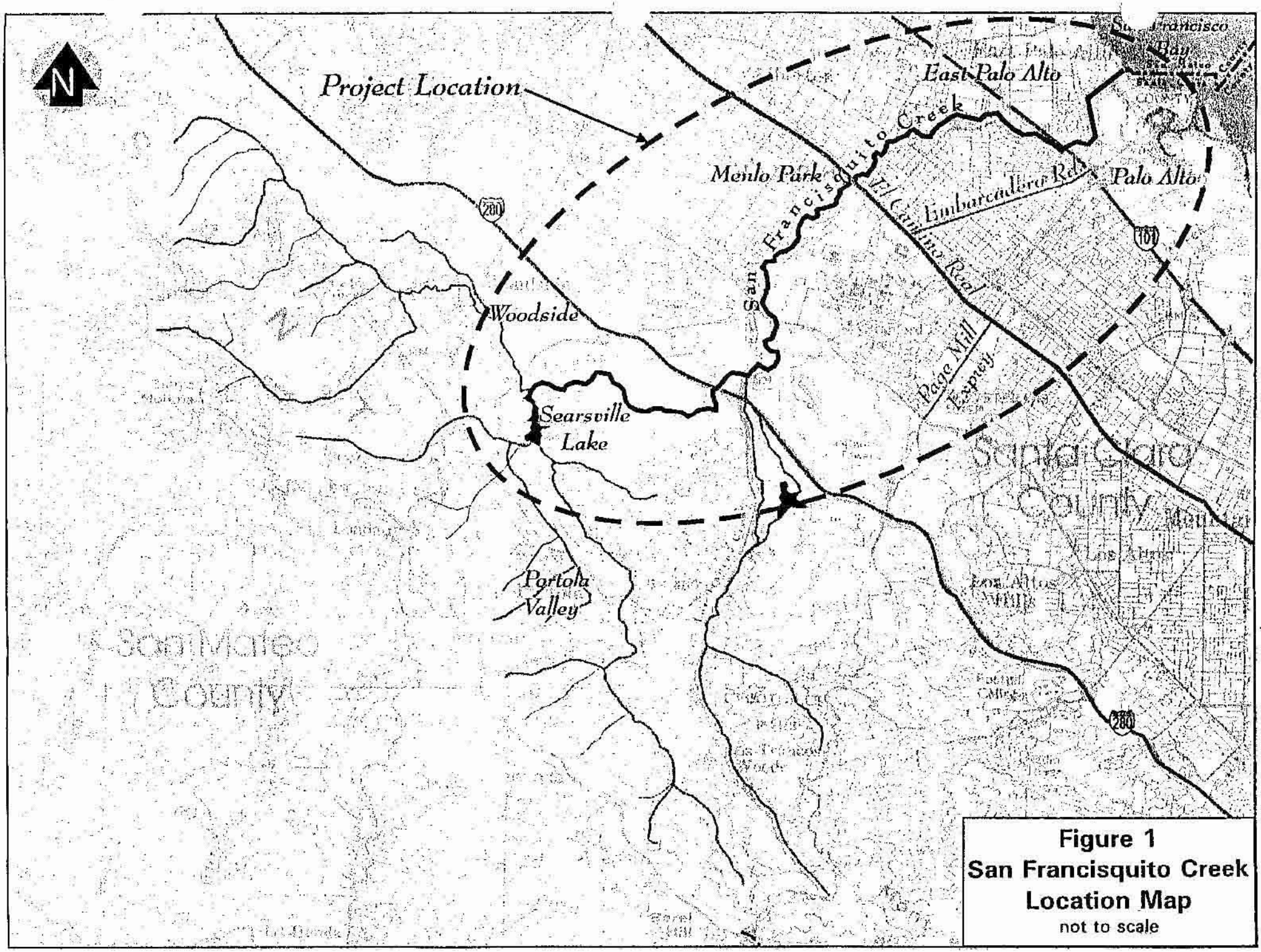
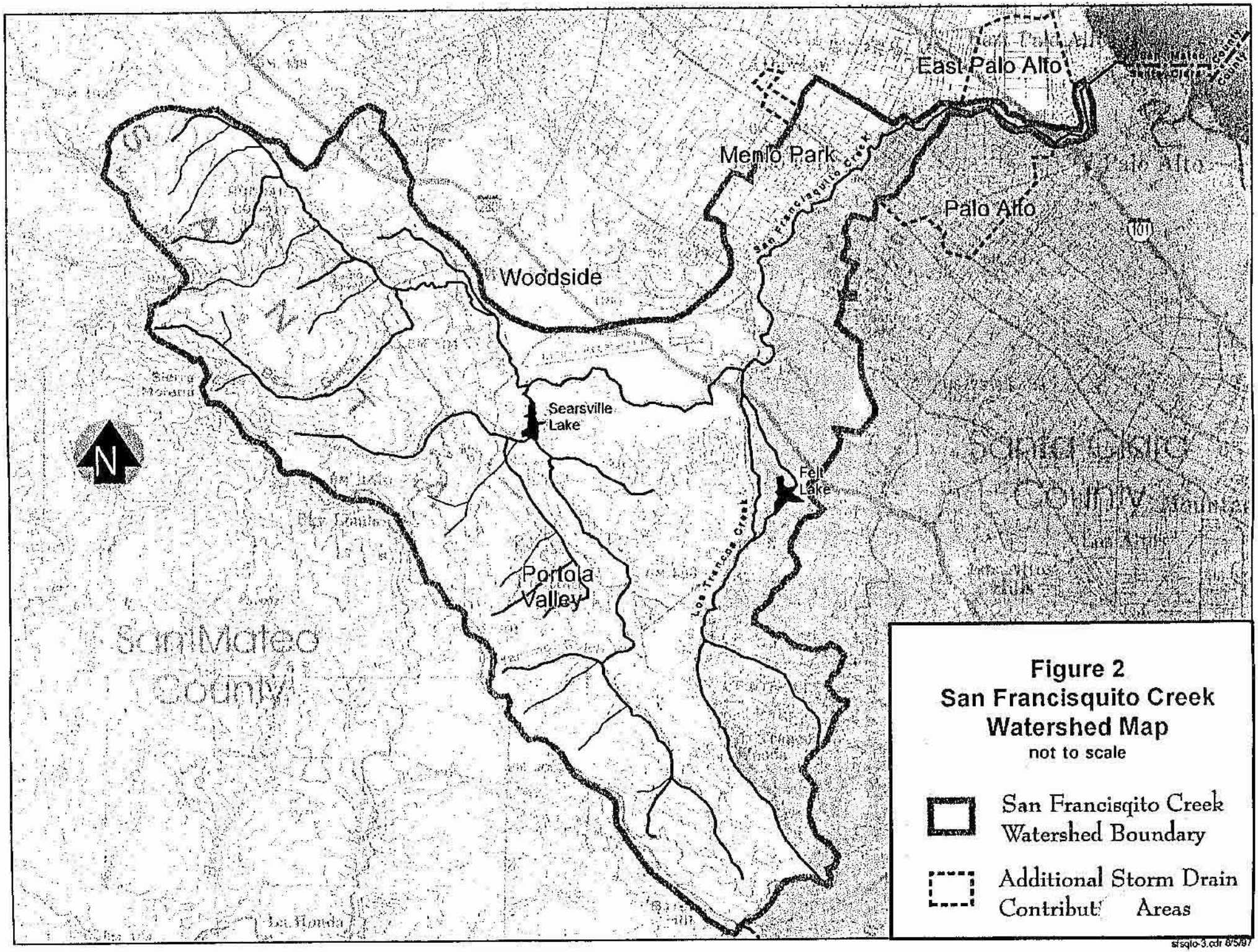


Figure 1
San Francisquito Creek Location Map
not to scale


East Palo Alto
Menlo Park
Palo Alto
San Francisquito Creek
101
Woodside
Searsville Lake
Felt Lake
Los Trancos Creek
Portola Valley
N
San Mateo County
Santa Clara County
Figure 2
San Francisquito Creek
Watershed Map
not to scale
San Francisqito Creek Watershed Boundary
Additional Storm Drain Contribut Areas
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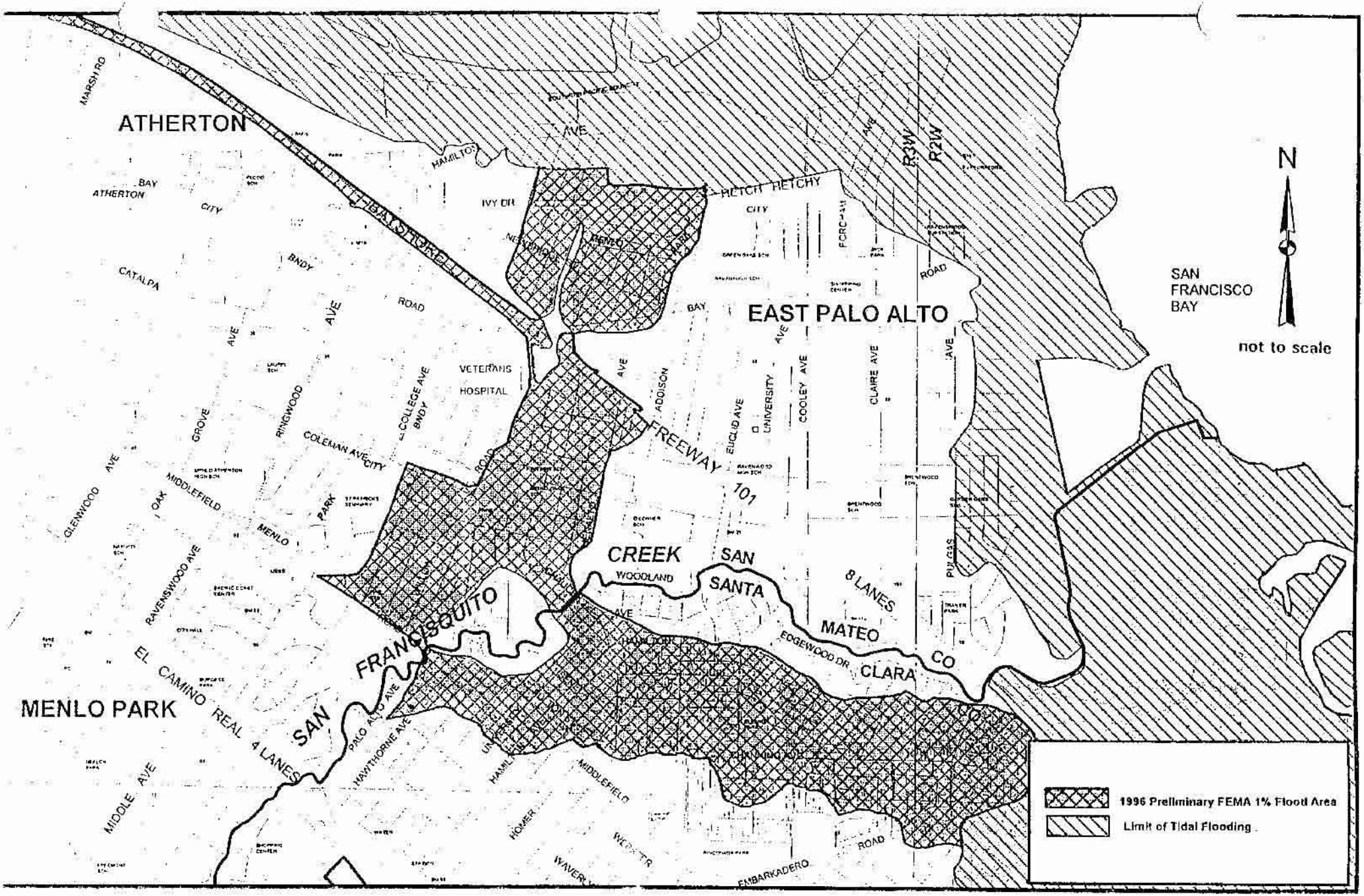


Figure 3
San Francisquito Creek
Flood Zone Map

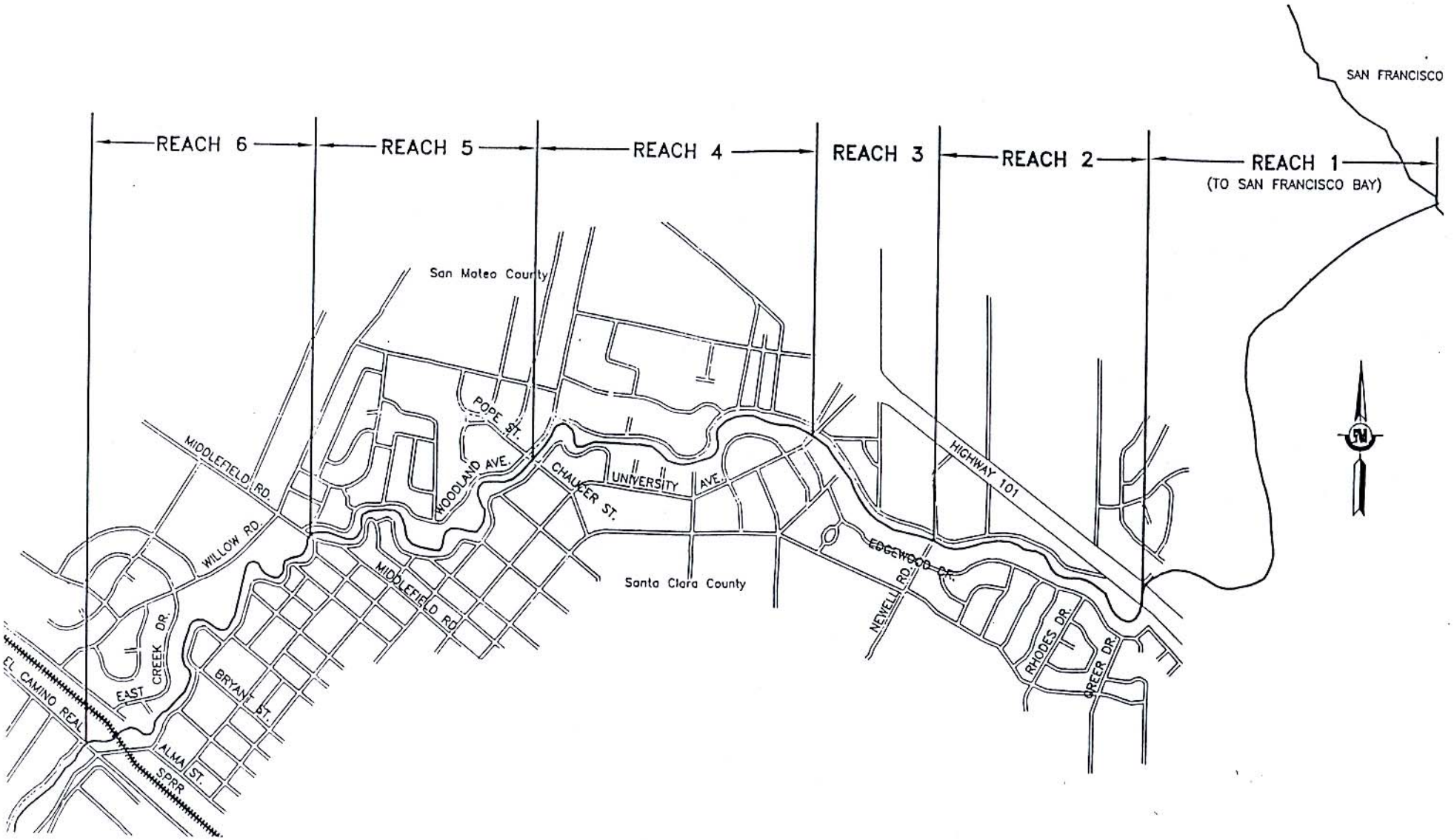


Figure 4
San Francisquito Creek
Reach Map
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PREVIOUS STUDIES

In 1958 and 1961, the U.S. Army Corps of Engineers (Corps) prepared a "Report of Survey for Flood Control and Allied Purposes, San Francisquito Creek." The Corps identified several flood control alternatives including bank protection and floodwalls, levees, concrete channelization, and a multi purpose reservoir. A dam-controlled reservoir, called the Ladera Dam alternative, was found to be economically feasible as a flood control alternative when combined with the recreation and water supply benefits of a permanent storage reservoir.

In 1964, Wilsey, Ham & Blair, under authorization from Stanford University, undertook an "Improvement Study of San Francisquito Creek." This study recommended a combination of bridge replacement (Middlefield Road and Pope/Chaucer Street) and concrete channelization of the creek between El Camino Real and Highway 101 (Reaches 2-6).

In 1968, James Vincent prepared a report entitled "Alternative Methods of Flood Control, San Francisquito Creek, California" as a dissertation for the Department of Civil Engineering at Stanford University. This report documents all previous investigations of flood control alternatives, provides an alternative hydraulic analysis, and makes recommendations for channel modifications that would increase the capacity of San Francisquito Creek.

In 1972, the Corps filed a "Survey Report on San Francisquito Creek." The Corps reexamined the Ladera Dam multi purpose reservoir, and considered a diversion channel along Willow Road. However, because minor channel conveyance improvements had been built in 1958 and 1969, the Corps concluded that benefits of further flood control work would not outweigh costs. No projects were recommended as a result of this study.

In 1979, FEMA prepared a Flood Insurance Study for Palo Alto. The study investigated the existence and severity of flood hazards in the city, in order to add Palo Alto to the National Flood Insurance Program administered by the Federal Insurance Administration. The study chronicled historic flooding and near flooding events in Palo Alto. The document delineated flood boundaries for the 100-year flood, and guidelines for floodplain management within the boundaries.

In 1995, FEMA began a restudy of the flood insurance requirements for Palo Alto as well as Menlo Park and East Palo Alto. The flood zone map and damage analysis in this report were based on preliminary maps provided in 1996 from the restudy. The preliminary FEMA maps are scheduled to be final in 1998.

PREVIOUS CONSTRUCTION

After severe flood damages occurred in 1955, and after an earthen levee broke in 1958, inundating the Palo Alto Golf Course and Airport, interim channel improvements were constructed along San Francisquito Creek. These improvements are described below.
After the 1955 flood, the Santa Clara Valley Water District (SCVWD) lined approximately 800 linear

feet of the south bank with sacked concrete upstream of Highway 101, between Highway 101 and Newell Road (Reach 2).

After the floods of 1958, the SCVWD constructed about 800 linear feet of low berm along the south bank lined with sacked concrete in 1955. The SCVWD also placed approximately 2,200 linear feet of sacked concrete along the south bank between this berm and the Newell Road bridge. In the same year, the San Mateo County Flood Control District (SMCFCD) constructed low floodwalls along Woodland Avenue in Menlo Park, upstream of Highway 101.

Also in 1958, the reach between Highway 101 and the Bay (Reach 1) was excavated, graded, and widened in a cooperative effort between the SCVWD and SMCFCD. Levees were repaired and improved to carry a design flow of 7,100 cubic feet per second (cfs) with 1.5 to 2 feet of freeboard. Based on the terms of an agreement made in September of 1958, the SCVWD prepared plans and specifications, advertised for bids, inspected construction, and advanced all necessary funds. The SMCFCD agreed to reimburse the SCVWD for half of the construction costs. In addition, each party was responsible for acquiring rights-of-way within its respective jurisdiction. The SCVWD agreed to maintain the levee on the southeasterly side of the creek, and the SMCFCD agreed to maintain the levee on the northwesterly side of the creek.

In 1969, "Interim Flood Control Measures" were implemented between Highway 101 and Middlefield Road (Reaches 2-5), in a cooperative effort between the SMCFCD and the SCVWD. The project included the installation of low berms at Middlefield Road and Pope/Chaucer Street bridges, and intermittent sacked concrete revetment and low floodwalls along both banks from approximately 1,200 feet upstream of University Avenue to Highway 101. The improvements were designed to increase the capacity of San Francisquito Creek to 6,000 cfs. It is not known if design freeboard was provided. The project was designed as an interim measure to reduce residential flooding while a permanent solution was to be studied and implemented.

These interim projects reduced the risk of damage to many residential properties and, in 1972, the Corps no longer found economic justification (i.e., benefits exceed costs) to fund a project on San Francisquito Creek to provide 1 percent level of protection.

PROBLEM DEFINITION

HISTORIC FLOODING

The largest flood on record for San Francisquito Creek occurred in December of 1955. At the United States Geological Survey (USGS) gaging station located near the Stanford golf course, the estimated flow was 5,560 cfs. This flood was approximately a 25-year event, which has a 4 percent chance of occurring in any given year. In the reaches downstream of El Camino Real (Reaches 1-6), flows would typically be several hundred cfs higher for such an event.

During the flood of 1955, the creek overtopped its banks in several locations, including the bridges at Middlefield Road, Pope/Chaucer Street, the Bayshore Freeway and two locations along the low levees upstream of the Bayshore Freeway. This flood inundated about 1,200 acres of commercial and residential property plus about 70 acres of agricultural property. Also inundated were the Palo Alto Airport and Golf Course. Damages were estimated to be nearly $2 million (1956 dollars). Figure 5 shows some of the effects of the 1955 flood.

Before this flood of record, the creek overtopped its banks six times between 1910 and 1955. However, because development in the area was sparse before the 1950's, only light damages resulted from these earlier floods.

In April of 1958, an estimated flow of 4,460 cfs measured at the USGS gaging station caused a levee failure downstream of the Bayshore Freeway with subsequent flooding of the Palo Alto Airport, City Landfill, and Golf Course to depths of up to four feet (see Figure 5). In addition, water backed up behind the Bayshore Freeway bridge, causing overbanking upstream of the highway (see Figure 5). Damages were estimated at about $300,000 (1958 dollars).

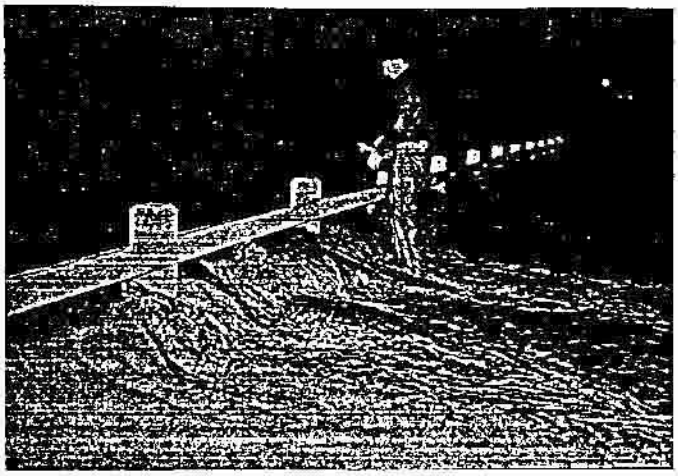
RECENT FLOODING

After the floods of 1955 and 1958, flood protection measures were implemented on the creek in the reaches upstream and downstream of the Bayshore Freeway. Since then, the creek has overtopped its banks only once, in 1982, at a flow of 5,220 cfs measured at the USGS gaging station. Flows probably were several hundred cfs greater downstream of El Camino Real. There have also been several occurrences of high water causing scour and erosion problems, in 1978, 1980, and 1982. During these events, erosion occurred along Palo Alto Avenue, especially near Waverly Street and between Fulton Street and Middlefield Road.

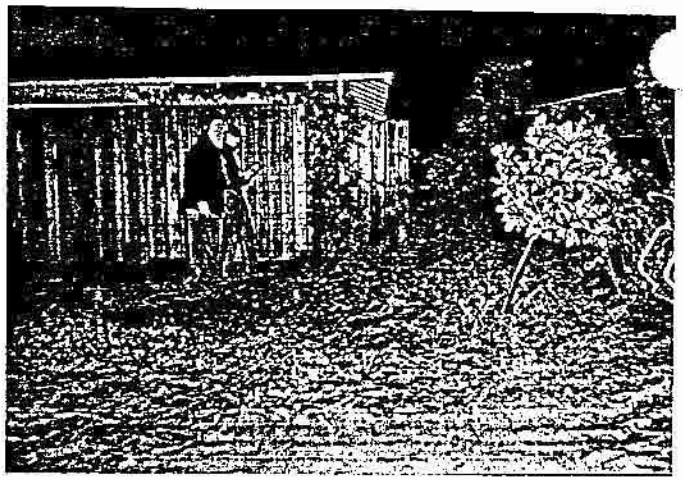
In 1982, the creek overtopped its banks near Alpine Road, at University Avenue, and downstream of Highway 101. Extensive erosion caused damage to private and public property, undermining roads and destroying fences, retaining walls, and private bridges. One home on Alpine Road near Highway 280 reported water damage. Figure 6 shows some of the effects of the 1982 high flow.

In 1995, a flow of 3,320 cfs measured at the USGS gaging station caused water to back up in the local drainage system, causing localized flooding near Highway 101.

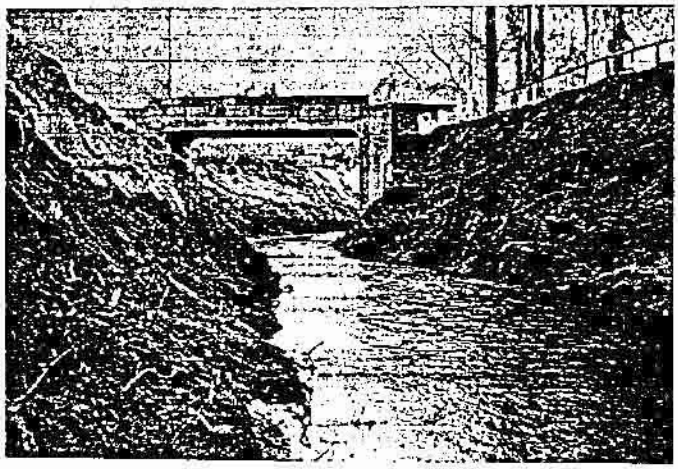
Figure 5
San Francisquito Creek
Flooding in 1955 and 1958



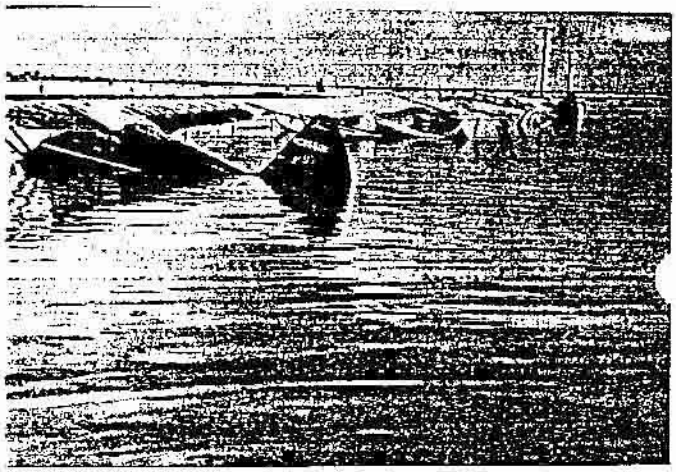
Pope/Chaucer St. Bridge, Dec. 1955
(Photo No. S2920-15)



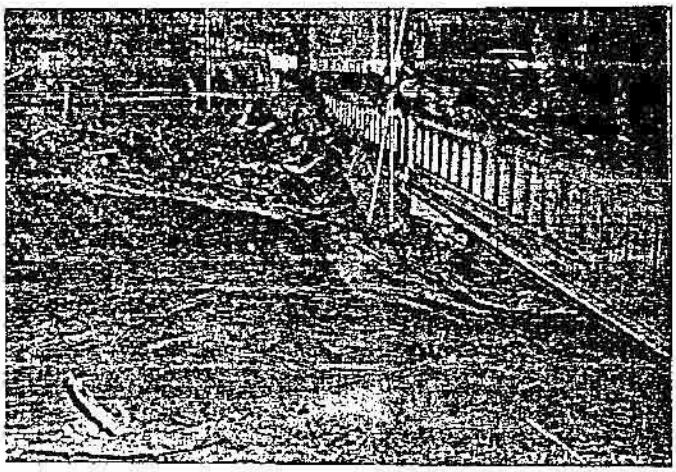
Residential area upstream of Bayshore Freeway,
Dec. 1955 (Photo No. S2920-10)



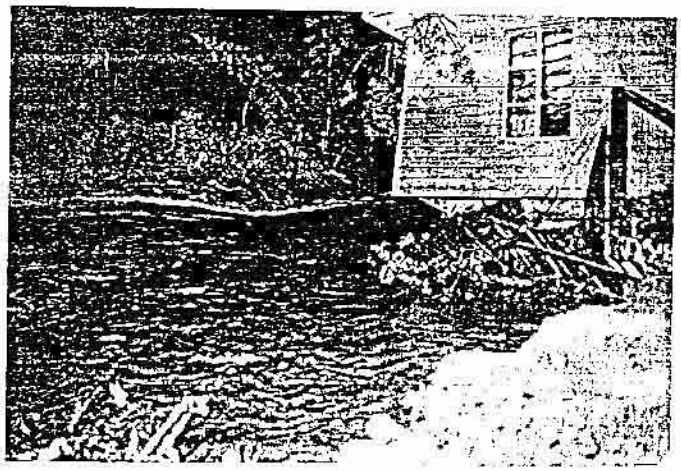
Newell Rd. Bridge, after Dec. 1955 flood
(Photo No. S2920-14)



Palo Alto Airport, after April 1958 flooding
(Photo No. S2920-8)

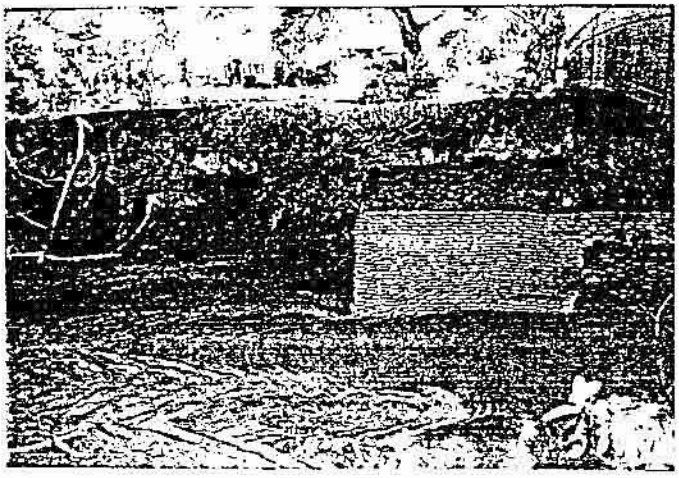


Upstream face of Bayshore Freeway Bridge,
April 1958 (Photo No. S2920-5)

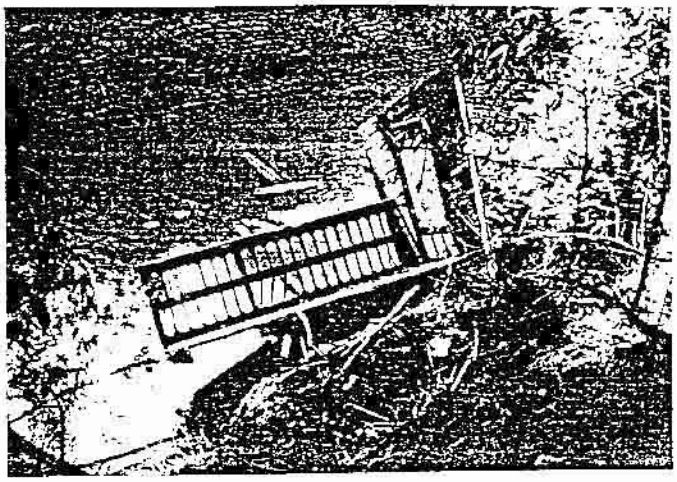


Residential flooding upstream Bayshore Freeway,
April 1955 (Photo No. S2920-6)

Figure 6
San Francisquito Creek
Effects of High Water in 1982, and Bridges at Pope/Chaucer Street and Middlefield Road

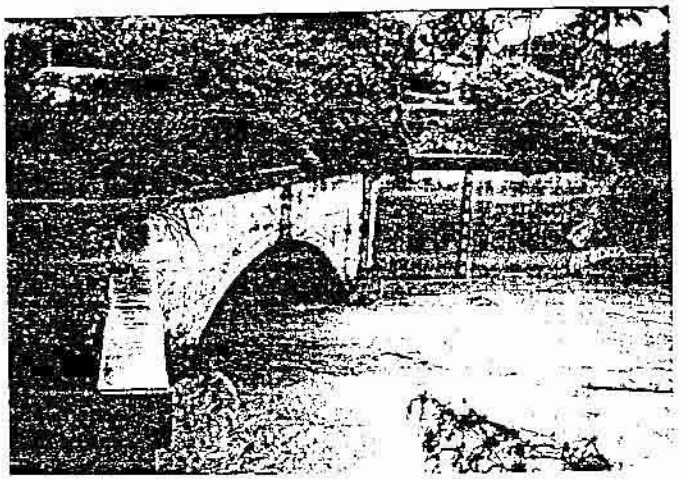


Erosion along Palo Alto Ave. downstream of Waverly St. footbridge, Jan. 1982 (S355-17)



Failed private footbridge washed downstream, Jan. 1982 (S355-32)





Upstream face of Pope/Chaucer St. Bridge in March 1966 (left) at low flow, and in March 1982 (right, S426-8) flowing at approximately 2,800 cfs (based on USGS Gaging Station near Stanford Golf Course)

Downstream face of Middlefield Rd. Bridge at low flow, March 1966



FLOODING PROBLEM AREAS

Certain areas of the channel are more problematic than others in terms of flooding. These areas are described below.

Bridges

The bridges from Highway 101 to Middlefield Road (Reaches 2-5) do not have adequate flow area to convey the 1 percent event. These existing bridge and upstream creek capacities and their corresponding design flows are shown in Table 1. Bridge capacities are defined by the quantity of flow that reaches the upstream soffit. This is not necessarily the quantity of flow that would breakout from the bridge. More detailed survey data of the bridge is required to make this determination.

Table 1
San Francisquito Creek
Highway 101 to downstream El Camino Real
Design Flows and Existing Bridge and Creek Capacities

Bridge Location	Design Flow*, cfs		Existing Capacity**, cfs	
	1%	10%	Bridge	Creek
Highway 101	9,300	4,900	6,500	6,000
Newell Road	9,300	4,900	7,800	7,000
University Avenue	9,300	4,900	5,200	7,000
Pope/Chaucer Street	9,300	4,900	5,200	6,000
Middlefield Road	9,100	4,800	4,600	6,200

* Per SCVWD, "Design Flood Flows Manual," March 1977.

** Bridge capacities are defined as the quantity of flow at which point the water surface reaches the upstream soffit. Creek capacities are to the top of channel for the creek just upstream of the corresponding bridge.

During the 1955 flood, the creek overtopped its banks at the Middlefield Road and Pope/Chaucer Street bridges. These bridges are problematic and have been identified by FEMA to be the breakout points during a 1 percent event (see Figure 3). Figure 6 shows the concrete arch bridge openings at these bridges.

The bridge at Highway 101 is also inadequate. Overtopping has occurred both upstream and downstream of the bridge. In 1959, the Bayshore Freeway was widened by several lanes (eventually to become Highway 101 and its frontage roads). The bridgework was added on

the upstream side, leaving the existing inadequate structure undisturbed. In addition, sediment does deposit the bridge, further reducing the flow area.

Channel Downstream of Highway 101

Under existing conditions, the channel downstream of Highway 101 (Reach 1) has inadequate capacity to convey the 1 percent flow of 9,300 cfs. The approximate top of channel capacity for this reach is 2,900 cfs with no freeboard throughout much of the levee system. Freeboard is the area between the water surface and top of channel, and is established to account for the risk of overtopping due to wave action or disturbances caused by debris in the channel or bridge openings. The capacity of the channel, including the 1958 design freeboard of 1.5 to 2 feet, is approximately 2,000 cfs. This flow is significantly less than the 1958 design flow of 7,100 cfs. Vegetation growth and sedimentation in the channel, land subsidence, and levee settlement and erosion have all contributed to a decrease in creek capacity of this reach.

This section of the creek is also subject to tidal flooding. Tidal flooding limits are shown on Figure 3.

Flooding of the region downstream of Highway 101 would damage the Palo Alto Airport and Golf Course, and may affect residential areas of East Palo Alto as well as commercial areas of Palo Alto west of Highway 101.

Channel Between Highway 101 and El Camino Real

Under existing conditions, the channel between Highway 101 and El Camino Real (Reaches 2-6) can convey an estimated 6,000 cfs before overbanking. This is less than the 1 percent flow of 9,300 cfs. At a flow rate of 6,000 cfs, water would reach the top of the channel in several locations. This flow matches the design flow for the 1969 channel improvements. It is not known if freeboard, which does not exist in several locations, was incorporated into the 1969 design. Since 1969, vegetation, sedimentation, and possibly land subsidence have contributed to a decrease in creek capacity.

None of the road crossings between Highway 101 and Middlefield Road (Reaches 2-5) can convey the 1 percent flow. The bridges at Middlefield Road and Pope/Chaucer Street restrict flow greater than approximately 6,000 cfs, causing water to back up behind them and overtop the channel banks. Because any flow in excess of about 6,000 cfs would spill from the channel at these bridges, the flow remaining in the channel would be within the capacity of the channel downstream of Pope/Chaucer Street. If more flow were to remain in the channel downstream of Pope/Chaucer Street (by modifying these bridges, for instance) it would exceed the downstream channel capacity and overbank at some downstream location.

Flooding in the area downstream of El Camino Real would affect the adjacent residential and commercial areas of Palo Alto, Menlo Park, and East Palo Alto.

Channel Upstream of El Camino Real

Upstream of El Camino Real, the channel has adequate capacity to convey the 1 percent flood.

DESCRIPTION OF THE ONE PERCENT FLOOD

San Francisquito Creek emerged onto the valley floor by flowing through the valley toward the Bay often overflowing its banks during periods of flooding. When this occurred, gravel and sand particles dropped out in the vicinity of the banks forming low ridges termed natural levees. Each time this occurred, the natural levees increased in height not allowing the water to flow back into the creek. This process resulted in the creek banks being higher than the adjacent land. As a result, when the water overflowed the natural levees, it flowed away from the creek through the adjacent land. This water followed the slope of the valley floor somewhat paralleling the creek to the Bay. Therefore, once water overtops the creek banks, it flows away from the creek toward the Bay causing relatively shallow but extensive flooding through developed land. This unique topographical feature results in the flooding of areas that do not drain to San Francisquito Creek.

The estimated extent of flooding from a 1 percent event (the flood flow that would be equaled or exceeded an average of one time in a 100 years, or has a 1 percent chance of occurring in any given year) is shown in Figure 3. Figure 3 and the following flood damage analysis are based on preliminary maps provided in 1996 from the FEMA studies that began in 1995. The map shows areas identified as special flood hazard areas and the limits of tidal flooding.

The most significant causes of overbanking in the study area are the bridges at Middlefield Road and at Pope/Chaucer Street. These bridges restrict flow greater than approximately 6,000 cfs causing water to back up behind them and overtop the banks into adjacent residential and commercial areas. During the 1 percent event, water is expected to overtop the banks on both sides of the creek at both these bridges. Flooding would occur both in San Mateo and Santa Clara Counties, in the cities of Menlo Park, East Palo Alto, and Palo Alto.

San Mateo County

During the 1 percent event, water would overtop the banks at the Middlefield Road bridge and extend northwest of Willow Road, and west to the Saint Patrick Seminary grounds, with shallow flooding of one foot or less. Flooding averaging one foot in depth would occur on the southeast side of Willow Road, bounded approximately by Robin Road, and would meet with waters overbanking from the Pope/Chaucer Street bridge. The resulting flood water would be approximately one foot in depth, and flow northward between Menalto Avenue and Willow Oaks Park to about Durham Street. From this point, water would continue to flow toward the Bay, at depths of less than one foot. Residential areas of the Menalto Park neighborhood, between Willow and Menalto Roads, would be flooded under less than one foot of water. Highway 101 would be flooded under less than one foot of water for a distance extending from about 2,000 feet southeast of the Willow Road interchange to about 1.6 miles

northwest of the interchange. Northeast of Highway 101, residential and industrial land, including areas of East Palo Alto and Menlo Park, would be flooded under less than one foot of water. This area is approximately bounded by Sevier, Poplar and Bay Avenues, and by Highway 101 to the southwest. Flood water would continue to flow over undeveloped baylands until it reached the Bay. The areas expected to be affected by a 1 percent flood event are shown in Figure 3.

In San Mateo County, approximately 1,950 buildings (1,800 residential and 150 industrial or commercial) on about 570 acres would be inundated up to one foot by a 1 percent flood event. Damages from this event are estimated to be about $20.7 million in 1996 dollars in San Mateo County (see Table 2).

Table 2
San Francisquito Creek
San Francisco Bay to El Camino Real
One Percent Flood Damage Report*

San Mateo County - Cities of Menlo Park and East Palo Alto

Land Use	Area Flooded (Acres)	Number of Buildings	Direct Structure Damage (Million $)	Direct Content Damage (Million $)	Indirect Damage (Million $)	Damage to Open Land (Million $)	Total 1% Flood Damages (Million $)
Single Family Resident	346	1,651	9.10	2.73	1.77	0	13.60
Multi Family Resident	21	148	0.67	0.20	0.13	0	1.01
Commercial	23	77	0.12	0.23	0.12	0	0.47
Industrial	72	72	1.06	2.65	1.67	0	5.38
Schools	10	7	0.07	0.13	0.07	0	0.27
Open Improved Land	88	0	0	0	0	0.02	0.02
Total*	**560**	**1,955**	**11.01**	**5.95**	**3.77**	**0.02**	**20.75**

* Damages are from the SCVWD Waterways Management Model and calculated in March 1996 based on the 1996 preliminary FEMA maps.

Santa Clara County

During the 1 percent flood event, creek water would overtop at the Middlefield Road bridge, and flow south and east across residential areas at an average depth of approximately one

foot, ponding up to two feet in some areas. This water would join waters overbanking the Pope/Chaucer Street bridge near Hale Street and Boyce Avenue, then flow east toward the Bay. The primarily residential area, bounded roughly by Hamilton Avenue on the north and Channing and Harker Avenues and Embarcadero Road to the south, would be inundated under about one foot of water, with several areas ponded to two feet in depth. East of approximately Louis Road, flood waters would flow at a depth of less than one foot in an easterly direction until reaching the Bay. Figure 3 shows the areas expected to be affected by a 1 percent flood event.

In Santa Clara County, approximately 700 acres of land and 2,900 buildings (primarily residential) would be flooded by a 1 percent flood event. Most of this area would flood to depths of approximately one foot, with some residential areas flooded up to two feet. Estimated damages of $134.7 million in 1996 dollars would occur in Santa Clara County as a result of this event. All of these damages would be within the City of Palo Alto (see Table 3).

Table 3
San Francisquito Creek
San Francisco Bay to El Camino Real
One Percent Flood Damage Report*

Santa Clara County - City of Palo Alto

Land Use	Area Flooded (Acres)	Number of Buildings	Direct Structure Damage (Million $)	Direct Content Damage (Million $)	Indirect Damage (Million $)	Damage to Open Land (Million $)	Total 1% Flood Damages (Million $)
Single Family Resident	570	2,585	82.99	24.90	16.18	0	124.07
Multi Family Resident	44	311	5.30	1.59	1.03	0	7.92
Commercial	19	5	0.52	1.04	0.55	0	2.11
Industrial	0	0	0	0	0	0	0
Schools	15	10	0.16	0.31	0.16	0	0.63
Open Improved Land	52	0	0	0	0	0.01	0.01
Total*	**700**	**2,911**	**88.97**	**27.84**	**17.92**	**0.01**	**134.74**

* Damages are from the SCVWD Waterways Management Model and calculated in March 1996 based on the 1996 preliminary FEMA maps.

Total Damages, Both Counties

Combined damages for both Counties affected by the 1 percent flood event would total over $155 million in 1996 dollars, with approximately 1,270 acres and 4,850 buildings affected by the flood waters. Most areas would be flooded to a depth of one foot or less (see Table 4).

Table 4
San Francisquito Creek
San Francisco Bay to El Camino Real
One Percent Flood Damage Report*

Total Damages, Santa Clara and San Mateo Counties

Land Use	Area Flooded (Acres)	Number of Buildings	Direct Structure Damage (Million $)	Direct Content Damage (Million $)	Indirect Damage (Million $)	Damage to Open Land (Million $)	Total 1% Flood Damages (Million $)
Single Family Resident	916	4,236	92.09	27.63	17.95	0	137.67
Multi Family Resident	65	459	5.97	1.79	1.16	0	8.93
Commercial	42	82	0.64	1.27	0.67	0	2.59
Industrial	72	72	1.06	2.65	1.67	0	5.38
Schools	25	17	0.22	0.44	0.23	0	0.90
Open Improved Land	140	0	0	0	0	0.03	0.03
Total*	**1,260**	**4,866**	**99.98**	**33.79**	**21.68**	**0.03**	**155.49**

* Damages are from the SCVWD Waterways Management Model and calculated in March 1996 based on the 1996 preliminary FEMA maps.

DEVELOPMENT OF UPPER WATERSHED

Urbanization of rural areas can contribute to increased creek flows during storm events. This occurs because the increase in impervious areas, such as parking lots, roofs and driveways, associated with development causes more rainfall to runoff, rather than soak into the soil. Water arrives in creeks sooner, and in greater quantity, than it would have if trickling through soil or vegetation. As each watershed becomes more urbanized, its impervious area increases, increasing the amount of runoff water contributed to creek flow. However, the increase in creek flow due to an increase in impervious area becomes less significant with higher magnitude events. This is because continuous rainfall that produces high magnitude events (such as the 1 percent flood) will saturate the ground surface. When extremely saturated, the ground behaves as though it were impervious; very little

additional infiltration can occur. Therefore, the addition of actual impervious surfaces usually does not significantly change runoff patterns during very high intensity events.

The following analysis is based on the 1 percent flood event. For this analysis, the Hydraulic Engineering Center's HEC-1 program was used to model runoff for San Francisquito Creek. HEC-1 is a rainfall-runoff program developed by the Corps. The program computes creek flow at any given time, using information related to rainfall and watershed characteristics. This program was used to estimate increases in creek flow resulting from possible future development of the upper watershed.

Sub-watersheds A, B, C, D, E, F and G are outlined in Figure 7, a sub-watershed map of the San Francisquito Creek watershed. Sub-watersheds F and G contain the highly urbanized areas of Palo Alto and Menlo Park. Baseline conditions include these already urbanized areas, where future conditions are not expected to change significantly. Sub-watersheds A, B, C, D, and E (upstream of Junipero Serra Boulevard) have remained relatively undeveloped. Possible future development of these sub-watersheds was examined to determine effects on creek flow.

Future development conditions were estimated using a combination of the General Plans for Santa Clara County (1994) and the City of Menlo Park (1994). The westernmost areas of the watershed (areas A, B, and C) are steep and heavily wooded, and the designated level of development is Very Low Density Residential. A significant portion of land is devoted to parks and open space. Sub-watershed D includes areas in the foothills, and is designated to be developed to a greater extent. Sub-watershed E includes primarily Stanford land, from the foothills to El Camino Real. It includes open space, campus areas, and the Stanford Shopping Center.

Table 5 shows estimated percent impervious cover for the upper five sub-watersheds under existing conditions (1983 information) and future conditions (based on General Plans, as described above). There is little difference between existing and future conditions of imperviousness in the upper watershed. This illustrates the intentions of local jurisdictions to continue to allow only very low density development in the hillsides.

Table 5
San Francisquito Creek
Estimated Percent Impervious Cover of Upper Sub-Watersheds
Existing and Future Conditions

Condition	% Impervious Surface Area				
	A	B	C	D	E
Existing (1983)	7	6	4	12	23
Future (General Plans)	7	6	4	19	25

Estimates of impervious cover account for the type and extent of land use evaluated for each particular area. Note that percent imperviousness is not equivalent to percent development. For instance, land that has been 100 percent developed at designation Very Low Density Residential will be approximately 15 percent impervious. Conversely, land developed at 50 percent Low Density Residential and 50 percent Open Space will also be approximately 15 percent impervious. Many combinations are possible. To model future conditions, maximum permissible development under current land use plans was assumed.

Percent imperviousness of the upper watersheds was used in the HEC-1 model to estimate potential increases in 1 percent peak flows at El Camino Real over existing conditions. Under future conditions, with continued development of sub-watersheds D and E, peak flows may increase 0.5 percent over existing conditions.

Figure 8 shows the hydrographs (creek flow rate vs. time) for the 1 percent event for existing and future conditions, as determined through this analysis. The hydrographs for these two conditions are nearly indistinguishable, indicating that future development as currently planned will have little impact on peak 1 percent flows in this watershed.

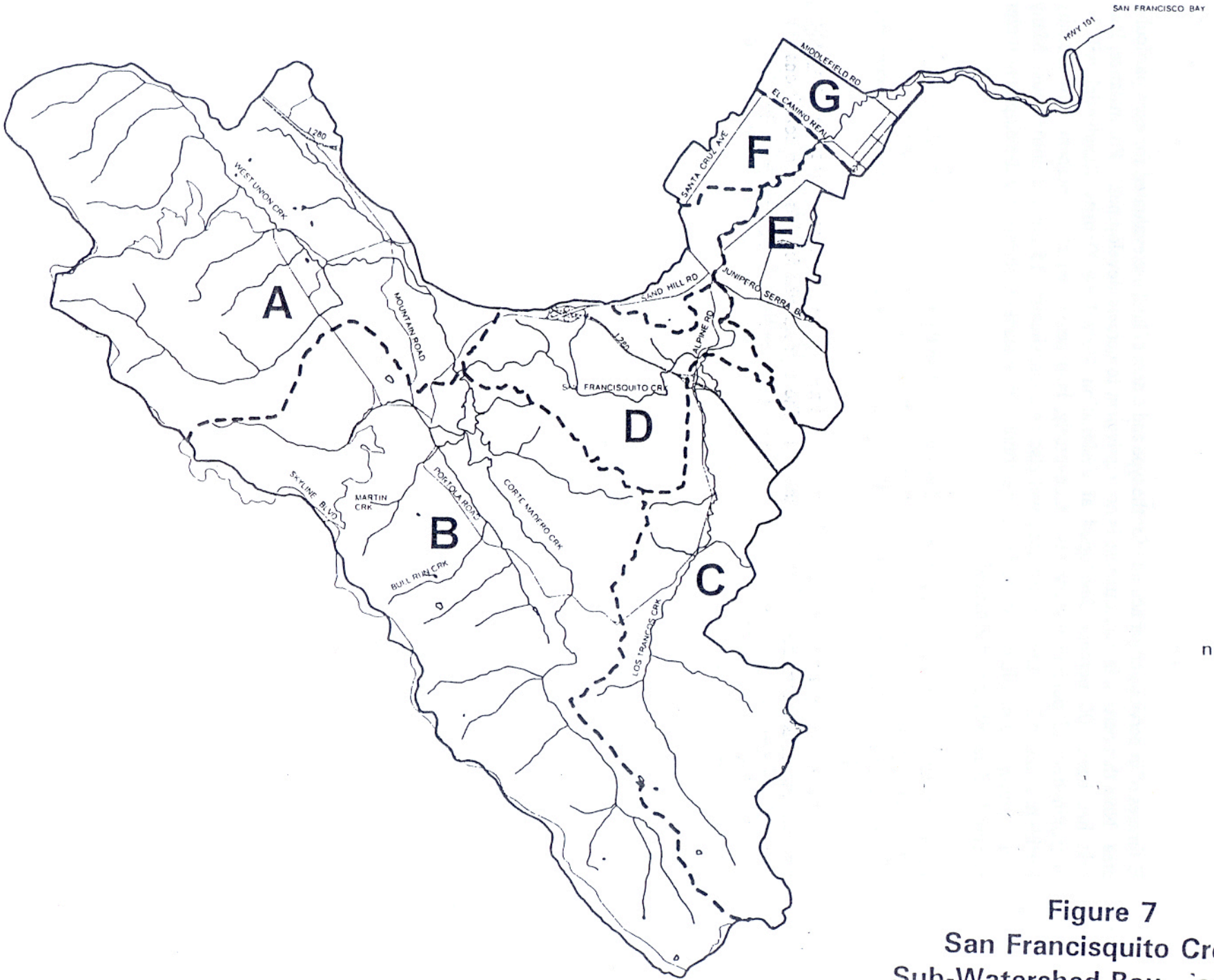
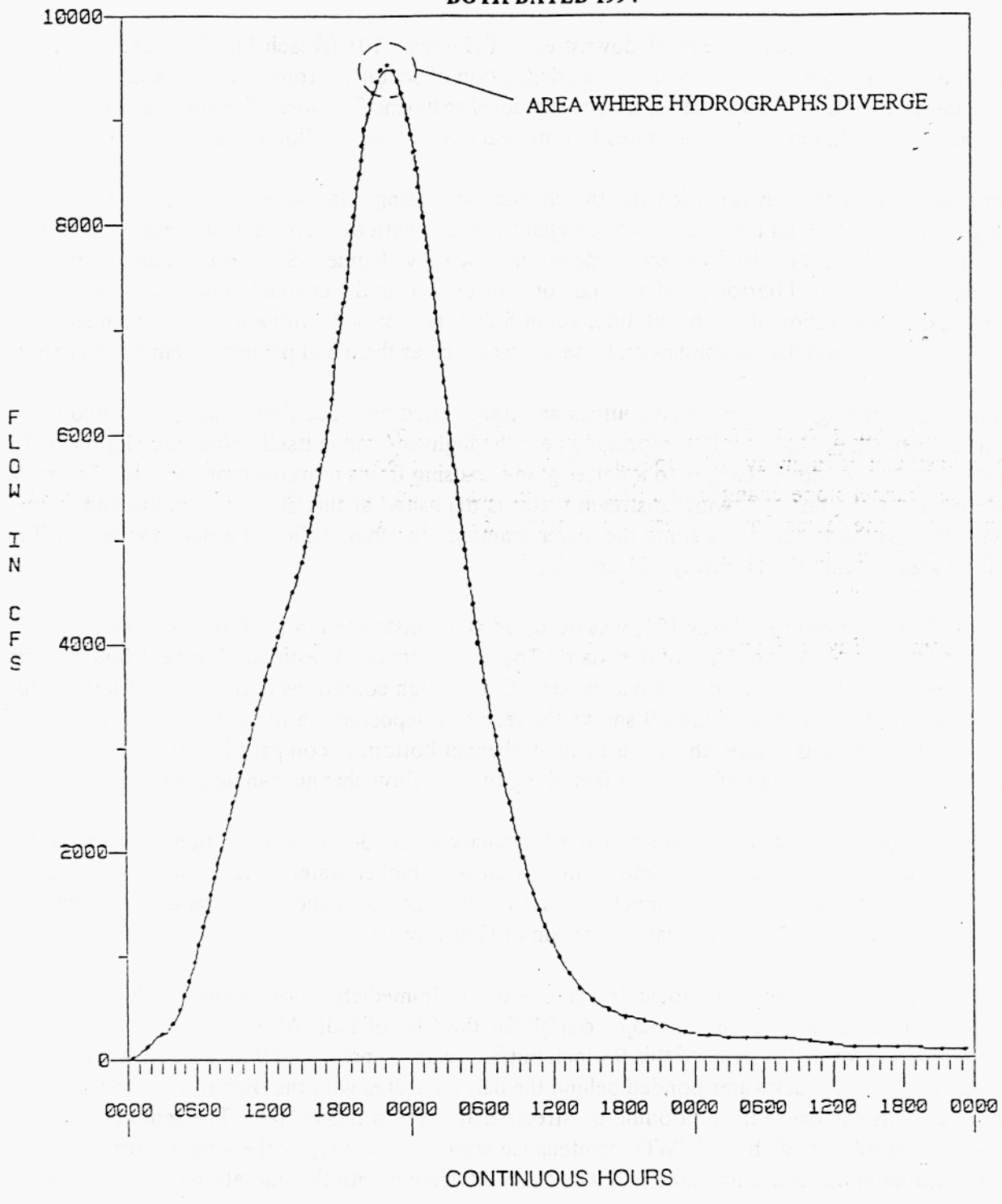


Figure 7
San Francisquito Creek
Sub-Watershed Boundary Map

(EXISTING) CONDITIONS BASED ON SCVWD ESTIMATES, 1983
AND
FUTURE CONDITIONS BASED ON GENERAL PLANS
FOR SANTA CLARA COUNTY AND THE CITY OF MENLO PARK
BOTH DATED 1994



LEGEND

——— EXISTING CONDITIONS

- - - - - FUTURE CONDITIONS

Figure 8
San Francisquito Creek
1% Hydrograph
(at El Camino Real)

SEDIMENT PROBLEMS

Sedimentation is a problem in the reach downstream of Highway 101 (Reach 1). This reach is subject to sedimentation from tidal action as well as deposition of sediment from upstream sources. When vegetation establishes in the sediments, it traps additional sediment. The loss of channel cross sectional area caused by sedimentation contributes to potential overbanking of flood waters.

Suspended silt from the Bay is carried into the channel with rising tidal flows, which extend upstream to Highway 101. As tidal inflows slow and begin to recede with the ebb flow, suspended silt settles onto the banks, while the tidal flow recedes down the low flow channel. Sediment accumulates along the sides of the channel bottom, and at bends or obstructions in the channel. Over time, benches at the approximate elevation of mean high tide, about 5 feet, are formed, with a low flow channel down the center. Vegetation that establishes on these benches secures them and protects them from erosion.

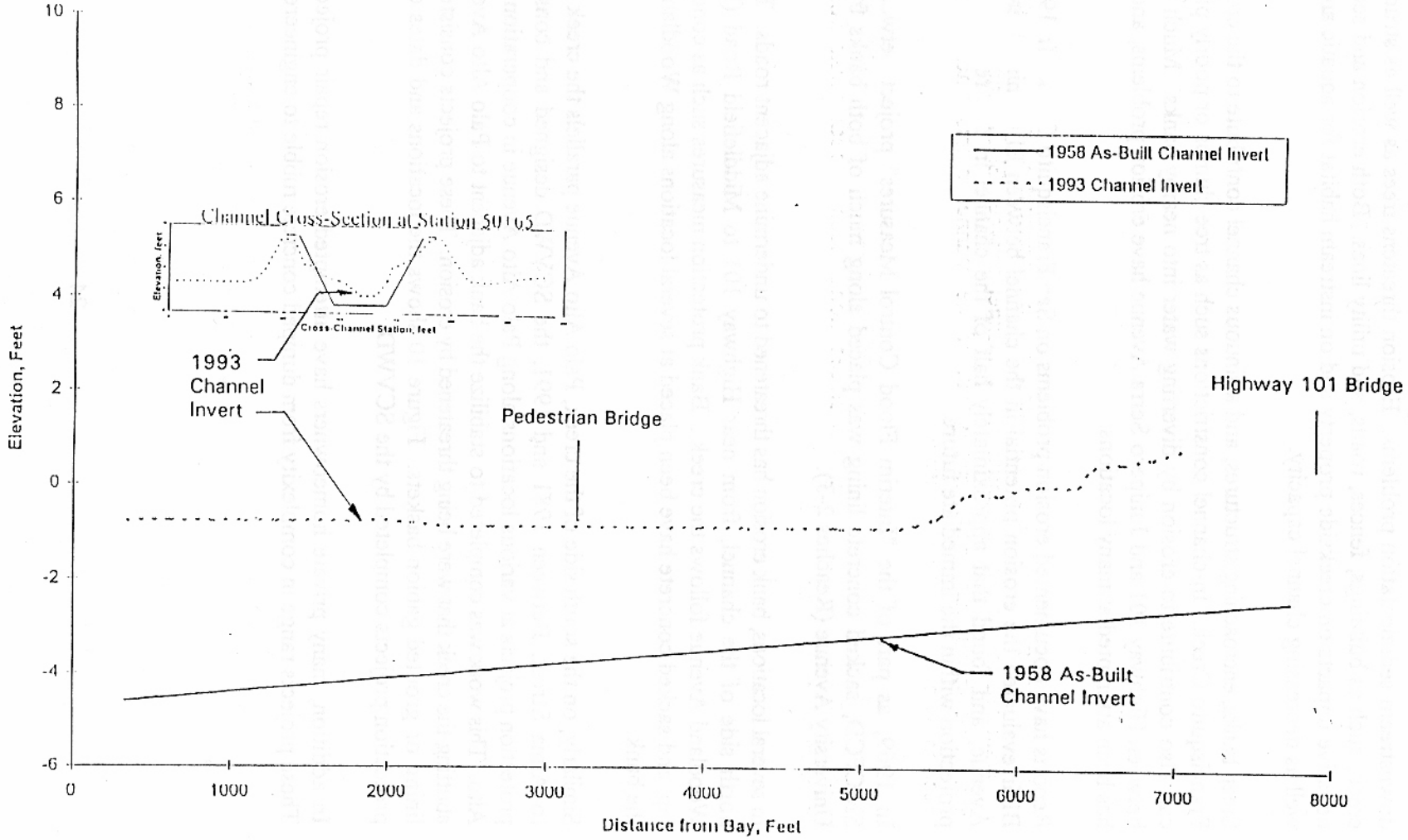
Sediment originating from upstream sources and transported by creek flow is also deposited in the reach downstream of Highway 101, especially near the highway bridge itself. Near the Highway 101 bridge, the channel slope changes to a flatter grade, causing flows to move more slowly. Sediment transported by the faster flowing upstream water is deposited at this change of grade and further downstream, as the water slows along the lower gradient. In 1996, sediment blocked at least 1/3 of the flow area beneath the Highway 101 crossing.

Reach 1, from the Bay to Highway 101, was designed and constructed in 1958 to carry the 1 percent flow of 7,100 cfs with 1.5 to 2 feet of freeboard. Today, its capacity is estimated to be 2,000 cfs with 1.5 to 2 feet of freeboard. The decrease in capacity from design conditions in this reach is largely due to deposition of sediments. Figure 9 shows the result of deposition in the channel downstream of Highway 101. In this figure, the 1958 as-built channel bottom is compared to the 1993 channel bottom. Sediment deposits of up to 3.5 feet along the low flow channel can be seen.

Sediment deposition not only reduces channel capacity at the deposition location, but also in the reaches immediately upstream. Sediment buildup causes a higher water surface for any given flow, since it reduces the depth of the channel. A higher water surface reduces the drainage efficiency of the channel upstream. This is the case upstream of Highway 101.

Sediment can also interfere with local drainage outfalls. Immediately downstream of Highway 101 along the southeasterly levee is a major outfall for the City of Palo Alto storm drain system. A sediment bar has formed in front of this 96-inch outfall, which is protected with a one-way flap gate. The sediment bar, or backwater ponded behind the bar, interferes with the operation of the one-way flap gate. This can cause local flooding on streets that drain to this outfall. The sediment bar was partially removed in 1993 by SCVWD maintenance crews. However, by the winter storms of 1995 enough sediment had reaccumulated and was again interfering with the operation of the flap gate.

Figure 9
San Francisquito Creek
Sedimentation Profile, Downstream of Highway 101
As-Built (1958) and 1993 Conditions



EROSION PROBLEMS

Channel and bank erosion threatens preservation of property and structures and contributes to downstream sedimentation problems. Erosion threatens trees as well as structures adjacent to the creek, such as buildings, fences, roads, and utility lines. Both erosion and sedimentation can have negative impacts on creekside property and on instream habitat for aquatic and riparian species, as well as decreasing channel capacity.

Steep banks, encroaching structures, and a sinuous channel contribute to the erosion problem on San Francisquito Creek. In-channel constrictions such as tree clumps or poorly placed bank protection can also contribute to erosion by diverting water into nearby banks. Much of the channel banks between Highway 101 and Junipero Serra Avenue have erosion problems, and erosion repair work has been attempted at many locations.

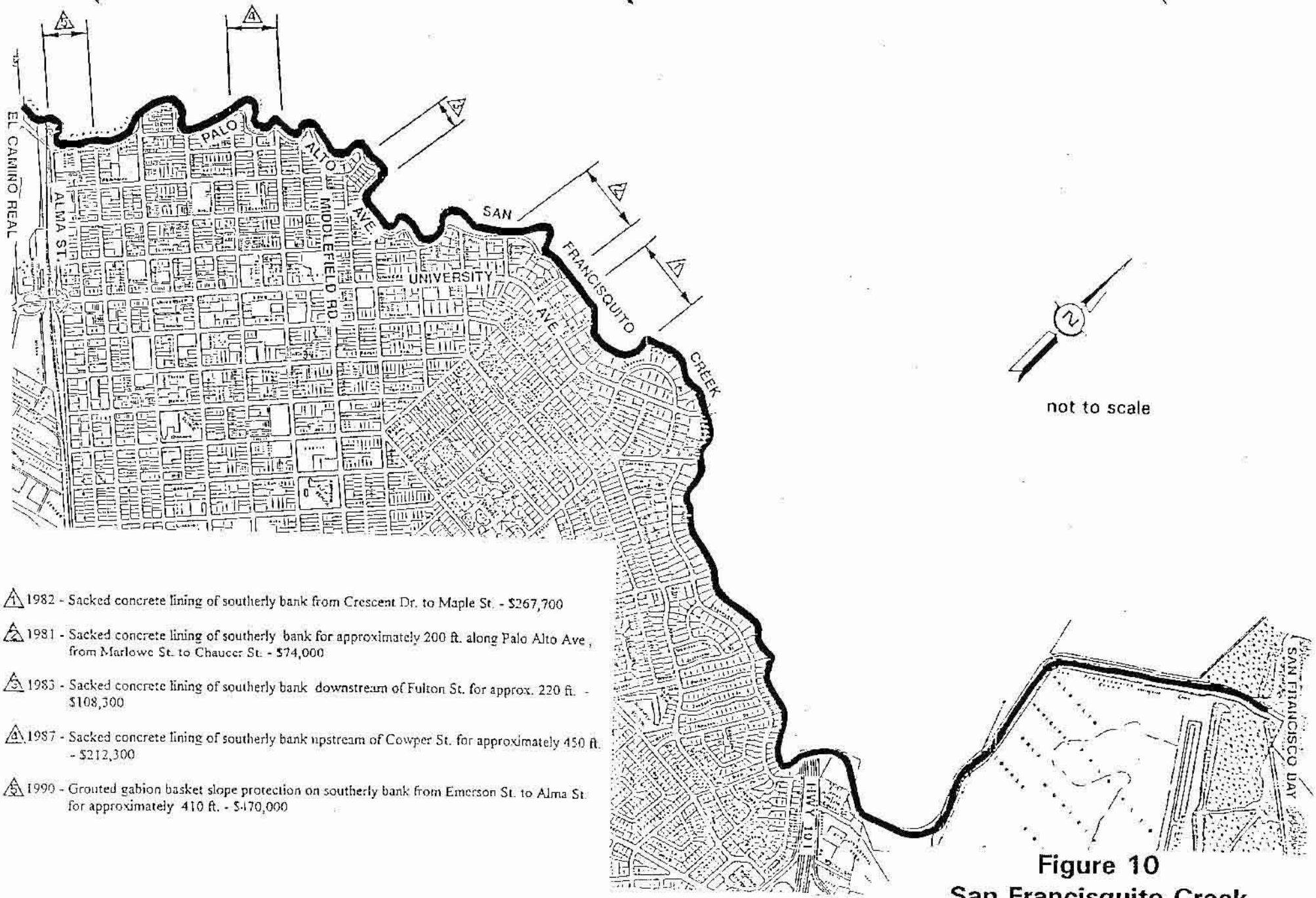
Reports have documented erosion problems on San Francisquito Creek. In 1964, Wilsey, Ham and Blair evaluated the erosion potential in the channel between El Camino Real and Junipero Serra Avenue, and found that approximately half of the channel in this reach would require erosion protection within the immediate future.

In 1969, as part of the "Interim Flood Control Measures" project between the SCVWD and SMCFCD, sacked concrete lining was placed along much of both banks from Highway 101 to University Avenue (Reaches 2-3).

In several locations, bank erosion has threatened to undermine adjacent roads. This is the case on the north side of the channel, from near Highway 101 to Middlefield Road (Reaches 2-5), where Woodland Avenue follows the creek . Bank protection measures such as concrete rubble, rock rip-rap, and sacked concrete have been placed at several locations along Woodland Avenue to stabilize the bank.

Similarly, on the south side of the creek, Palo Alto Avenue parallels the creek from Marlowe Street to Alma Street. Between 1981 and 1991, the SCVWD designed and constructed several bank protection projects at various locations along Palo Alto Avenue in cooperation with the City of Palo Alto. This work was completed to stabilize the bank adjacent to Palo Alto Avenue and other streets abutting the creek that were being threatened by erosion. These projects consisted of sacked concrete lining or grouted gabion baskets. Figure 10 shows the locations and dates of recent, major bank protection projects completed by the SCVWD.

In addition, many private homeowners have attempted erosion repair projects on their property. These projects range in complexity from dumped concrete rubble to engineered retaining walls.



1982 - Sacked concrete lining of southerly bank from Crescent Dr. to Maple St. - $267,700

1981 - Sacked concrete lining of southerly bank for approximately 200 ft. along Palo Alto Ave, from Marlowe St. to Chaucer St. - $74,000

1983 - Sacked concrete lining of southerly bank downstream of Fulton St. for approx. 220 ft. - $108,300

1987 - Sacked concrete lining of southerly bank upstream of Cowper St. for approximately 450 ft. - $212,300

1990 - Grouted gabion basket slope protection on southerly bank from Emerson St. to Alma St. for approximately 410 ft. - $470,000

Figure 10
San Francisquito Creek
Recent Bank Protection Projects
Completed by SCVWD

LAND SUBSIDENCE EFFECTS ON FLOOD CONTROL

Land subsidence has occurred in the study area as a result of overdraft pumping of the groundwater basin. It is estimated that subsidence began about 1920. The ground level has dropped as much as 2.5 feet in the study area since this time, with the greatest amount of subsidence occurring in the tidal area near the Bay. Figure 11 shows land subsidence in north Santa Clara County from 1934 to 1967, and from 1960 to 1967.

The result of land subsidence is higher water surface in the creek relative to the now lower adjacent land. Once land subsidence has occurred, the loss in ground surface elevation is permanent. It is estimated that subsidence around the South Bay stopped occurring in approximately 1970, when groundwater pumping decreased substantially due to successful management of water supply by the SCVWD.

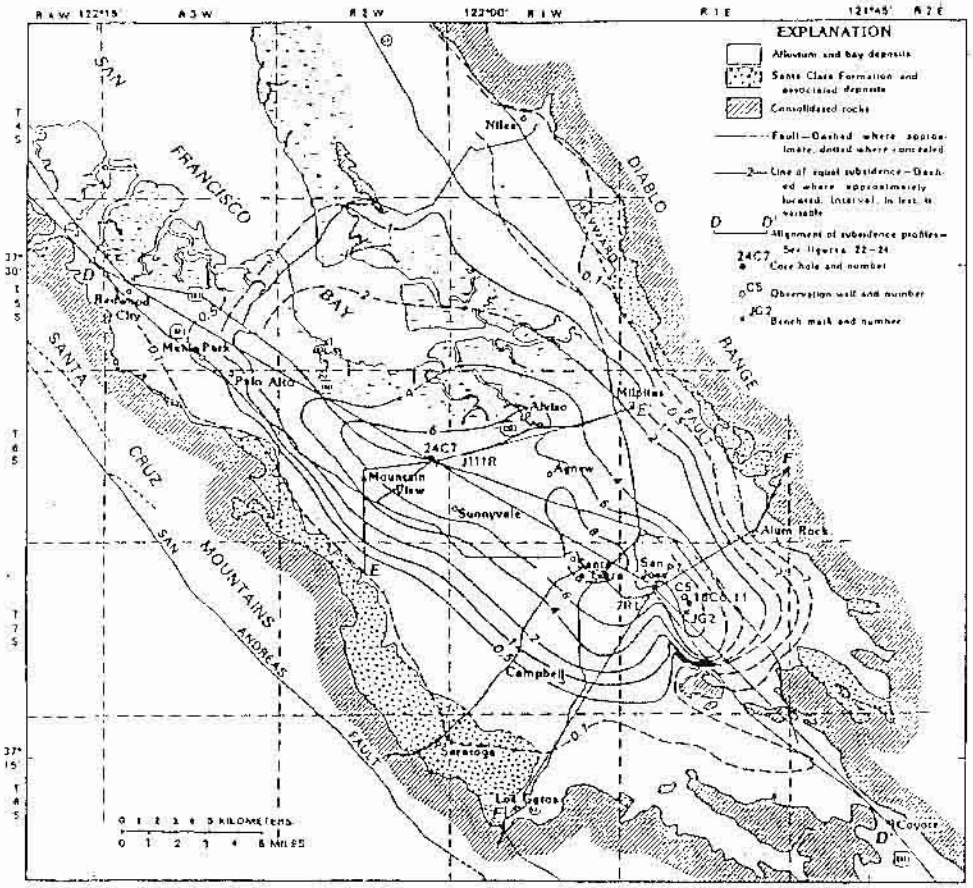
Since 1958, when the earth levee channel was constructed between Highway 101 and the Bay (Reach 1), approximately one foot of subsidence has occurred in the vicinity of these levees. The subsidence has contributed to the decrease in the level of protection provided by these levees.

LOCAL DRAINAGE PROBLEMS

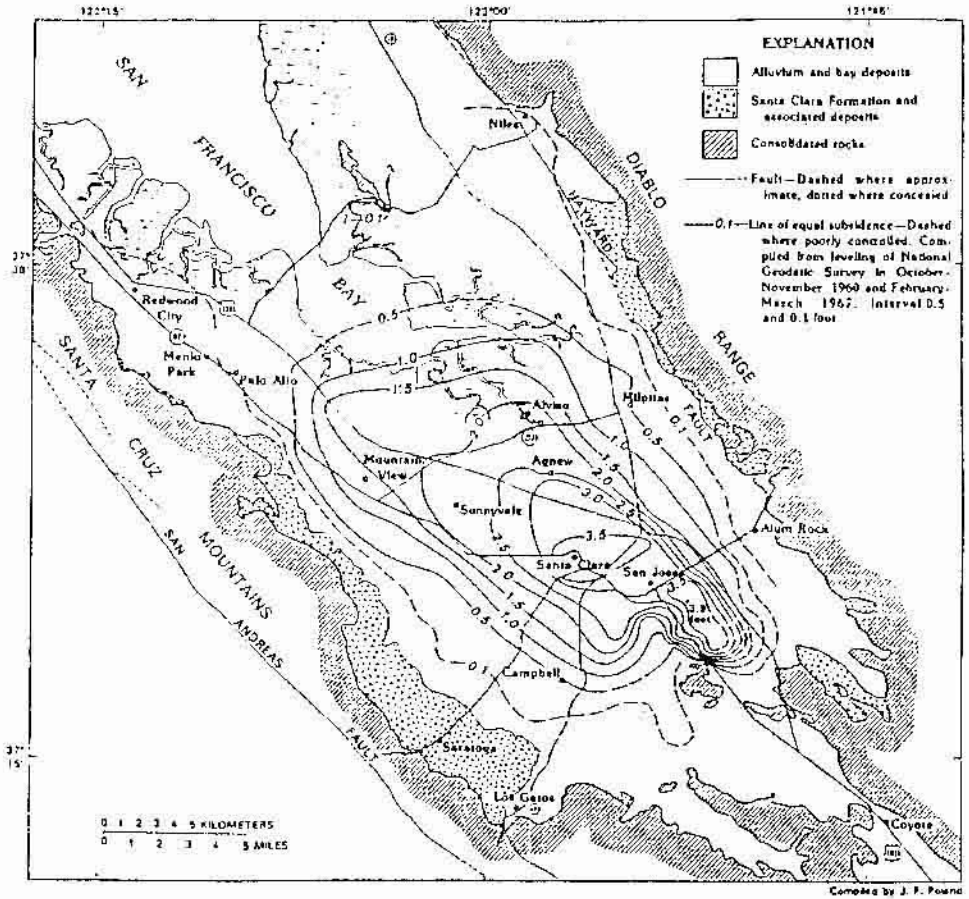
Within the context of this study, local drainage is defined as the system of street gutters, storm drain inlets, storm sewers, and outfall structures that convey local surface runoff into the creek. The local drainage facilities are owned, operated, and maintained by the cities or property owners whose lands they drain.

There is a local drainage problem in the area near and downstream of Highway 101. This is due to land near the Bay being low-lying and nearly level. This area has very little grade and gravitational drainage to the creek is limited because elevation differences between adjacent land and the creek are small. Significant flows in the creek are likely to interfere with the drainage of storm water from outfalls into the creek by keeping one-way flap gates closed, or by acting as a block to open-ended outfalls.

In this same area, land subsidence has aggravated local drainage by further reducing the elevation difference available for gravitational drainage. On the San Mateo County side, a pumping station has been installed in the tidal area of the creek, about 3,000 feet upstream from the bayshore to assist the local drainage of the East Palo Alto and Menlo Park areas. Upstream of Highway 101, local drainage facilities have not been significantly affected by subsidence.



Land subsidence from 1934 to 1967, north Santa Clara County.



Land subsidence from 1960 to 1967, north Santa Clara County.

Figure 11
Land Subsidence in North Santa Clara County

Figures are from USGS Report "Land Subsidence in the Santa Clara Valley, California, as of 1982", USGS, 1988

MAINTENANCE CONCERNS

From the Bay to Searsville Dam, San Francisquito Creek has never had any type of coordinated program to maintain the creek or creek capacity. This is due to the numerous owners that exist along the creek and lack of any coordinated effort between these owners. Creekside property owners include citizens, firms, corporations, and local governments and each property owner is responsible for creek maintenance on their property. Unfortunately, just as the owners differ from one property to the next, so differ the maintenance concerns from one part of the creek to the next. For example, the reaches upstream and downstream of Highway 101 have different maintenance concerns.

Upstream of Highway 101, channel bottom and bank erosion is the main concern. Creek erosion is a concern because it threatens properties adjacent to the creek and produces sediment that reduces creek capacity. Property owners address this issue on an ongoing basis. In these reaches, the banks are high and steep. During each flow event, some scouring occurs at the toe of the banks. As the side slopes become undercut, the banks begin to slough into the creek leaving unstable banks and unprotected trees. This leaves properties adjacent to the creek at risk of being lost. During high flow events, unprotected trees can be dislodged. These trees float down to bridges where they become lodged, trap debris, and become blockages that impede the flow. These blockages can cause or aggravate flooding. Creek erosion also contributes to the sedimentation problems all along the creek. Gravel and soil particles are transported by the fast flowing waters and deposited in areas along the creek where the water slows. This reduces creek capacity by raising the creek bottom, making the creek shallow where it was once relatively deep.

In the reaches between El Camino Real and Highway 101, where the channel does not have adequate capacity to convey the 1 percent flood, excessive vegetation growth is also a concern. Limited access hinders the control of vegetation and removal of debris, such as trees and trash, by property owners from the creek. These reaches lack a coordinated vegetation control program. Without such a program, vegetation has become overgrown in some locations and is contributing to the reduction in channel capacity.

From Highway 101 to the Bay, the deposition of sediments is the main concern. Sedimentation is an ongoing process and there is no coordinated sediment removal program. In this reach, sediment is accumulated from two sources, suspended silts associated with tidal inflow and upstream fluvial flow. The presence of sediment decreases channel capacity, interferes with the operation of local drainage outfalls, and provides a place for vegetation to become established. Over the years, vegetation has become established within the channel. This is also due to no coordinated vegetation removal program. In this reach, there is also a problem with the levee elevations. The levees are no longer at their 1958 as-built elevations due to land subsidence, settlement and erosion. This, too, decreases channel capacity.

PREVIOUSLY CONSIDERED ALTERNATIVES

This section of the report discusses the flood control alternatives that were previously examined by various authorities. In some cases, previously considered alternatives were modified to accommodate constraints that did not exist when they were first studied. Some new alternatives are also discussed because of strong interest by the CRMP group.

BASIS OF ALTERNATIVES EXAMINED

This study consisted of updating previously considered flood control alternatives with respect to their impacts, construction feasibility, and costs. These alternatives address the flooding problem on San Francisquito Creek downstream of El Camino Real, and fall under three types of flood control categories. These are: 1) upstream storage of flood waters, 2) diversion of high flows, and 3) channel modifications. A No Project alternative is also presented that describes the current practices along San Francisquito Creek.

Upstream storage of flood waters involves retaining high flows in an upstream basin or reservoir to reduce instream flows during the peak discharge period of a storm. After peak flows have passed, the stored water is released back into the creek system when the threat of overbanking is gone.

Diversion of high flows involves constructing an auxiliary channel that diverts high flows out of the creek, leaving behind only flow that is within the channel capacity. The diverted water is then conveyed to another channel with adequate capacity.

Channel modification includes work done in or near the creek to increase its capacity to convey peak flows within the creek corridor itself. Such work could include construction of floodwalls or levees, revetment, removal of flow obstructions, or bridge modifications.

These alternative types were considered separately. Each had either been studied previously or discussed sufficiently by the CRMP group to merit investigation. While many combinations of alternatives are possible, an investigation of additional combinations is beyond the scope of this reconnaissance study. In addition, this report makes no recommendations toward a preferred solution to the flooding problem.

This report only discusses alternatives that provide protection for the 1 percent (100-year) flood. Levels of protection other than the 1 percent flood could also be considered. A 50-year standard would be a significant increase in level of protection for existing conditions, but since the 50-year flow is already 90 percent of the 100-year flow, the alternative costs and impacts would be substantially the same. Higher levels of protection such as 200-year or 500-year are also possibilities. This may be advantageous since there is some movement nationwide to raise the standards for areas protected by levees.

A detailed analysis that considers combinations and variations of alternatives, in addition to a

detailed analysis of impacts, would be required to make a sound recommendation as to the most effective plan in terms of social, economic, and environmental costs and benefits. All the alternatives meriting consideration would require extensive studies, environmental review, and public review before a solution could be selected. This report presents information that could be used as a starting point for such analyses. Finally, because the as-built and existing capacities differ for the reaches upstream versus downstream of Highway 101, alternative solutions and scenarios are presented separately for these areas.

ALTERNATIVE SOLUTIONS - UPSTREAM OF HIGHWAY 101

Between El Camino Real and Highway 101, channel modifications were constructed in 1969 that increased the creek capacity to 6,000 cfs. The design freeboard used for these modifications is not known. However, if any alternative is implemented in the future, it must meet current FEMA standards of providing 3 feet of freeboard. If these freeboard requirements are not met, then FEMA will not remove the surrounding areas from the 1 percent flood zone and hence, from their flood insurance requirements. Based on this freeboard standard, the existing approximate capacity of the creek in these reaches is 4,000 cfs, and existing top of channel capacity is, at a minimum, 6,000 cfs. Therefore, some of the alternatives discussed in the following sections describe three scenarios:

1. Design an alternative or combination of alternatives to reduce the peak 1 percent flow from 9,300 cfs to 4,000 cfs downstream of El Camino Real, entailing virtually no additional channel modifications.

2. Design a smaller scale alternative or combination of alternatives to reduce the peak 1 percent flow from 9,300 cfs to 6,000 cfs downstream of El Camino Real and implement channel modifications downstream of El Camino Real to provide 3 feet of freeboard.

3. Design a channel modification/enlargement alternative, downstream of El Camino Real, to contain the peak 1 percent flow of 9,300 cfs.

There are many ways to increase the channel capacity between El Camino Real and Highway 101 to 6,000 cfs with 3 feet of freeboard, including but not limited to the following: flood proofing or replacing bridges, removing sediment from the channel bottom and from beneath bridges, improving existing berms and floodwalls, and removing vegetation.

Significant impacts and cost estimates of the flood control alternatives are included in the alternatives discussion. Significant impacts include construction, flooding, local drainage, erosion, and sedimentation impacts, as well as environmental impacts on the stream corridor and sensitive species habitat. Environmental impacts are discussed in a very general way, as a full environmental impact assessment is beyond the scope of this report.

Alternatives that did not reduce flooding from the 1 percent event or would have excessive significant environmental impacts were not considered feasible. Cost estimates for these alternatives

were not provided.

All of the alternative solutions discussed for the reaches upstream of Highway 101 are summarized for comparison in a table at the end of this section.

No Project

The No Project alternative describes the current practices along San Francisquito Creek upstream of Highway 101. Under the No Project alternative, current practices would continue and no action would be taken to reduce the existing flood hazard. Residences and businesses within the floodplain would continue to face potential hardships due to flooding, and FEMA flood insurance would still be required. Properties immediately next to the creek would remain at risk to bank erosion and failure.

Maintenance access would still be limited and be the responsibility of creekside property owners. Limited access would hinder the control of vegetation and removal of debris, such as trees and trash, by property owners. Sedimentation would continue to diminish channel capacity, pose problems for storm drain outfalls, and allow vegetation to become further established. Currently, there is no coordinated program to maintain the vegetation or sediment in the creek for a specific creek capacity. However, maintenance would continue by the SCVWD and SMCFCD on each agency's right-of-way and during high flows. In addition, there would still be an annual creek walk to identify locations requiring maintenance by property owners.

Bank erosion and tree loss to erosion would continue along the creek. During high flow events, trees could fall into the creek and create blockages. Trees fall into the creek when the ground in which they are anchored is eroded and undermined. Fallen trees could be carried downstream to a culvert or bridge where they may become lodged. When other debris flowing down the creek accumulates on the tree, a blockage is created. The blockages may result in significant reductions in flow capacity and cause or aggravate flooding. Under the No Project alternative, bridge piers would be routinely inspected during high flows and blockages removed as required by the SCVWD and SMCFCD.

Some flooding could be expected to occur on average once every 18.5 years upstream of Highway 101. This corresponds to the approximate top of channel capacity of 6,000 cfs. During a 1 percent flood, damages as high as $155 million would occur (1996 dollars), with up to 4,850 residences and businesses in both counties experiencing some flooding.

The total first cost of the No Project alternative is estimated to be $66 million in 1996 dollars. This is the present worth of the total average annual cost over a 50-year project life at 7 percent interest. The average annual cost is the sum of the average annual flood damages, flood emergency costs, flood insurance administration costs, and general maintenance and erosion repair costs. The average annual cost of the No Project alternative is estimated to be $4.8 million. A detailed breakdown of the estimated costs is included in Appendix A.

Expand Searsville Lake

This alternative was considered in the past by the Corps and others. The alternative would include removing Searsville Dam and replacing it with a larger dam. The larger dam would have an additional height of approximately 20 feet and would capture upstream flood waters during high flow events. The larger dam would maintain the present lake level during ordinary conditions with a flow-through outlet at the existing lake level surface elevation of approximately 340 feet. However, during high flow events, flood waters would be detained by the additional height provided by the larger dam.

This alternative would reduce the 1 percent flow to 6,600 cfs downstream of El Camino Real. This flow exceeds the existing top of channel capacity of approximately 6,000 cfs downstream of El Camino Real and, therefore, additional measures would be required to provide 3 feet of freeboard in order to eliminate FEMA flood insurance requirements upstream of Highway 101. Full 1 percent protection could not be attained by this alternative alone because two major tributaries, Bear Creek and Los Trancos Creek, are not controlled by Searsville Dam. Without the additional channel improvements downstream of El Camino Real, FEMA flood insurance requirements would continue for a smaller 1 percent floodplain. Costs for these additional measures were not included in the cost estimate for this alternative.

To provide an additional 20 feet of height, the existing concrete block dam at Searsville Lake would be replaced by an earth dam, with a maximum height of approximately 60 feet. Figure 12 shows a cross section of the earth dam at its centerline. The outlet of the earth dam would be at an elevation of approximately 340 feet, allowing the lake to maintain its existing level. This alternative analysis assumed the existing dam would have to be replaced. A detailed analysis would have to be done as part of a comprehensive study to determine whether the existing dam could be expanded upon.

The lake would appear similar to existing conditions most of the time. However, during high flow events, the lake level would rise behind the earth dam, flooding the area south of the existing lake. During the 1 percent flow event, approximately 215 additional acres would be inundated. This area currently includes undeveloped land and residential areas. In addition, part of the Jasper Ridge Biological Preserve would be inundated during high flow events. Figure 13 illustrates the approximate area of inundation expected during the 1 percent flood event. This area, including portions of several properties, would need to be acquired as part of this alternative.

Access would be preserved along existing roadways by constructing berms and raising affected roadbeds by constructing culverts or bridge piers. The cost of constructing berms and raising existing roadbeds was not included in the cost estimate for this alternative.

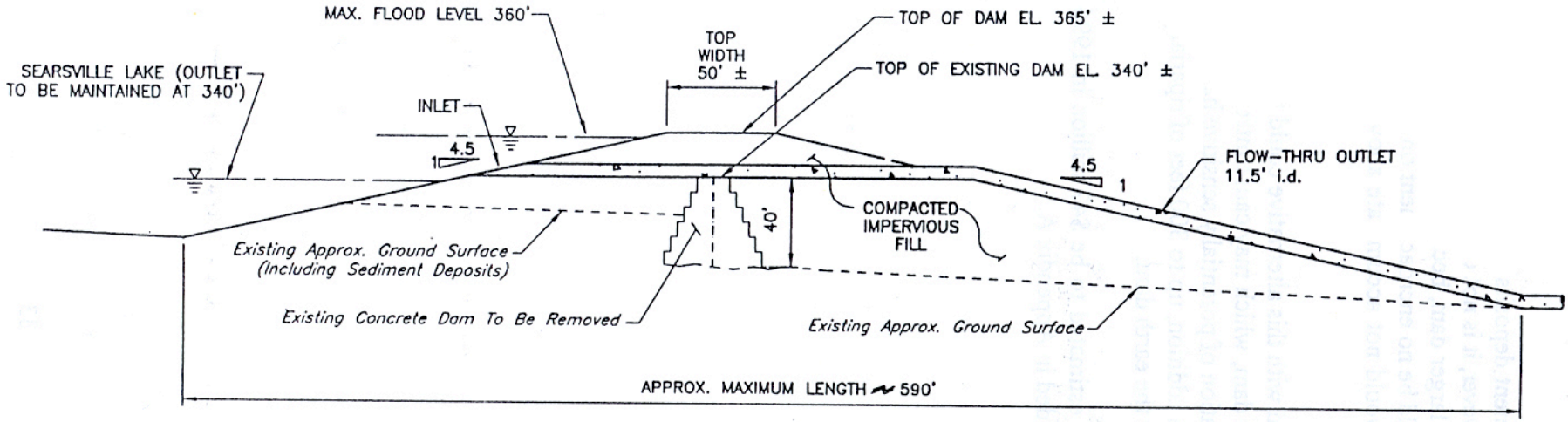
This alternative would not solve the erosion problems occurring downstream of Searsville Lake. High flows would continue to erode creekside properties. Sedimentation problems would also continue to occur.

Sedimentation in Searsville Lake itself has been a persistent problem; a large portion of the original

capacity of the lake has been lost to sediment deposits on the lake floor. Construction of the earth dam would not alleviate this problem. However, it is not expected that sedimentation would interfere with the flood protection provided by the larger dam, because the lake level would be maintained at its existing elevation. Therefore, there would be no encroachment on the flood storage portion of the expanded reservoir because sediments would not accumulate above 340 feet, the maximum lake elevation under normal conditions.

Possible environmental impacts associated with this alternative could include the effects of draining the lake during construction of the larger dam, which may cause introduction of non native aquatic species to San Francisquito Creek. Inundation of potentially sensitive habitat areas during high flow events may also be an issue of concern. In addition, up to 300 feet of riparian corridor, downstream of the existing dam, would be covered by the earth dam.

The total first cost of this alternative is estimated to be $47 million in 1996 dollars. A detailed breakdown of the estimated costs is included in Appendix A.



TYPICAL SECTION
Section at Maximum Height
not to scale

Figure 12
San Francisquito Creek
Expand Searsville Lake
Dam

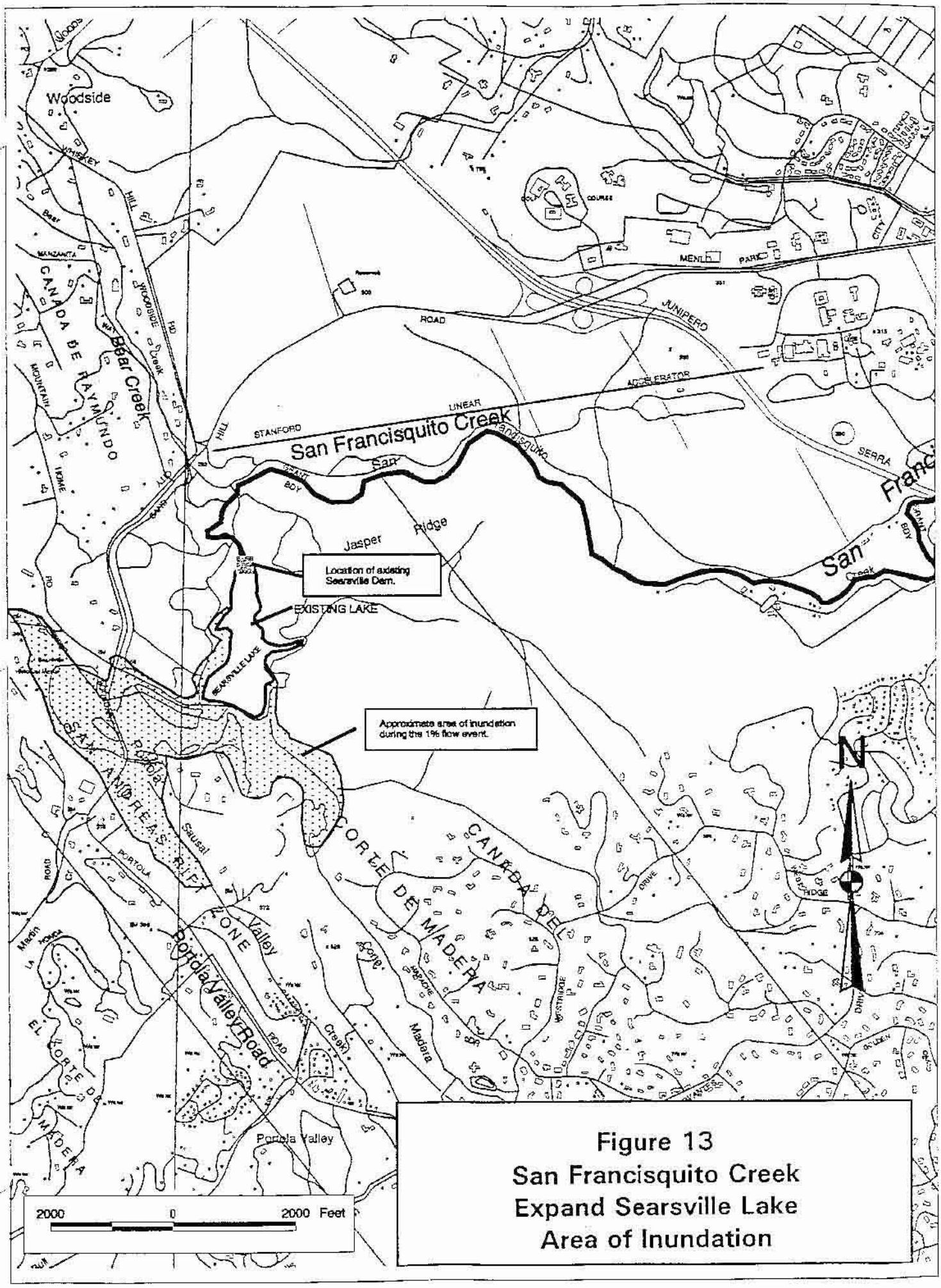


Figure 13
San Francisquito Creek
Expand Searsville Lake
Area of Inundation

Webb Ranch Flood Basin *(updated Ladera Dam concept)*

In 1961, the Corps studied an instream flood control reservoir at what was called the Ladera Dam site. To accommodate land constraints that did not exist in 1961, this alternative was relocated approximately 800 feet upstream of Highway 280 in a valley currently known as Webb Ranch. Figure 14 shows the approximate location of the Webb Ranch Dam. The concept of this alternative would be to construct a single-purpose, flow-through earth dam. The earth dam would include a flow-through outlet large enough to allow unobstructed flow of San Francisquito Creek during most flow events. However, during very high flow events, the capacity of the dam's outlet would be exceeded, causing a temporary detention of flood waters behind the dam. During such events, as high flows begin to recede, flood waters would continue to drain naturally through the dam outlet, allowing the temporarily stored water to flow into San Francisquito Creek. The net downstream effect of the earth dam would be to reduce the magnitude of peak flows, while extending the duration of high flows.

Two separate flood control options were investigated at the Webb Ranch site. A High Dam and a Low Dam. The High Dam would store enough flood water to reduce peak 1 percent flow to approximately 4,000 cfs downstream of El Camino Real. This would allow for elimination of FEMA flood insurance requirements upstream of Highway 101. Under existing conditions, channel capacity between Highway 101 and El Camino Real is estimated to be 4,000 cfs with 3 feet of freeboard. The Low Dam would temporarily store enough flood water to reduce peak 1 percent flow to approximately 6,000 cfs downstream of El Camino Real. Therefore, channel modifications between Highway 101 and El Camino Real would be required to provide 3 feet of freeboard in order to eliminate FEMA flood insurance requirements upstream of Highway 101.

Figure 14 indicates the approximate area of inundation expected for both the High and Low Dams at Webb Ranch during the 1 percent event. Figure 15 illustrates a typical cross section of a flow-through earth dam at its outlet.

Webb Ranch Flood Basin, High Dam

The High Dam would provide necessary, temporary storage to prevent downstream channel overbanking between Highway 101 and El Camino Real during a 1 percent event. This area of the channel is already adequate to convey flows up to 4,000 cfs with 3 feet of freeboard. FEMA flood insurance requirements could, therefore, be eliminated upstream of Highway 101. The High Dam would be up to 70 feet high at its maximum height, with the maximum water surface ten feet lower. Figure 15 shows the approximate section and dimensions for the High Dam. The dam would be approximately 610 feet long in the direction of creek flow, and approximately 1,760 feet wide along its crest.

The dam would have an unobstructed outlet approximately 8 feet in diameter. The outlet would be designed to convey a maximum flow of approximately 1,500 cfs, which would be reached only during the 1 percent event. This would limit the downstream flow to a maximum of 4,000 cfs, the existing channel capacity between Highway 101 and El Camino

Real with 3 feet of freeboard. At flows above about 900 cfs, the outlet culvert would begin to flow full, and the resulting pressure flow would temporarily preclude fish passage. This would occur for a short duration, on average approximately once every two years.

Preliminary analyses indicate that the 1 percent event would cause inundation of much of the valley to a depth of 35 to 40 feet for about one day, with standing water up to 25 feet deep for two days, and water remaining 5 feet deep for about three days. During this time, high flows would continuously drain through the dam's outlet into San Francisquito Creek. During the 1 percent event, approximately 300 acres of land behind the dam would be temporarily inundated.

Preliminary analysis of the 10 percent event, whose magnitude is reached or exceeded on average once every ten years, indicates that the valley would be submerged up to 20 feet deep near the dam for approximately 5 hours, with standing water to about 5 feet remaining for about a day and a half. Retention of flood water during the 10 percent event would reduce instream flow to about 2,800 cfs downstream of El Camino Real, which is well within the existing capacity of the channel for this reach.

The total first cost of the Webb Ranch High Dam is estimated to be $135 million in 1996 dollars. A detailed breakdown of the estimated costs is included in Appendix A.

Webb Ranch Flood Basin, Low Dam

A second flood control option investigated at this site is the Webb Ranch Low Dam. This dam would have a maximum height of approximately 60 feet at its center. The Low Dam, designed to protect the downstream channel from flows higher than 6,000 cfs, would cause less extensive inundation in the Webb Ranch Basin than the High Dam, by allowing higher flows to pass through. The Low Dam would be approximately 530 feet long in the direction of creek flow, and approximately 1,690 feet wide along the crest. Figure 16 shows a cross sectional view of the Low Dam.

The Low Dam would have an outlet approximately 12 feet in diameter. Pressure flow (full culvert) would occur at flows above approximately 1,650 cfs, which would occur on average once every three years. During the 1 percent flow event, the culvert would have a maximum outflow of approximately 4,000 cfs at the dam site. The 1 percent flood event would result in a maximum channel flow of approximately 6,000 cfs downstream of El Camino Real.

This option alone would not provide full protection from the 1 percent event. The channel between Highway 101 and El Camino Real would need to be modified to convey the 6,000 cfs with 3 feet of freeboard in order to eliminate FEMA flood insurance requirements upstream of Highway 101. Such modifications were not included in the cost or feasibility analysis of the Low Dam option.

During the 1 percent event, initial estimates indicate that the valley would be flooded to a

depth of about 25 feet for about half a day, with standing water remaining at least 5 feet deep for about one full day. Approximately 250 acres of land would be temporarily inundated during the 1 percent event.

Preliminary estimates indicate that the 10 percent event would cause inundation of the valley near the dam to a depth of about 5 feet for about 12 hours. The flow downstream of El Camino Real would be reduced to about 4,150 cfs during the 10 percent event, which is within the existing capacity of the channel for this reach.

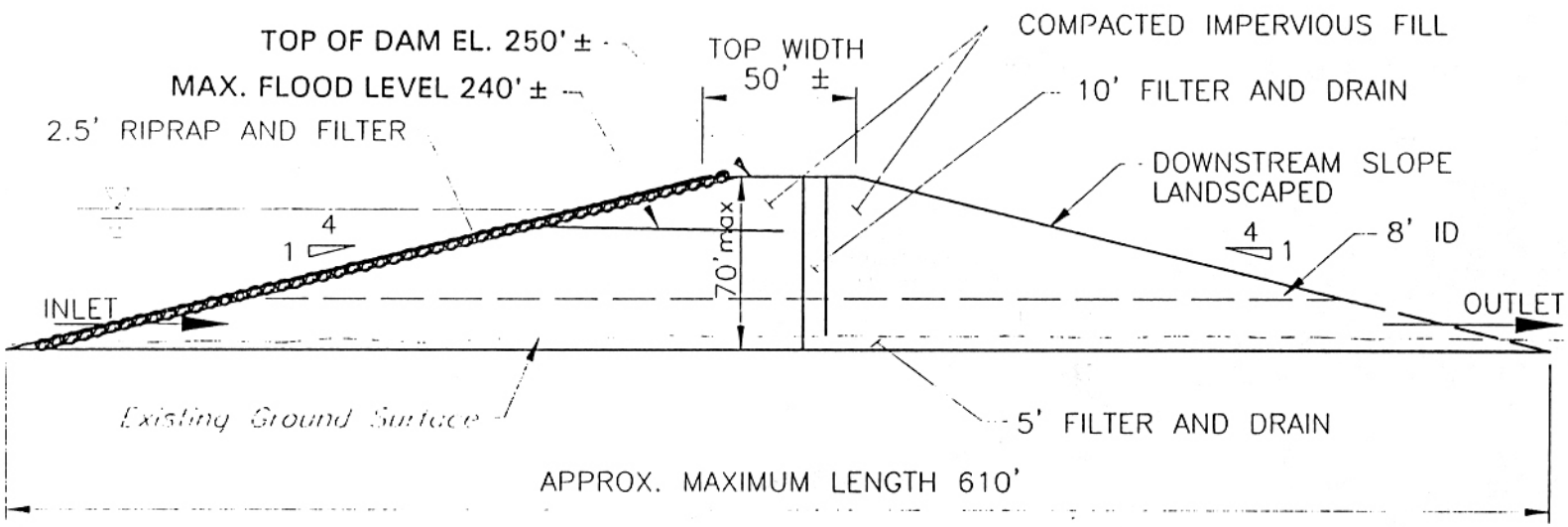
The total first cost of the Webb Ranch Low Dam is estimated to be $107 million in 1996 dollars. A detailed breakdown of the estimated costs is included in Appendix A.

The above estimates are based on limited knowledge of the area's topography and on approximate design parameters. The above numbers are subject to revision after more detailed analysis and design have been performed.

Although high flows would be reduced in magnitude, erosion problems downstream of the Webb Ranch Flood Basin would continue. This alternative also does not address sedimentation problems downstream of the Webb Ranch Flood Basin.

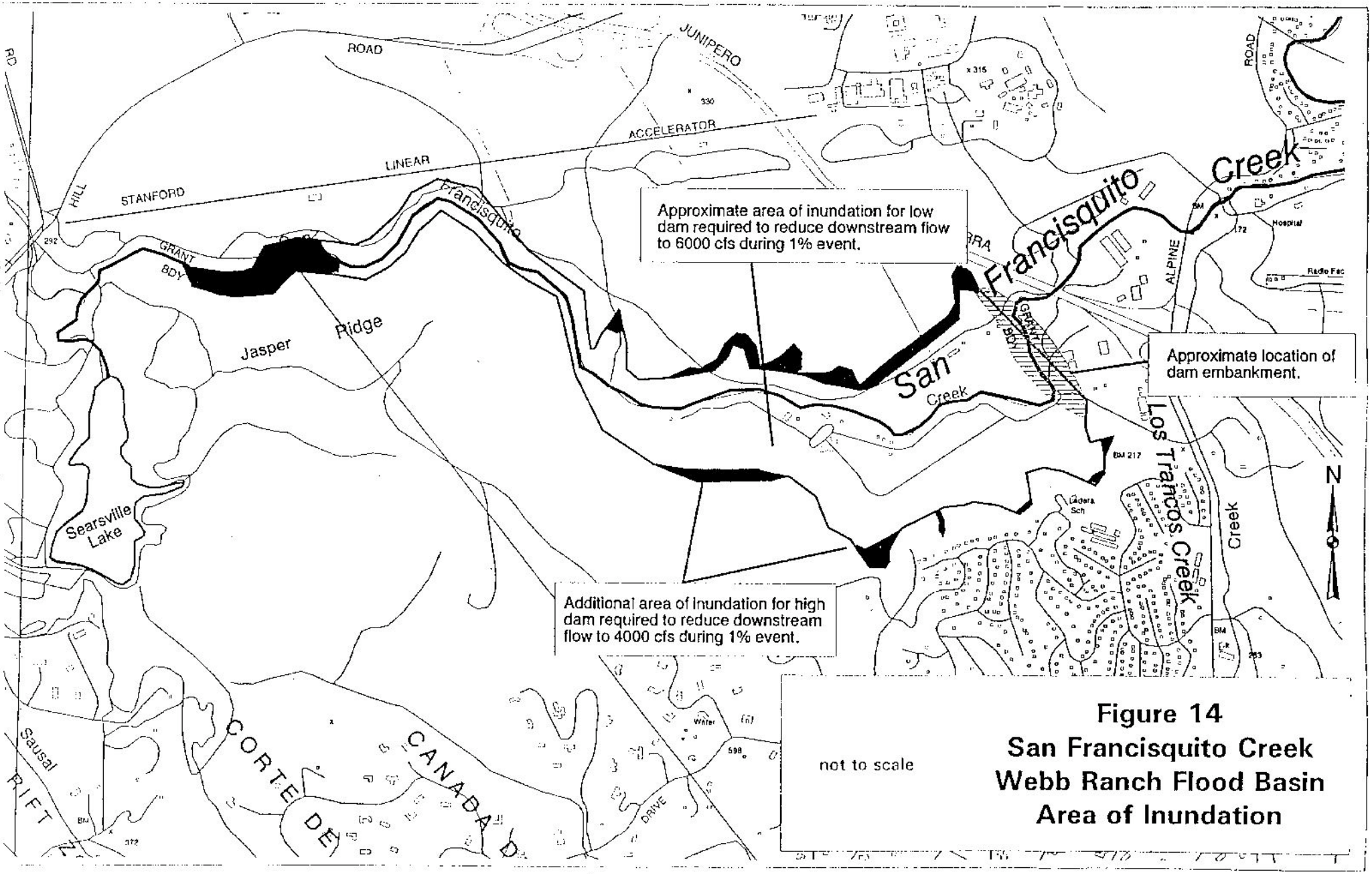
Sedimentation of the inundated areas behind the Webb Ranch Dam could be expected to occur. The combination of high velocities in and near the creek, and relatively short duration of inundation of the valley floor, would curb potential sedimentation problems in the flood basin area. Loss of flood detaining capacity due to sedimentation is not anticipated at this site.

Possible environmental impacts of the Webb Ranch Flood Basin alternative could include the impact of dam construction on the riparian corridor, including loss of some riparian habitat under the dam footprint; infrequent temporary inundation of potentially sensitive habitat; possible sedimentation issues; and fish passage and rearing issues. The possibility of high velocity flow through the dam outlet during most storm events may significantly affect upstream fish passage. A detailed environmental analysis would need to be performed as part of a comprehensive study.



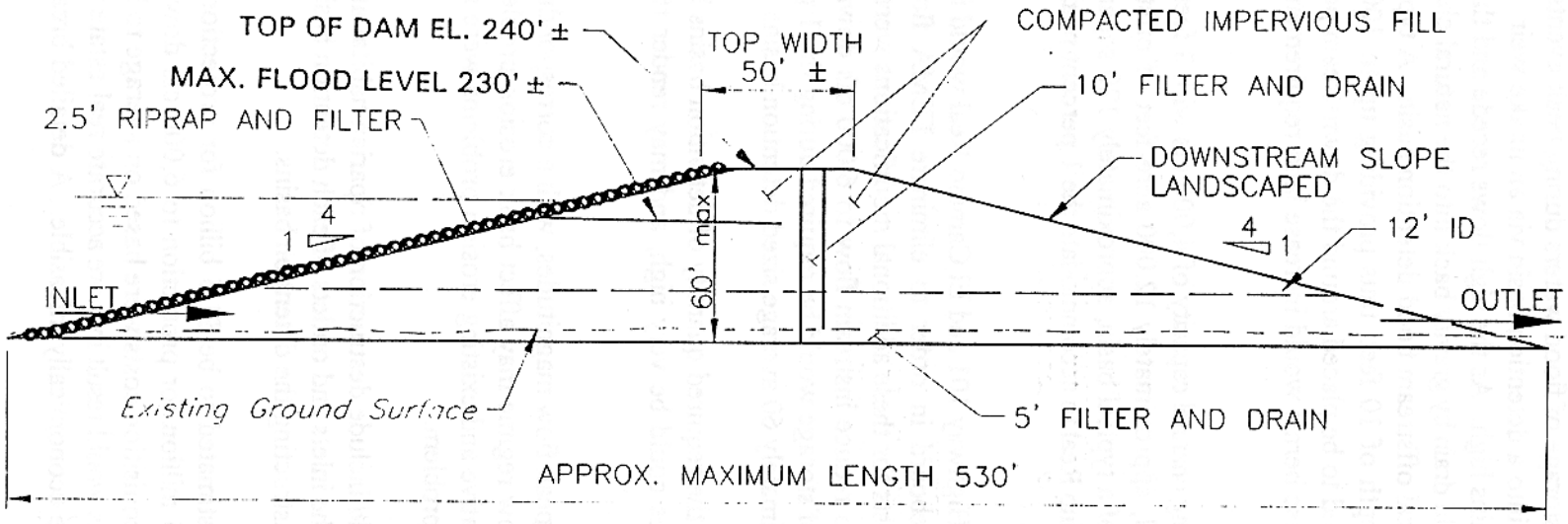
TYPICAL SECTION
Section at Maximum Height
not to scale

Figure 15
San Francisquito Creek
Webb Ranch Flood Basin
High Dam



not to scale

Figure 14
San Francisquito Creek
Webb Ranch Flood Basin
Area of Inundation



TYPICAL SECTION
Section at Maximum Height
not to scale

Figure 16
San Francisquito Creek
Webb Ranch Flood Basin
Low Dam

Upstream Diversion and Offstream Storage

The idea of this alternative was examined in the past by the Corps and others. The alternative would consist of constructing offstream facilities for storage of flood waters during peak events. High flows would be diverted from the natural channel into a detention basin via an intake weir. Water would remain in storage while the creek flow remains high. As the high flows recede and the water in the creek channel lowers, the detention basin would drain by gravity back into the natural channel. Figure 17 depicts a plan and section view of a typical offstream flood detention basin. A typical detention basin may be ten acres with an average depth of 10 feet, thus providing up to 100 acre-feet of temporary storage. An earthen berm may need to be placed around the downstream portion of each storage basin in areas of sloping land. These berms would increase land requirements by about 5 percent for each basin.

To attenuate flows to accommodate the existing channel capacity of 4,000 cfs with 3 feet of freeboard between Highway 101 and El Camino Real, approximately 12,000 acre-feet of offstream storage would be required. Given the dimensions of a typical basin, approximately 120 separate detention basins would be required upstream of El Camino Real to accommodate the 1 percent peak event under existing channel conditions.

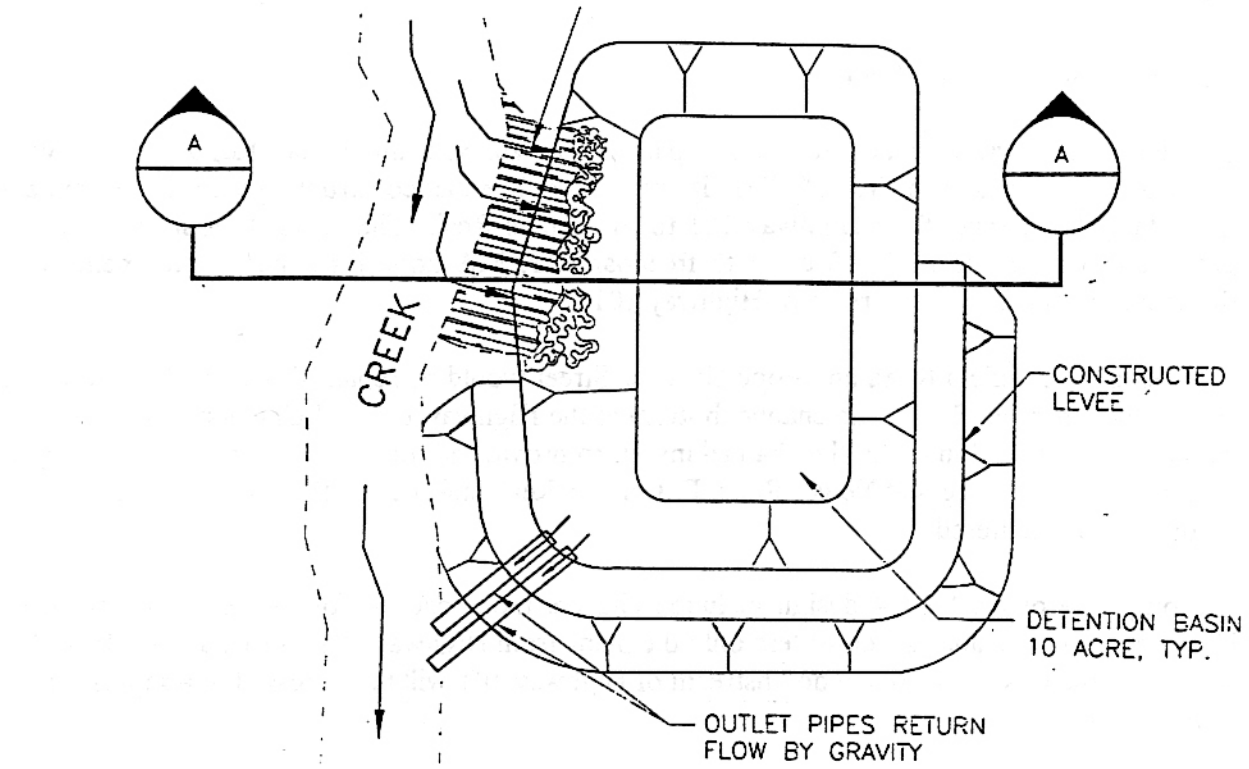
Modifications in the channel reach between Highway 101 and El Camino Real would be required to convey the 6,000 cfs with 3 feet of freeboard in order to eliminate FEMA flood insurance requirements upstream of Highway 101. Costs for these additional modifications were not included in the cost estimate for this alternative. To reduce instream flow to 6,000 cfs downstream of El Camino Real, approximately 6,000 acre-feet of storage would be required during the 1 percent event. This would necessitate constructing approximately 60 average sized detention basins.

At this time, possible sites for constructing the required quantity of detention basins have not been identified. Real estate values for these sites could be very high, and may render this alternative economically infeasible.

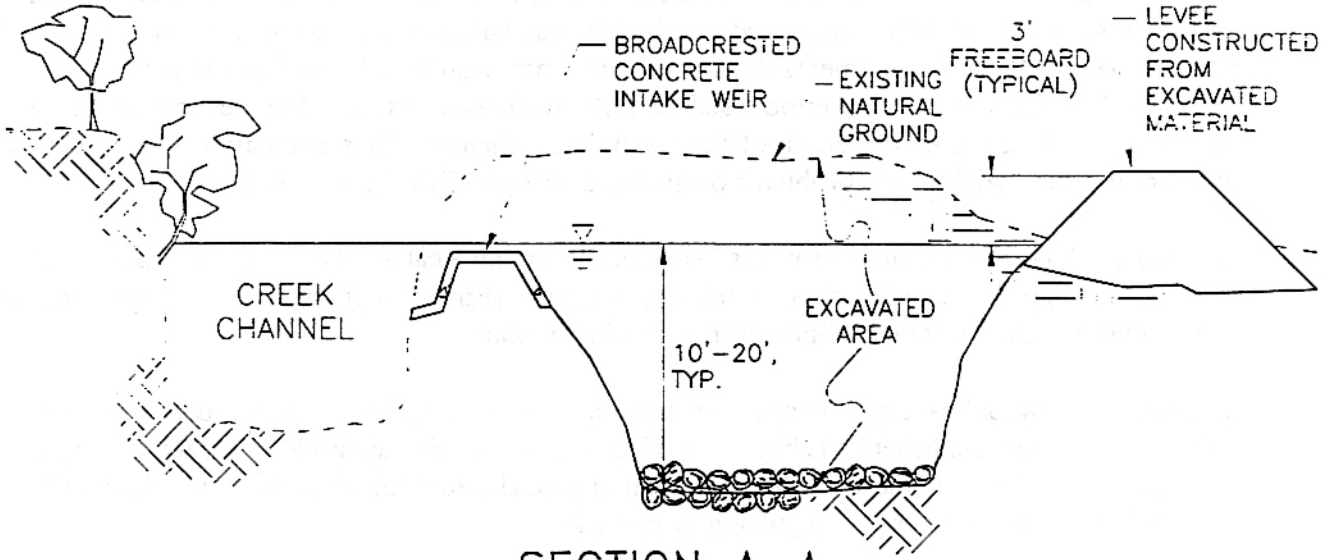
This alternative would result in a decrease in peak flow magnitudes, with a corresponding increase in the duration of high flows. The altered flow regime may affect bank erosion problems. Possible erosion problems resulting from this alternative and existing erosion problems were not examined. Sedimentation would also continue to be a problem.

Environmental impacts of this alternative could include destruction of riparian habitat at the locations of intake weirs; possible fisheries impacts at the inlets and outlets of each detention basin; and upland impacts due to clearing, excavating and constructing the detention basins.

The total first cost of this alternative is estimated to be $1.5 billion for protection to 4,000 cfs downstream of El Camino Real, and $505 million for protection to 6,000 cfs downstream of El Camino Real, both in 1996 dollars. Land acquisition costs were based on average to high estimates of local real estate values. Further site analysis would result in more accurate real estate values, and/or a determination that this alternative may be economically infeasible. A detailed breakdown of the estimated costs is included in Appendix A.



PLAN VIEW
not to scale



SECTION A–A
not to scale

Figure 17
San Francisquito Creek
Offstream Flood Detention Basin
Typical Plan and Section

Concrete Channel Modification

This alternative was designed in 1964, as part of the Wilsey, Ham & Blair Report, "Improvement Study of San Francisquito Creek." The alternative would entail constructing a concrete trapezoidal or rectangular channel from Highway 101 to El Camino Real. The channel would be deeper and provide protection up to 9,400 cfs with freeboard. FEMA flood insurance requirements would, therefore, be eliminated upstream of Highway 101.

Bridges at Middlefield Road and Pope/Chaucer Street would be replaced with bridges designed to convey the 1 percent flow. The channel bottom at the Highway 101 and University Avenue bridges would be lowered, along with the channel invert, to provide additional capacity for conveying the 1 percent flow. The bridges at Newell Road, El Camino Real, and the Southern Pacific Railroad tracks would remain unaltered.

Although the original 1964 design included channel modifications for the reach downstream of Highway 101, this analysis considers only the plans from Highway 101 to El Camino Real. Flood control alternatives for the reach downstream of Highway 101 will be discussed in a separate section of this report.

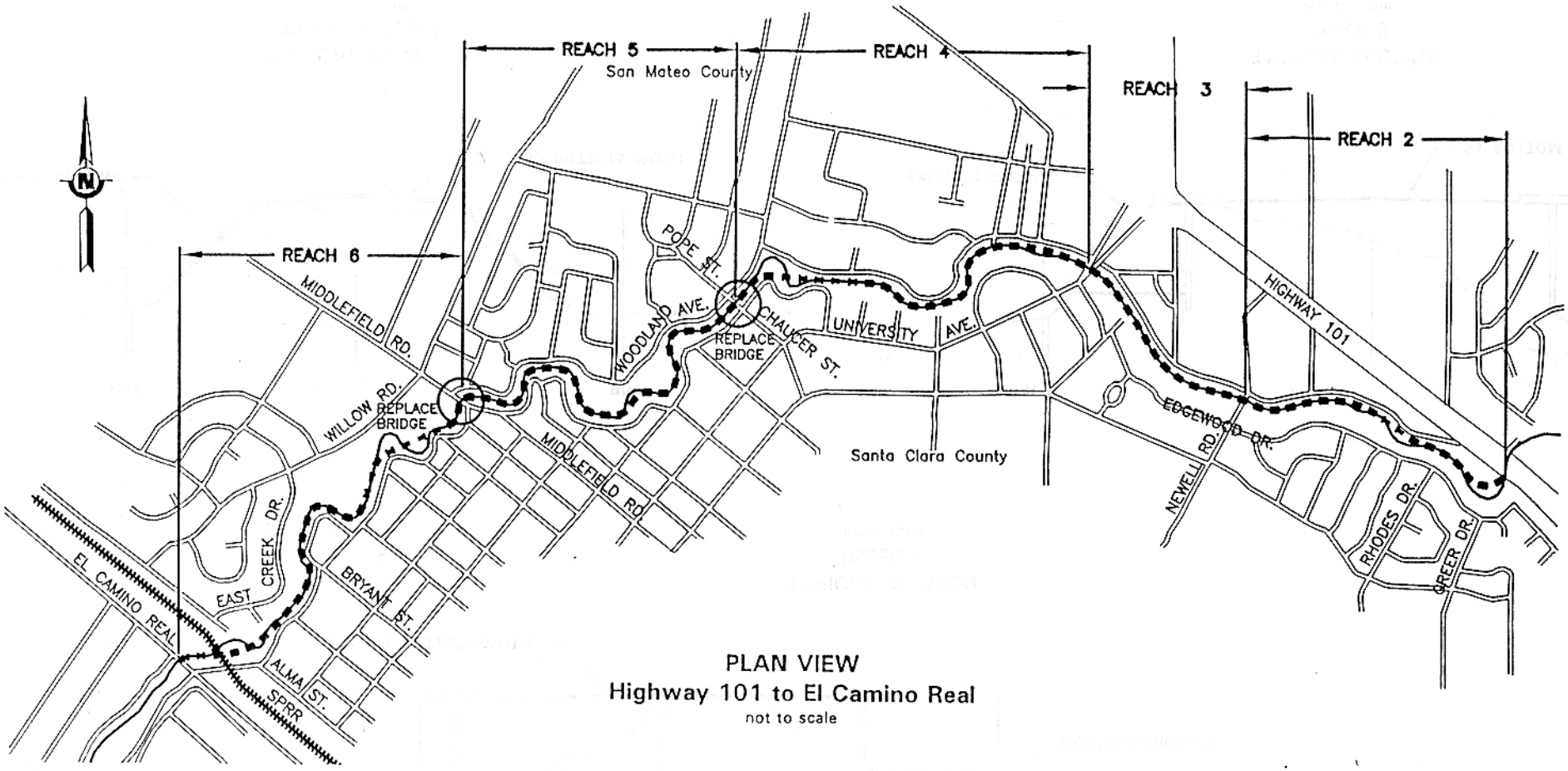
Figure 18 illustrates the layout of the concrete channel, which follows the alignment of the natural creek. Figure 19 depicts typical cross sections used in this design.

This alternative would eliminate bank erosion problems between Highway 101 and El Camino Real. Since the channel would have concrete sides and bottom, it would not be subject to erosion. However, sediment and debris associated with high flows could subject the concrete lining to abrasive forces. Maintenance requirements for the project reach would be limited to the removal of large debris such as fallen trees and periodic sediment removal, as necessary. Maintenance access would be provided along the entire length of the constructed channel. This alternative does not address erosion or other maintenance problems occurring upstream of El Camino Real.

By eliminating potential sediment sources between El Camino Real and Highway 101, this alternative may reduce fluvial sedimentation in the reach downstream of Highway 101. However, tidal sedimentation downstream of Highway 101 would continue.

This alternative would have severe environmental impacts. Channelization and concrete lining would destroy the riparian and fisheries habitat from Highway 101 to El Camino Real. Habitat provided by San Francisquito Creek in these reaches may support special status species; destruction and mitigation of such habitat would be highly regulated or untenable.

Due to excessive significant environmental impacts, this alternative is not feasible. No feasible sites would be available for mitigation of impacts to over three miles of stream corridor. Therefore, cost estimates were not prepared for this alternative.

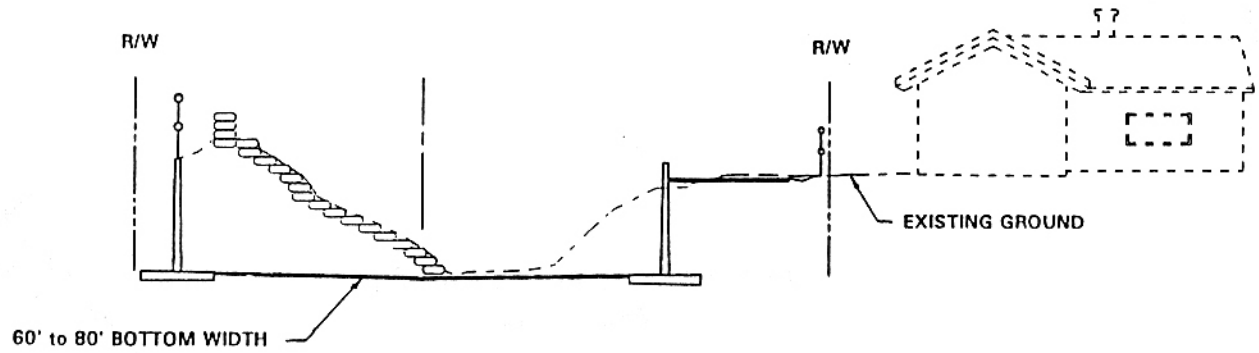


PLAN VIEW
Highway 101 to El Camino Real
not to scale

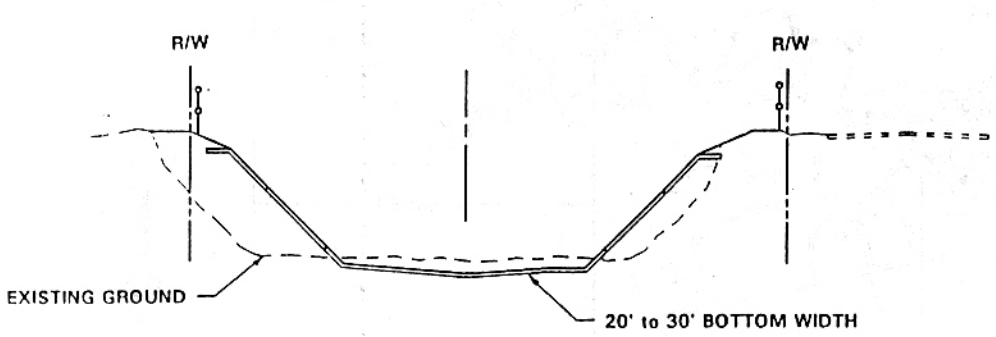
LEGEND
EXISTING NATURAL CREEK
CONCRETE LINED CHANNEL

NOTES:
1. Plans by Wilsey, Ham & Blair, 1964
2. See Figure 19 for typical sections

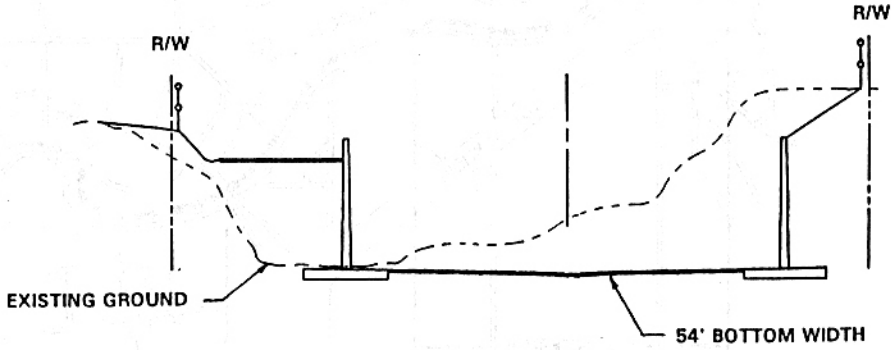
Figure 18
San Francisquito Creek
Concrete Channel Modification
Plan Layout



TYPICAL SECTION
Reach 2
not to scale



TYPICAL SECTION
Reach 3, 4, & 5
not to scale



TYPICAL SECTION
Reach 6
not to scale

Figure 19
San Francisquito Creek
Concrete Channel Modification
Typical Secti

Natural Channel Widening

This alternative was included in this study as a more feasible approach to a channel modification alternative and would provide protection up to 9,300 cfs with freeboard. The idea of this alternative would be to acquire sufficient right-of-way from Pope/Chaucer Street to Highway 101 to allow the creek to naturally erode and seek its own stable configuration over time, without requiring in-channel work or bank stabilization. The bridges at Pope/Chaucer Street and Middlefield Road would be replaced with bridges that could convey the 1 percent flood. Eliminating these existing bridges would allow the 1 percent event to remain contained in the channel upstream of Pope/Chaucer Street. However, downstream of Pope/Chaucer Street, levees or floodwalls would be required to provide 1 percent protection. Figure 20 shows the layout and components of this alternative.

The levees or floodwalls would be set back from the top of the banks along the creek corridor to allow the creek banks to naturally erode and seek a stable configuration. An appropriate top width that allows for natural erosion of the creek banks along the creek corridor would be acquired.

A 2:1 side slope was used on both sides of the creek to estimate a channel width for this alternative. A comprehensive geomorphic investigation would be required to determine the actual appropriate creek corridor width. Estimated levee widths, based on required height of protection, were added to the estimated top widths as part of the land requirements.

Figures 21, 22, and 23 illustrate typical cross sections for this alternative. These cross sections show the estimated 2:1 bank slope and flood control measures at each reach. The required right-of-way width would vary from reach to reach, but would generally be from the northern edge of Edgewood Drive, Crescent Drive, and Palo Alto Avenue on the Santa Clara County side of the creek, to the southern edge of Woodland Avenue on the San Mateo County side of the creek. In Reaches 2, 3, and 4A, Woodland Avenue and the first row of properties would also be required. These figures illustrate the impacts that this alternative would have on creekside properties and roads.

Figure 20 shows the reaches where levees or floodwalls would be. All levees and floodwalls include 3 feet of freeboard to meet FEMA requirements. Construction of floodwalls to heights greater than 6 feet was not considered feasible, as it would severely restrict access to the creek for both maintenance and recreational purposes. Therefore, levees would be used along reaches requiring more than 6 feet of protection.

For this alternative, approximately 13,200 linear feet of levee ranging from 5 to 10 feet in height would be constructed, with 6,100 linear feet in Menlo Park and 7,100 linear feet in Palo Alto. Approximately 4,400 linear feet of floodwall would be constructed, with 3,200 linear feet of a 5 to 6 foot high wall in Menlo Park and 1,200 linear feet of a 5 foot high wall in Palo Alto. Table 6 tabulates the required levee or floodwall heights for each reach downstream of Pope/Chaucer Street.

Table 6
San Francisquito Creek
Natural Channel Widening
Levee and Floodwall Heights and Land Requirements

Reach	Levee or Floodwall	Required Height of Levee or Floodwall (feet)	Number of Parcels Required in San Mateo County	Number of Parcels Required in Santa Clara County	Undeveloped or Partial Acquisitions Required from both Counties (acres)
2	Levee	7 to 9	17	38	1.0
3	Levee	7 to 10	13	17	1.3
4	Both	5 to 7.5	6	16	2.9
Total			**36**	**71**	**5.2**

Acquisition of many creekside properties would be necessary to implement this alternative. The approximate extent of right-of-way required is shown in Figure 20. Where residential parcels would be substantially reduced by right-of-way requirements, or where access to parcels would be completely cut off by the acquisition of roadways, full acquisition of parcels would be required. Where only a small part of a parcel would be required for adequate right-of-way, partial acquisition of that parcel would be required. In this way retention of property by creekside property owners could be maximized. Table 6 tabulates the estimated number of parcels and acres of land required for this alternative. In San Mateo County, approximately 36 parcels would be taken in whole. In Santa Clara County, approximately 71 parcels would be taken in whole. In addition, approximately 5 acres of land, either undeveloped or partial acquisitions, would be required as well as about 6,000 linear feet of Woodland Avenue.

Downstream of Pope/Chaucer Street, local drainage into San Francisquito Creek would be adversely affected during high flow events by the higher water surface caused by levees and floodwalls.

Maintenance requirements for the creek between Pope/Chaucer Street and Highway 101 would be significantly reduced. Bank erosion and channel vegetation would be allowed to occur. Periodic removal of large debris, such as fallen trees, would still occur, as such debris poses a threat to bridges. Problems posed by erosion upstream of Pope/Chaucer Street were not addressed by this alternative.

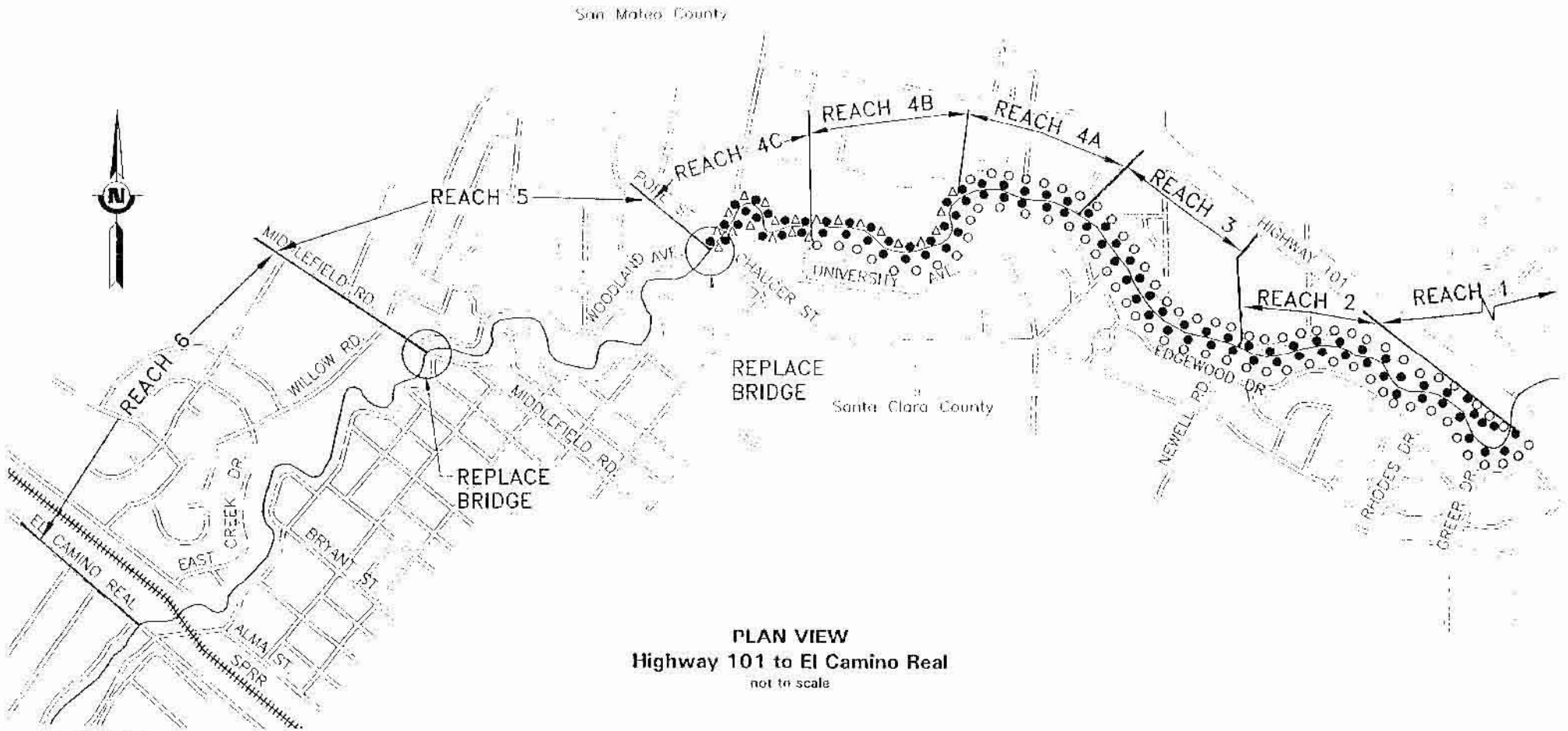
Sedimentation within the project reaches was not expected to affect performance of the flood control measures, and would be left in place. However, sediments resulting from natural erosion may be

transported and deposited downstream of Highway 101, potentially increasing sediment problems in that area. Problems related to tidal sedimentation downstream of Highway 101 were not addressed by this alternative.

This alternative would establish continuous maintenance access from Pope/Chaucer Street to Highway 101 and could provide recreation opportunities such as creekside bicycle/pedestrian paths and parks along acquired rights-of-way.

Environmental impacts of this alternative would be very low, as the riparian corridor would remain essentially undisturbed and buffer areas created throughout the project reaches. Localized remediation may be necessary at Middlefield Road and Pope/Chaucer Street, due to short term construction disturbances from the bridge replacements.

The total first cost of this alternative, in 1996 dollars, is estimated to be $78 million. A detailed breakdown of the estimated costs is included in Appendix A.



PLAN VIEW
Highway 101 to El Camino Real
not to scale

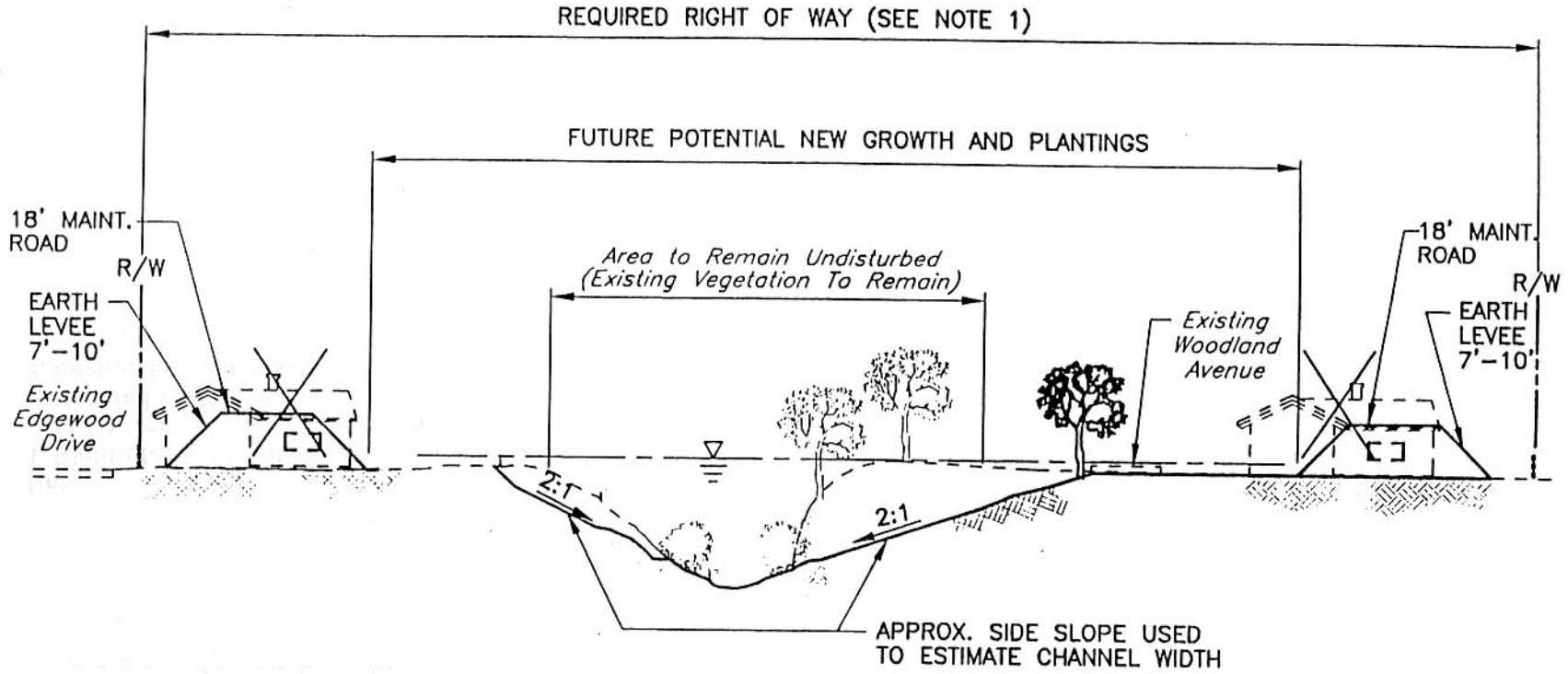
LEGEND

- EXISTING NATURAL CREEK
- EXISTING ROADS
- OOO LEVEES
- ΔΔΔ FLOODWALLS
- ●●● PROPOSED BUFFER ZONE (NATURAL EROSION WIDENING)

NOTES:

1. **Existing vegetation to remain**
2. **See Figure 21, 22, and 23 for typical sections**

Figure 20
San Francisquito Creek Natural Channel Widening Plan Layc

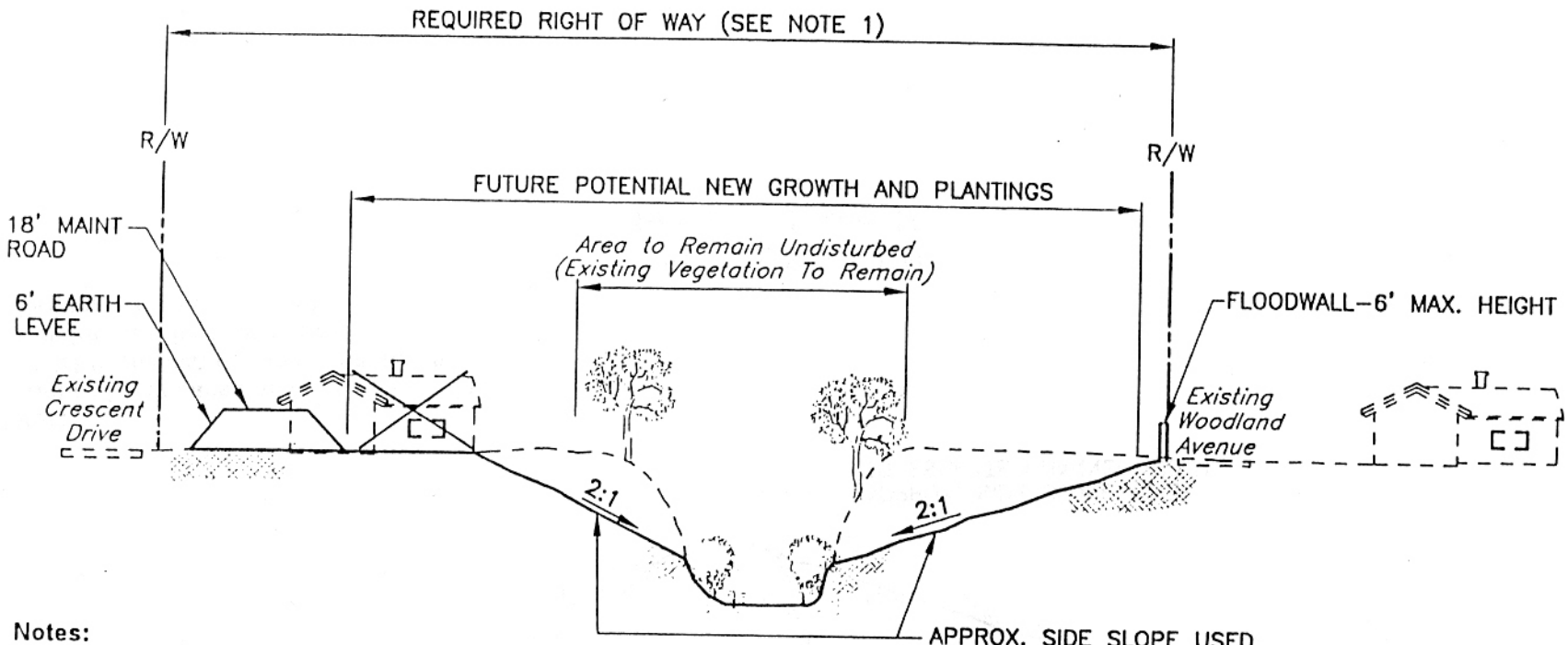


Notes:

1. **Right-of-way based on approx. side slope of 2:1 from existing toe of channel, plus required width of earth levee.**
2. **Section looking upstream.**

TYPICAL SECTION
Reach 2, 3, and 4A
not to scale

Figure 21
San Francisquito Creek
Natural Channel Widening

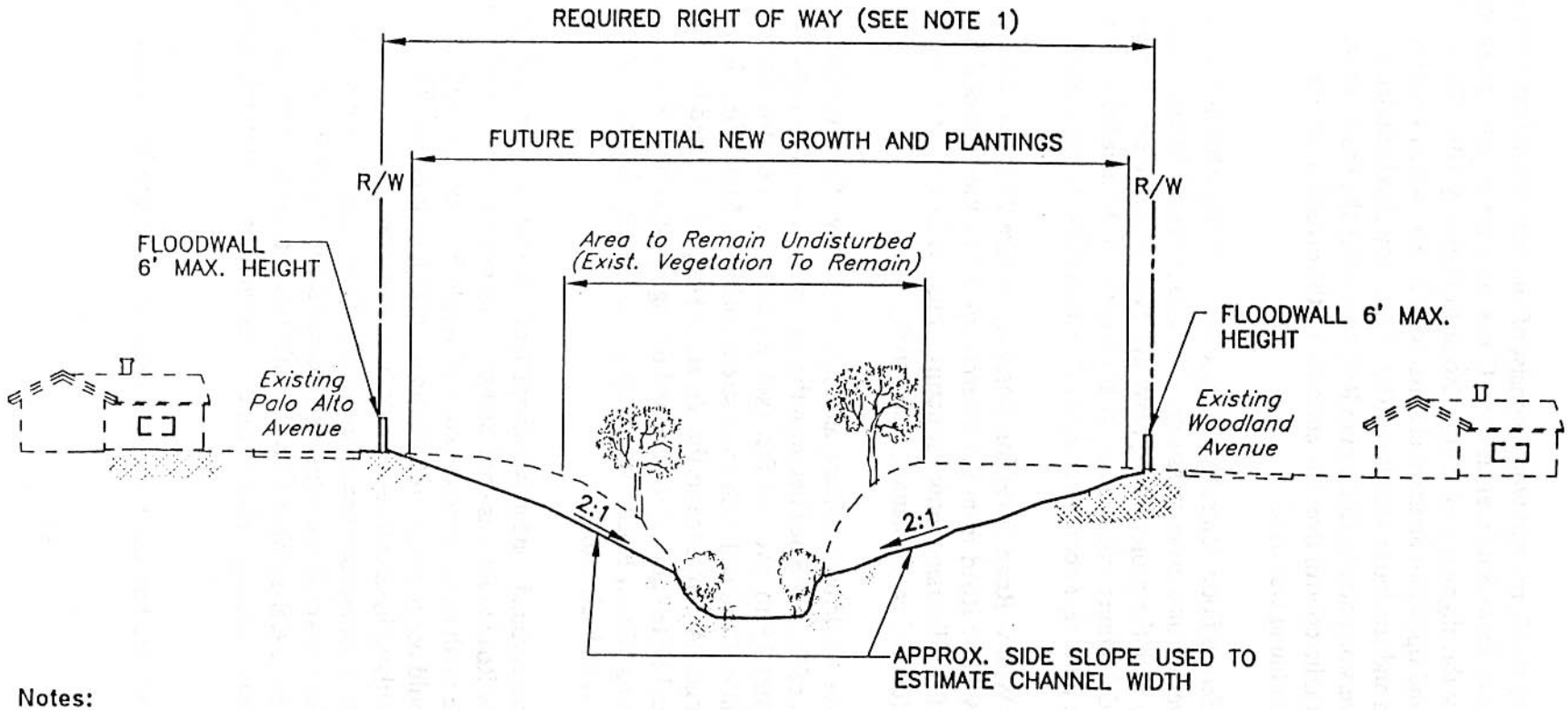


Notes:

1. Right-of-way based on approx. side slope of 2:1 from existing toe of channel, plus required width of earth levee.
2. Section looking upstream.

TYPICAL SECTION
Reach 4B
not to scale

Figure 22
San Francisquito Creek
Natural Channel Widening



Notes:
1. Right-of-way based on approx. side slope of 2:1 from existing toe of channel, plus required width of earth levee.
2. Section looking upstream.

TYPICAL SECTION
Reach 4C
not to scale

Figure 23
San Francisquito Creek
Natural Channel Widening

Willow Road Diversion Conduit

This alternative was studied in 1972 by the Corps and would consist of an underground concrete box conduit that would divert high flows from San Francisquito Creek at a point just upstream of Middlefield Road and would follow the alignment of Willow Road to Highway 101. The conduit would continue under the highway and open into an earth channel with levees, which would parallel Willow Road to Ravenswood Slough and continue to the Bay. The 1972 study also included concrete lining the channel upstream of the diversion point to El Camino Real to protect the creek against high erosion forces and to maintain hydraulic control over the entrance to the diversion conduit. In this alternative analysis, however, gabion lining was used.

This alternative was the locally preferred flood control plan in the early 1970's, when local citizens expected Willow Road to be converted into an expressway. The underground diversion conduit would have been built concurrently with the proposed expressway. However, the expressway was never built and minor channel modifications, constructed in 1969 between Middlefield Road and Highway 101, made this alternative no longer economically feasible, according to the Corps.

Figure 24 shows the layout of the Willow Road Diversion Conduit. Figure 25 shows the ground surface and conduit profile along Willow Road from the diversion point to Ravenswood Slough. Figure 26 is a schematic diagram of the diversion intake structure. Figures 27 and 28 show typical cross sections of the diversion conduit and earth channel, respectively.

Construction impacts of this alternative would be significant, although temporary. Construction would require excavation along the length of Willow Road between the diversion point and Highway 101, with excavation depths ranging from 15 to over 30 feet (see Figure 25). Construction would necessitate temporary closures of Willow Road and each cross street, including Middlefield Road and part of the Highway 101 interchange. An entrance to the Veterans Hospital, located just west of Highway 101 on Willow Road, would be temporarily obstructed during construction. Construction would also impact major utilities along Willow Road. Water, gas, storm drain, electrical, telephone and sewer lines would be interrupted and relocated.

Downstream of Highway 101, the underground conduit would open into an earth channel with levees, which would follow alongside Willow Road to Ravenswood Slough. The ground surface and conduit profile in Figure 25 illustrates that the earth levee diversion channel would be above ground; the low-lying natural ground in this area would not provide cover for an underground conduit. The channel bottom would remain below grade, although earth levees would be constructed to several feet above grade. Bridges would be required at existing road crossings, the Southern Pacific Railroad (SPRR) tracks, and State Route 84. The channel would also cross the Hetch-Hetchy pipeline. To construct this channel, approximately 80 parcels paralleling Willow Road would be acquired and cleared. These parcels include high-density, low-income housing. There would be social impacts from relocating up to 300 families.

As an alternative to an open channel, the box conduit could continue above grade downstream of Highway 101, with Willow Road rebuilt on top. Willow Road would then be elevated above

surrounding structures, including connecting streets and driveways. This option would preserve real estate and structures next to Willow Road, although access to the elevated Willow Road would be hampered. Connecting streets and driveways would need to be raised to meet the elevated Willow Road. At Ivy Drive, Willow Road would be rebuilt approximately 12 feet above existing grade. At the SPRR tracks and State Route 84, Willow Road would be approximately 14 feet above grade. Cost estimates for this option, to continue the conduit above grade downstream of Highway 101, were not determined.

Two separate conduit sizes were investigated as part of this alternative. The larger conduit, at approximately 11 feet high by 37 feet wide, would reduce instream peak 1 percent flow to approximately 4,000 cfs downstream of the diversion. Under existing conditions, channel capacity between El Camino Real and Highway 101 is estimated to be 4,000 cfs with 3 feet of freeboard, thus the larger conduit would provide 1 percent protection and eliminate FEMA flood insurance requirements upstream of Highway 101.

The smaller conduit, at approximately 11 feet high by 26 feet wide, would reduce instream peak 1 percent flow to approximately 6,000 cfs downstream of El Camino Real. Channel modifications between El Camino Real and Highway 101 would be required to convey the 6,000 cfs with 3 feet of freeboard in order to eliminate FEMA flood insurance requirements upstream of Highway 101. Costs for these additional modifications were not included in the cost estimate for this alternative.

Except for the level of flood protection provided, the only difference between the two alternatives investigated is the size of the diversion conduit and costs associated with construction.

Because the Willow Road Conduit would divert high flows out of the creek upstream of Middlefield Road, the erosive forces of very high flows would be reduced. However, the frequency of low and medium flows would not be reduced, and would continue to contribute to erosion problems. No measures to reduce erosion problems either upstream or downstream of the diversion point were included in this alternative, except gabion lining between El Camino Real and the diversion point. Therefore, bank protection projects may still be required as well as the removal of large debris such as trees from the creek channel. Large debris may also have to be periodically removed from the diversion conduit. The concrete surfaces of the diversion conduit would also have to be monitored for abrasion and repaired as necessary.

This alternative does not address sedimentation problems. Furthermore, sedimentation within the underground conduit, either at the upstream end from fluvial transport, or at the downstream end from tidal inflow, is likely. A detailed study would be required to analyze the likelihood or impact of sedimentation along the diversion conduit.

Environmental impacts associated with the Willow Road Diversion Conduit alternative could include impacts on the riparian zone upstream of the diversion point, where the banks would be lined with gabions. In addition, fish passage issues at the inlet and outlet of the diversion conduit must be addressed. There would also be impacts on tidal lands, where earth levees would be built, and potential impacts associated with introducing freshwater to a brackish slough. A detailed analysis of

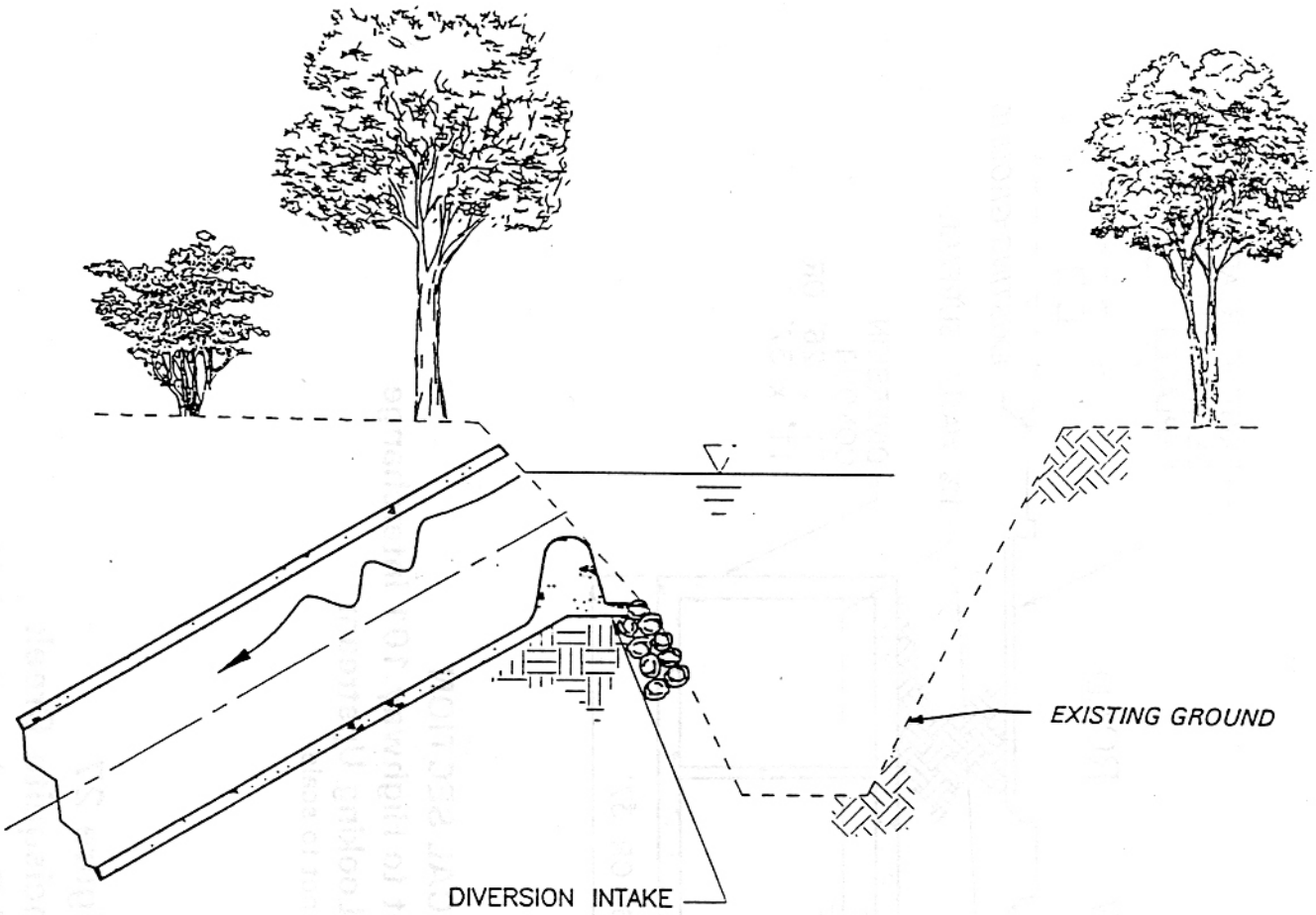
the environmental impacts would be done as part of a comprehensive investigation.

An alternative to routing the conduit along Willow Road would be to route it along Menalto Avenue. High flows would be diverted from San Francisquito Creek at a point just downstream of the Pope/Chaucer Street bridge. This alternative would require replacing the bridges at Middlefield Road and Pope/Chaucer Street to provide adequate capacity for the 1 percent peak flow upstream of Pope/Chaucer Street. There are several advantages to this design over the Willow Road plan:

- Upstream of Highway 101, the underground conduit would be approximately half the length of the Willow Road Conduit.
- Construction would take place on a minor street, rather than a major thoroughfare, lessening the overall traffic impacts.
- Upstream of Highway 101, there are no major street crossings or interchanges.
- The tunnel at Highway 101 would be shorter, crossing at a straight section of highway, rather than through an interchange.
- Menalto Avenue may have fewer utilities than Willow Road.

The disadvantages of the Menalto Avenue Conduit occur downstream of the end of Menalto Avenue, where the conduit would have no clear path to the Bay. At this point, the conduit would cross residential neighborhoods, industrial parks, the Hetch-Hetchy pipeline, SPRR tracks, and State Route 84. This possible alternate alignment is shown on Figure 24. Because the purpose of this analysis was to update previously considered alternatives, a conduit along Menalto Avenue was not fully investigated.

The total first cost of this alternative is estimated to be $191 million for protection to 4,000 cfs downstream of Middlefield Road, and $170 million for protection to 6,000 cfs downstream of Middlefield Road, both in 1996 dollars. A detailed breakdown of the estimated costs is included in Appendix A.



TYPICAL SECTION
Section at Diversion Intake Point
not to scale

Figure 26
San Francisquito Creek
Willow Road Diversion Conduit
Diversion Intake Structure

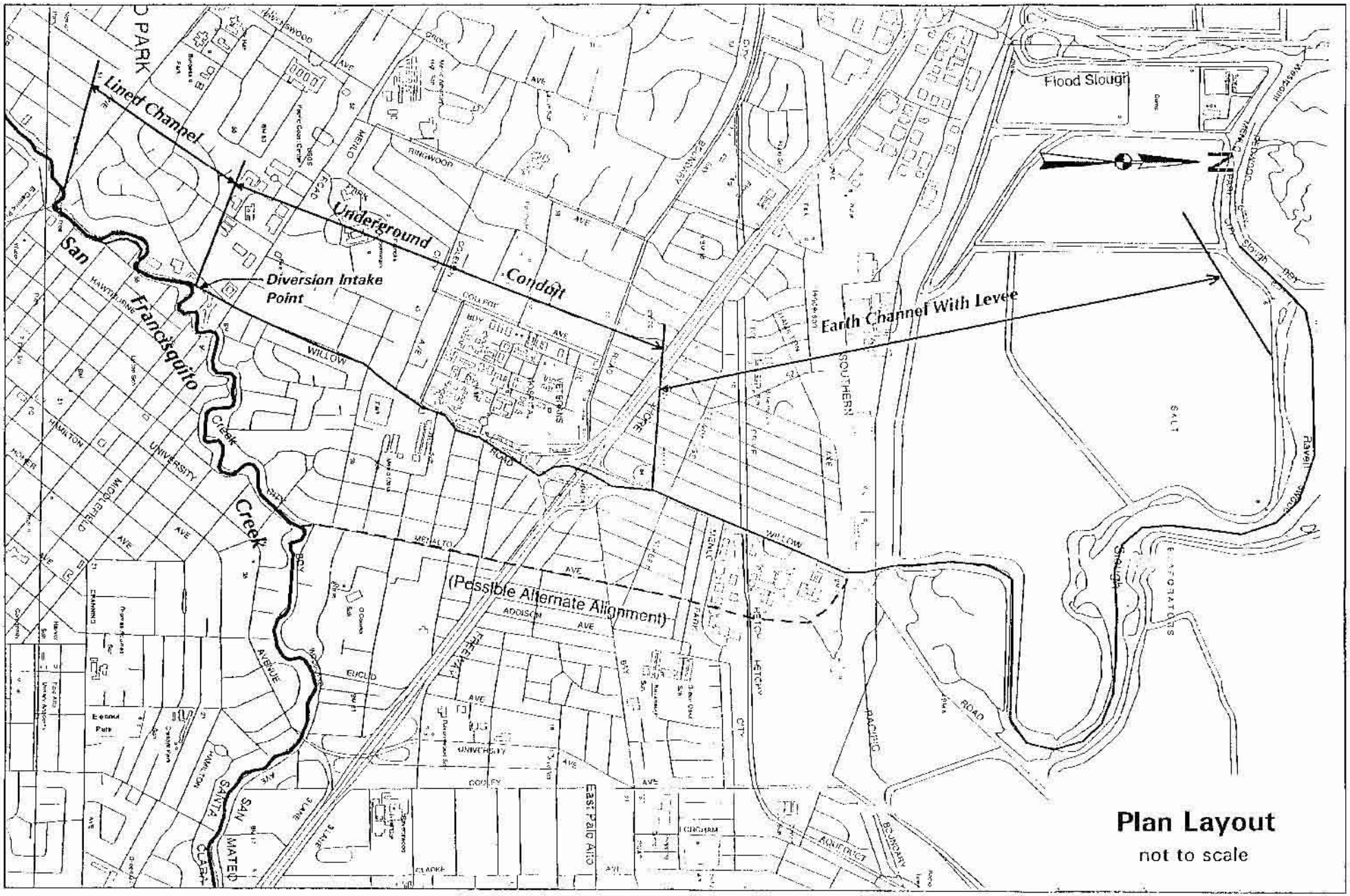


Figure 24
San Francisquito Creek
Willow Road Diversion Conduit

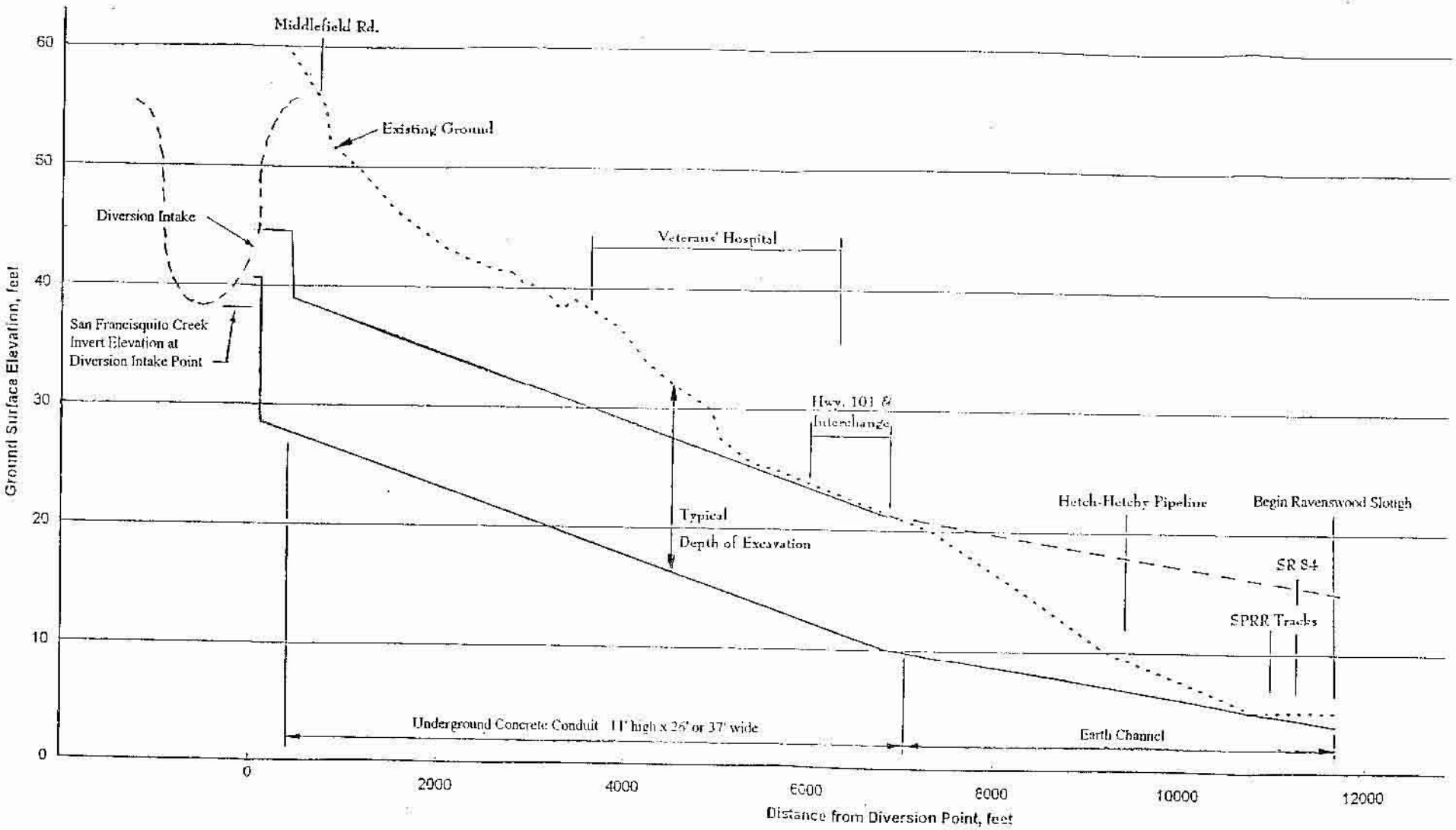
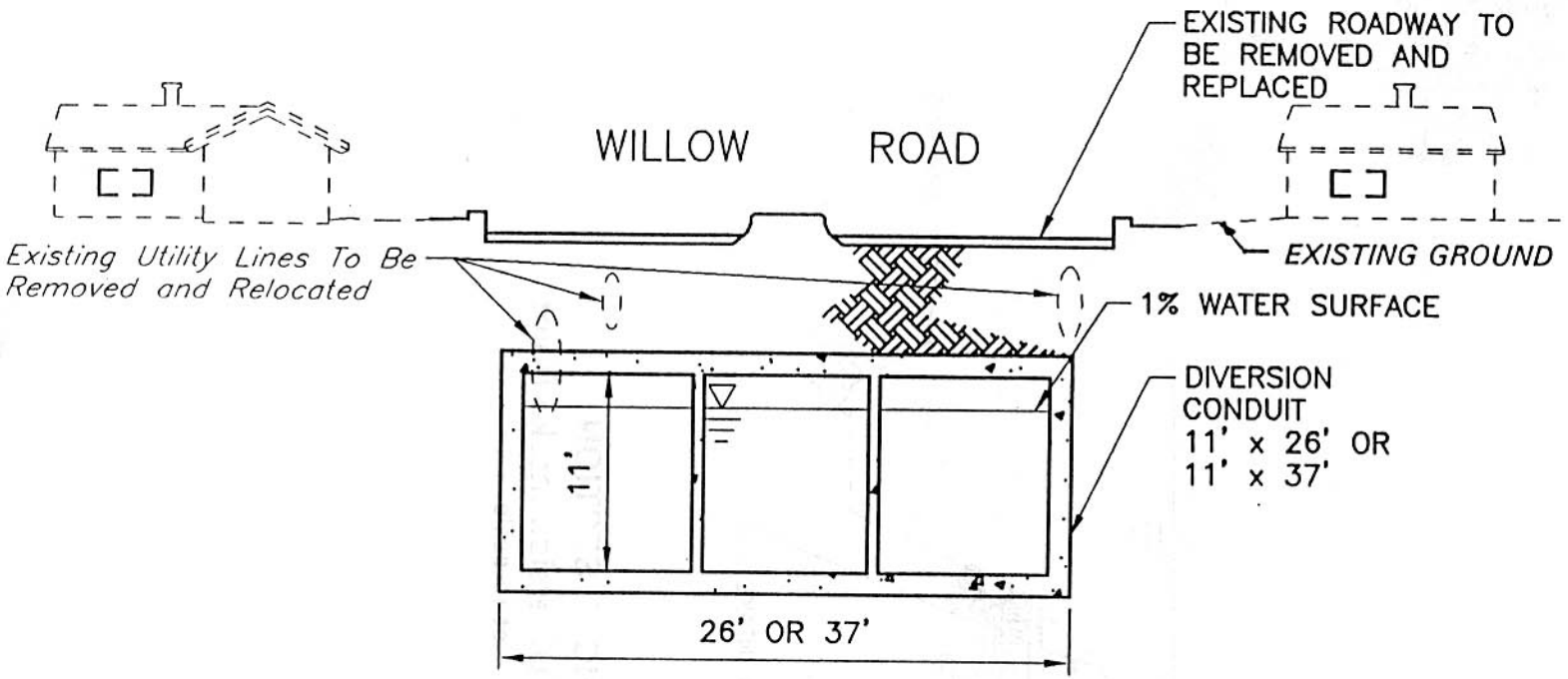
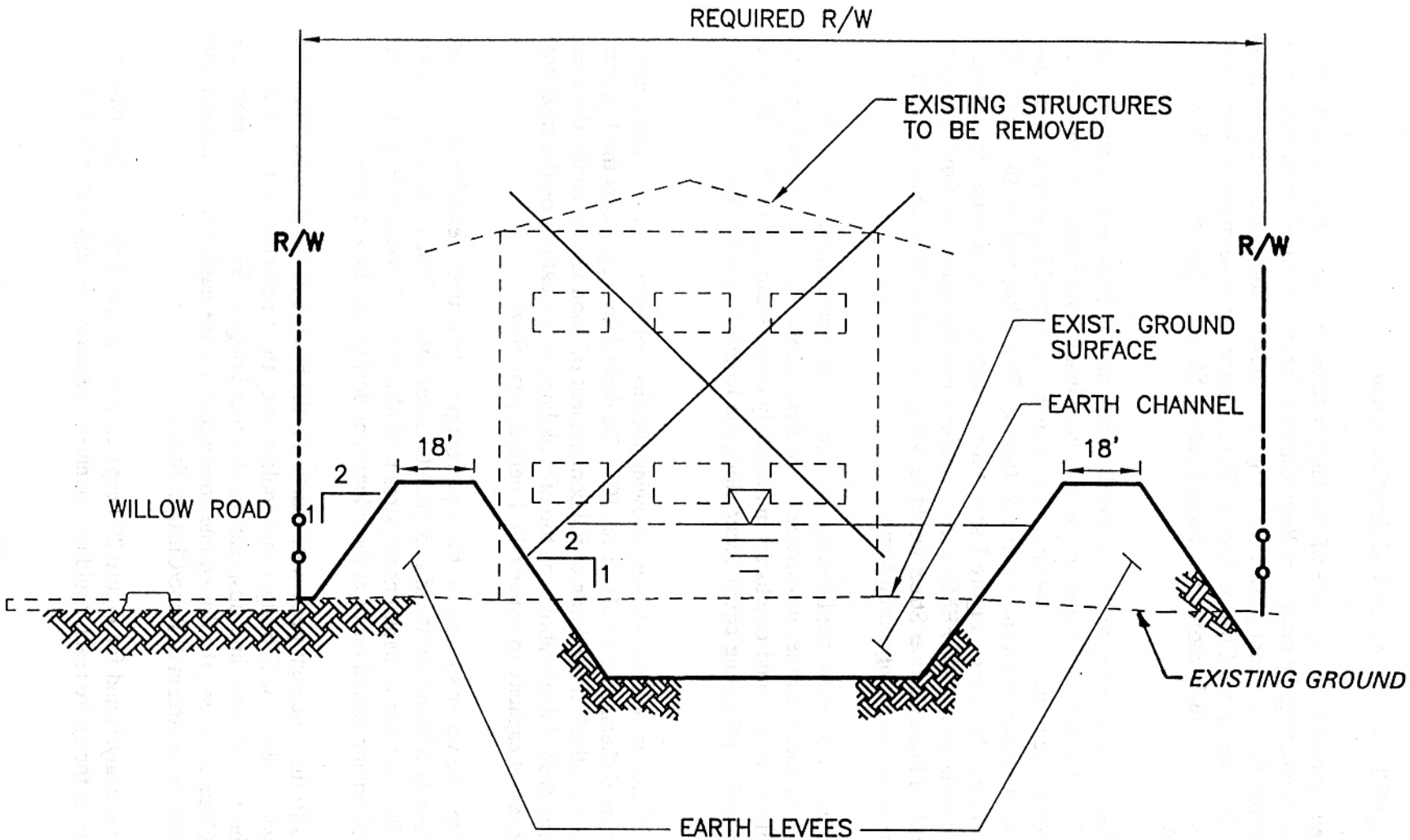


Figure 25
San Francisquito Creek
Willow Road Diversion Conduit
Ground Surface and Cor it Profile



TYPICAL SECTION
Diversion Intake Point to Highway 101 Interchange
Section Looking Upstream
not to scale

Figure 27
San Francisquito Creek
Willow Road Diversion Conduit
Underground Concrete Conduit



TYPICAL SECTION
Highway 101 Interchange to Ravenswood Slough
Section Looking Upstream
not to scale

Figure 28
San Francisquito Creek
Willow Road Diversion Conduit
Earth Channel with Levees

Replace Bridges at Pope/Chaucer Street and Middlefield Road

This alternative merited investigation because of the large interest by the CRMP group. The alternative would involve replacing the bridges at Pope/Chaucer Street and Middlefield Road with bridges that would convey the 1 percent peak flow. Figure 6 shows photographs of the bridge openings at Middlefield Road and Pope/Chaucer Street. These photos show normal low flow water levels, except photo S426-8, which shows the Pope/Chaucer Street bridge culvert flowing at approximately 2,800 cfs.

Under existing conditions, these bridges cause overbanking during flow events larger than approximately 6,000 cfs. This occurs because the bridges have inadequate hydraulic capacity and cause water to backup behind them and overflow out of the channel. Overbanking at these locations, causes flood water to flow overland on the south side through Palo Alto, and on the north side through Menlo Park and East Palo Alto. Figure 3 shows the areas subject to flooding during the 1 percent event, based on a preliminary 1996 FEMA maps. According to the study, the flow remaining in the channel downstream of Pope/Chaucer Street would be within the downstream channel capacity, and no further downstream overbanking would occur.

Replacing these bridges would not solve the flooding problem on San Francisquito Creek. It would only cause the water to breakout further downstream. Analysis shows that if both bridges were replaced, a 1 percent flow event would overbank immediately downstream of the Pope/Chaucer Street bridge. Continuous overbanking could occur along the length of the creek all the way to Newell Road or beyond.

Figure 29 is a profile of San Francisquito Creek, showing the channel bottom, top of bank, and 1 percent water surface from El Camino Real to Highway 101. The dashed line represents the 1 percent water surface under the hypothetical condition of full containment of flood waters within the creek corridor. Areas where the dashed line is above the top of bank line show locations on the creek that do not have adequate channel capacity to convey the 1 percent peak flow.

The dashed line indicates the water surface for the 1 percent peak flow under existing conditions, which include the bridges at Middlefield Road and Pope/Chaucer Street. The large discrepancies between the water surface and top of bank lines upstream of Middlefield Road and Pope/Chaucer Street confirm that overbanking would occur at these locations during high flow events.

The dotted line relates to the 1 percent peak water surface if the bridges at Middlefield Road and Pope/Chaucer Street were replaced with bridges that could convey the 1 percent event. The dotted line remains below the top of bank line upstream of the two bridges. However, immediately downstream of Pope/Chaucer Street, the dotted line converges with the dashed line, showing that overbanking would occur downstream of Pope/Chaucer Street.

The model used for this analysis and for Figure 29 keeps all water in the creek. In this way, the capacity of each section of the entire reach could be examined uniformly. It also becomes apparent that "fixing" one area would not solve the flooding problem, but simply move it somewhere else.

Replacing the bridges at Middlefield Road and Pope/Chaucer Street only, is not a feasible alternative solution to the potential flooding problem on San Francisquito Creek. It does not eliminate flooding from the 1 percent event. This alternative would simply move the overbanking problem downstream. Many of the same areas subject to flooding under existing conditions would remain in the floodplain, even with a changed overbanking location. New areas would also be subject to flooding. However, bridge replacement could become part of the solution for another alternative. Several alternatives discussed in this report include replacing the bridges at Middlefield Road and Pope/Chaucer Street.

All of the alternative solutions discussed for the reaches upstream of Highway 101 are summarized for comparison in Table 7.

Figure 29
San Francisquito Creek
1% Water Surface Profile
Highway 101 to El Camino Real
With and Without Pope/Chaucer St. and Middlefield Rd. Bridges

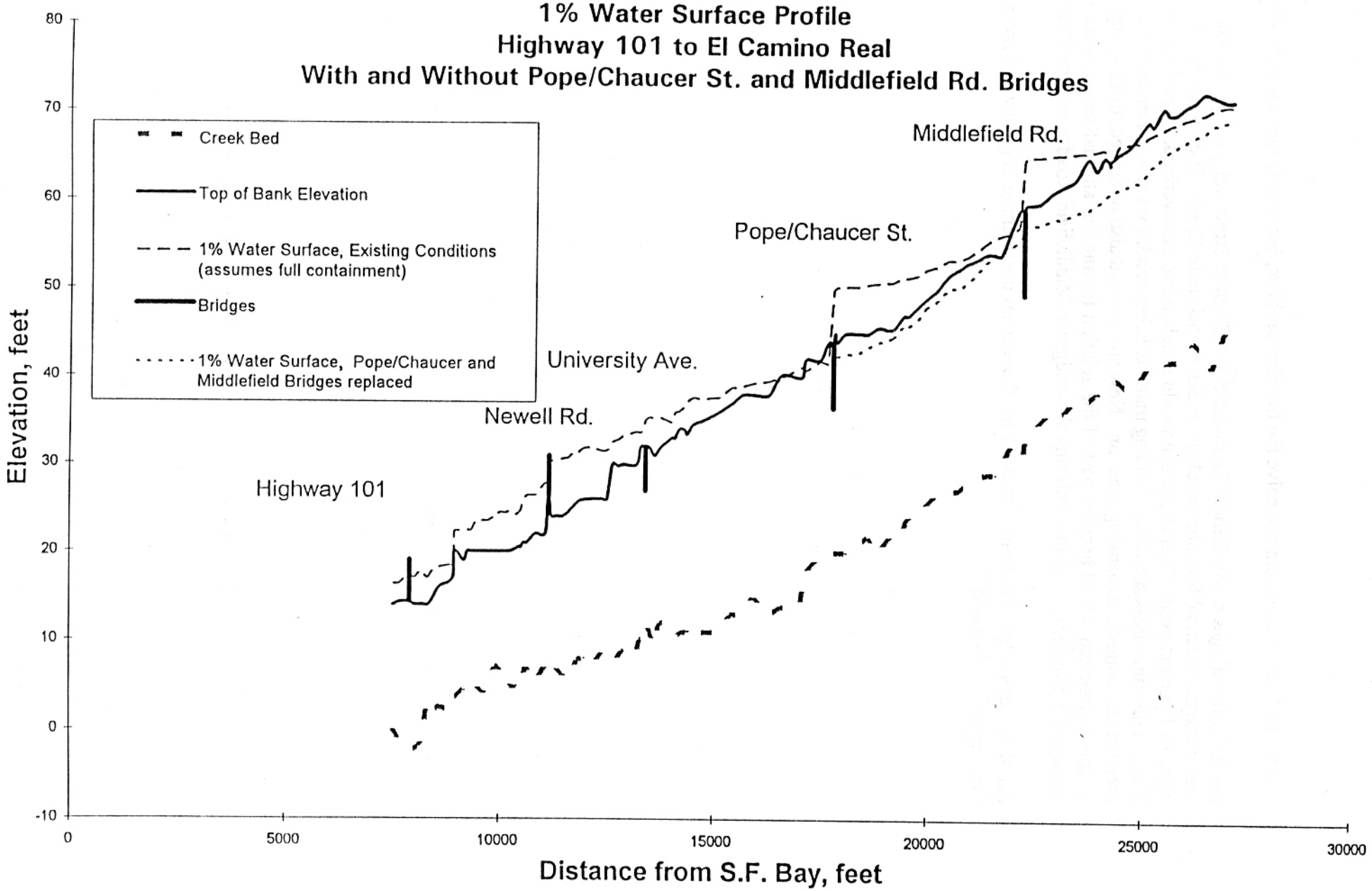


Table 7
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Upstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
No Project	No measures taken to reduce current risk of flooding. Ongoing erosion repair work and maintenance would be required.	Flooding problems and mandatory flood insurance would continue. A total of 4,850 buildings in both counties, mostly residential, would be affected by the 1% flood.	Sedimentation, erosion, and loss of private property would continue to occur.	Limited maintenance access along creek. Discontinuous rights-of-way and easements. Maintenance by SCVWD and SMCFCD would continue on agency's right-of-way and during high flows.	Areas downstream of El Camino Real are subject to flooding. Emergency bank protection measures would be necessary.	Does not solve problems of flooding, erosion, or sedimentation. FEMA flood insurance program requirements continue.	**First Cost:** **(Present Worth of Annual Costs)** **TOTAL** **$66.4** **Annual Cost:** Flood Damages 3.2 Emergency Costs 0.9 Ins. Admin. Costs 0.5 Maintenance 0.2 **TOTAL** **$4.8**
Expand Searsville Lake To reduce instream flow to 6,600 cfs downstream of El Camino Real.	Would raise Searsville Dam by approx. 20' to capture upstream floodwaters. Would inundate total of approx. 250 acres during 1% peak event (approx. 215 acres add'tl land) and new dam would cover approx. 300' of add'tl riparian corridor. Would reduce 1% peak flow at El Camino Real to 6,600 cfs. Lake would remain at existing level and size most of the time.	This alternative alone would not eliminate 1% flooding and mandatory flood insurance. Floodplain would remain downstream of Middlefield Rd.	Sedimentation, erosion, and loss of private property would continue to occur.	No Project maintenance program issues would continue. Additional sedimentation and maintenance issues may occur because of the lake and dam.	Could have potentially significant environmental and social impacts. New dam would have impacts on the riparian corridor.	Would inundate part of Jasper Ridge Biological Preserve during peak events. Would require acquisition of up to 16 hillside properties. Additional measures required downstream of El Camino Real to eliminate FEMA flood insurance requirements upstream of Hwy 101.	**First Cost:**[2] R/W 33.0 Construction 9.5 Mitigation 0.9 Design, Geotech., Insp. 3.9 **TOTAL** **$47.3** **Annual Cost:** Annualized First Cost 3.4 Annual Maintenance 0.2 **TOTAL**

Table 7
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Upstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
							$3.6
Webb Ranch Flood Basin High Dam To reduce instream flow to 4,000 cfs downstream of El Camino Real.	Would construct single-purpose flood control dam upstream of Hwy 280. Would require max. height of approx. 70', width of 1,760' along the crest, and max. length of approx. 610' in the direction of creek flow. Approx. 300 acres of land would be temporarily inundated during very large storm events, but would remain dry most of the time.	Would provide 1% protection upstream of Hwy 101.	Sedimentation process would continue. May reduce erosion problems.	No Project maintenance program issues would continue. Additional sedimentation and maintenance issues may occur because of the dam.	Could have social and potentially significant environmental impacts. May impact instream and upland sensitive habitat and fish passage. Dam would have impacts on the riparian corridor.	Would eliminate FEMA flood insurance program requirements upstream of Hwy 101. Would require purchase or permanent easement of approx. 300 acres of land from Stanford. May allow for environmental enhancement upstream of dam.	**First Cost:** R/W 106.6 Construction 19.8 Mitigation 1.3 Design, Geotech., Insp. 7.9 **TOTAL $135.6** **Annual Cost:** Annualized First Cost 9.8 Annual Maintenance 0.1 **TOTAL** **$9.9**
Webb Ranch Flood Basin Low Dam To reduce instream flow to 6,000 cfs downstream of El Camino Real.	Would construct single-purpose flood control dam upstream of Hwy 280. Would require max. height of approx. 60', width of 1,690' along the crest, and max. length of approx. 530' in the direction of creek flow. Approx. 250 acres of land would be temporarily inundated during very large storm events, but would remain dry most of the time.	This alternative alone would not eliminate 1% flooding and mandatory flood insurance. Floodplain would remain downstream of Middlefield Rd.	Sedimentation process would continue. May reduce erosion problems.	No Project maintenance program issues would continue. Additional sedimentation and maintenance issues may occur because of the dam.	Could have social and potentially significant environmental impacts. May impact instream and upland sensitive habitat and fish passage. Dam would have impacts on the riparian corridor.	Would require purchase or permanent easement of approx. 250 acres of land from Stanford. May allow for environmental enhancement upstream of dam. Additional measures would be required downstream of El Camino Real to eliminate FEMA flood insurance program requirements upstream of Hwy 101.	**First Cost:[3]** R/W 87.7 Construction 13.6 Mitigation 0.7 Design, Geotech., Insp. 5.4 **TOTAL $107.4** **Annual Cost:** Annualized First Cost 7.8 Annual Maintenance 0.2 **TOTAL**

Table 7
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Upstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
							$8.0
Upstream Diversions & Offstream Storage To reduce instream flow to 4,000 cfs downstream of El Camino Real.	Would divert flows above 1,500 cfs (diversion of up to 6,000 cfs) from San Francisquito Creek and flows above 800 cfs (diversion of up to 1,550 cfs) from Los Trancos Creek upstream Hwy 280 into temporary offstream storage during storm events. Would require storage of up to 12,000 acre-feet during the 1% event.	Would provide 1% protection upstream of Hwy 101.	Sedimentation process would continue. May reduce erosion problems.	No Project maintenance program issues would continue. Additional sedimentation and maintenance issues may occur because of the diversion structures and ponds.	Could have significant social and environmental impacts, including riparian zone impacts and potential fish passage issues.	Would eliminate FEMA flood insurance program requirements upstream of Hwy 101. Would require up to 1,400 acres of land that have not yet been identified.	**First Cost:[3]** R/W 1,071.0 Construction 339.7 Mitigation 54.0 Design, Geotech., Insp. 84.9 **TOTAL $1,549.6** **Annual Cost:** Annualized First Cost 112.3 Annual Maintenance 0.1 **TOTAL $112.4**
Upstream Diversions & Offstream Storage To reduce instream flow to 6,000 cfs downstream of El Camino Real.	Would divert flows above 3,500 cfs (diversion of up to 4,000 cfs) from San Francisquito Creek and flows above 800 cfs (diversion of up to 1,550 cfs) from Los Trancos Creek upstream Hwy 280 into temporary offstream storage during storm events. Would require storage of up to 6,000 acre-feet during the 1% event.	This alternative alone would not eliminate 1% flooding and mandatory flood insurance. Floodplain would remain downstream of Middlefield Rd.	May reduce erosion problems. Would not address sedimentation problem.	No Project maintenance program issues would continue. Additional sedimentation and maintenance issues may occur because of the diversion structures and ponds.	Could have significant social and environmental impacts, including riparian zone impacts and potential fish passage issues.	Would require up to 700 acres of land that have not yet been identified. Additional measures would be required downstream of El Camino Real to eliminate FEMA flood insurance program requirements upstream of Hwy 101.	**First Cost:[3]** R/W 347.8 Construction 104.3 Mitigation 27.0 Design, Geotech., Insp. 26.1 **TOTAL $505.2** **Annual Cost:** Annualized First Cost 36.6 Annual Maintenance 0.2 **TOTAL** **$36.8**

Table 7
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Upstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
Concrete Channel Modification To contain 9,400 cfs downstream of El Camino Real.	Would deepen the channel between El Camino Real and Hwy 101, and line it with concrete to improve conveyance for the 1% event. Would also replace bridges at Middlefield Rd. and Pope/Chaucer St.	Would provide 1% protection upstream of Hwy 101.	Would eliminate erosion problems downstream of El Camino Real. Would partially address sedimentation problem downstream of Hwy 101.	Would reduce maintenance requirements and costs, and establish continuous maintenance access between Hwy 101 and El Camino Real.	Would have significant environmental impacts. Would require mitigation for over 3 miles of instream impacts, including fishery and special species habitats and SRA cover.	Not a feasible alternative. Not possible to mitigate for impacts to habitats associated with the creek corridor.	Not Feasible
Natural Channel Widening To contain flow of 9,300 cfs downstream of El Camino Real.	Would acquire sufficient creekside right-of-way to allow channel to erode and seek its own stable configuration between Pope/Chaucer St. and Hwy 101. Would also replace Middlefield Rd. and Pope/Chaucer St. bridges and construct levees and floodwalls between Pope/Chaucer St. and Hwy 101.	Would provide 1% protection upstream of Hwy 101.	Sedimentation and erosion process would continue, possibly increasing sediment downstream Hwy 101. Between Pope/Chaucer St. and Hwy 101 this is ok, but would continue to be a problem downstream Hwy 101 and upstream Pope/Chaucer St.	Would establish continuous maintenance access and reduce overall maintenance requirements between Hwy 101 and Pope/Chaucer St. Regular maintenance still required to keep large debris out of creek. Would reduce need for erosion protection between Hwy 101 and Pope/Chaucer St.	Would have minimal environmental impacts, possible impact on local drainage systems, and social impacts associated with property acquisition.	Would eliminate FEMA flood insurance program requirements upstream of Hwy 101. Would require acquisition of 107 creekside parcels in Palo Alto and Menlo Park. Could provide public access to creek for recreational purposes. Would require permanent closure of sections of Woodland Avenue.	**First Cost:** R/W 61.4 Construction 8.2 Mitigation 7.1 Design, Geotech., Insp. 2.0 **TOTAL** **$78.7** **Annual Cost:** Annualized First Cost 5.7 Annual Maintenance 0.1 **TOTAL** **$5.8**
Willow Rd. Diversion Conduit Large Conduit To reduce	Floodwaters above 4,000 cfs would be diverted from the channel upstream Middlefield Rd. into an underground conduit (approx. 11' x 37') The underground	Would provide 1% protection upstream of Hwy 101.	Sedimentation process would continue. May reduce erosion problems.	No Project maintenance program issues would continue. Additional sedimentation and maintenance issues may exist with diversion	Would have major construction impacts along Willow Rd. Possible environmental impacts could include fish passage issues and introducing fresh water	Would eliminate FEMA flood insurance program requirements upstream of Hwy 101. Would require acquisition of multi-unit residential structures and assisted relocation of low	**First Cost:** R/W 21.8 Construction 121.9 Mitigation

Table 7
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Upstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
instream flow to 4,000 cfs downstream of Middlefield Rd.	conduit would carry approx. 5,500 cfs during the 1% event. It would follow the alignment of Willow Rd., then deliver floodwater to an earth channel with levees downstream of Hwy 101 to Ravenswood Slough.			channel.	to tidal slough. May impact local drainage systems. Social impacts associated with property acquisition.	income tenants in East Menlo Park.	16.8 Design, Geotech., Insp. 30.5 **TOTAL $191.0** **Annual Cost:** Annualized First Cost 13.8 Annual Maintenance 0.1 **TOTAL $13.9**
Willow Rd. Diversion Conduit Small Conduit To reduce instream flow to 6,000 cfs downstream of Middlefield Rd.	Floodwaters above 6,000 cfs would be diverted from the channel upstream of Middlefield Rd. into an underground conduit (approx. 11' x 26') The underground conduit would carry approx. 3,500 cfs during the 1% event. It would follow the alignment of Willow Rd., then deliver floodwater to an earth channel with levees downstream of Hwy 101 to Ravenswood Slough.	This alternative alone would not eliminate 1% flooding and mandatory flood insurance. Floodplain would remain downstream of Middlefield Rd.	Sedimentation process would continue. May reduce erosion problems.	No Project maintenance program issues would continue. Additional sedimentation and maintenance issues may exist with diversion channel.	Would have major construction impacts along Willow Rd. Possible environmental impacts could include fish passage issues and introducing fresh water to tidal slough. May impact local drainage systems. Social impacts associated with property acquisition.	Would require acquisition of multi-unit residential structures and assisted relocation of low income tenants in East Menlo Park. Additional measures would be required downstream of El Camino Real to eliminate FEMA flood insurance program requirements upstream of Hwy 101.	**First Cost:[3]** R/W 21.8 Construction 105.3 Mitigation 16.8 Design, Geotech., Insp. 26.3 **TOTAL $170.2** **Annual Cost:** Annualized First Cost 12.3 Annual Maintenance 0.2 **TOTAL $12.5**
Replace Bridges at Pope/Chaucer Street and Middlefield	Would replace Pope/Chaucer St. and Middlefield Rd. bridges with bridges that could convey the 1% event.	Would move breakout points from Middlefield Rd. and Pope/Chaucer St. bridges to downstream of Pope/Chaucer St.,	Sedimentation, erosion, and loss of private property would continue to occur.	No Project maintenance program issues would continue.	Would relocate overbanking to downstream of Pope/Chaucer St. and may add new areas to the	Not a feasible alternative. Would not solve problem of flooding, erosion, or sedimentation. Would induce flooding to new	Not Feasible

Table 7
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Upstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
Road.		where flooding problems would continue.			floodplain.	areas. FEMA flood insurance program requirements would continue.	

NOTES:
1. The 1% flood event is defined as the flow of water that has a 1 percent chance of occurring in any given year. Sometimes, the 1 percent flood is called the hundred year flood because it is the flood flow that would be equaled or exceeded about a hundred times in ten thousand years - or an average of one time in a hundred years.
2. Costs not included for additional measures downstream of El Camino Real to eliminate FEMA flood insurance requirements upstream of Hwy 101 or for constructing berms and raising existing roadbeds to preserve existing roadways.
3. Costs not included for additional measures downstream of El Camino Real to eliminate FEMA flood insurance requirements upstream of Hwy 101.

This summary of conceptual flood control alternatives represents a review of plans which have been examined in the past for San Francisquito Creek. Many more alternatives and combinations thereof are possible. However, examination of additional alternatives and combinations is beyond the scope of this reconnaissance level study and will not be performed at this time. This information serves only as a general guide to the features and costs of previously examined plans.

ALTERNATIVE SOLUTIONS - DOWNSTREAM OF HIGHWAY 101

Under existing conditions, the channel downstream of Highway 101 does not have adequate capacity to convey the 1 percent peak flow of 9,300 cfs. This portion of the creek was designed in 1958 to carry a flow of 7,100 cfs with 1.5 to 2 feet of freeboard. Since then, extensive sedimentation and vegetation growth has occurred in the channel, as well as land subsidence, and settlement and erosion of the levees. The combination of these factors has reduced the total carrying capacity of the channel to approximately 2,000 cfs with 1.5 to 2 feet of freeboard. The approximate top of channel capacity is 2,900 cfs. At this flow, there is no freeboard throughout much of the levee system and any flow greater than 2,900 cfs could cause flooding.

Channel improvements along any creek system must occur downstream and proceed upstream. This would ensure that the downstream reaches could handle the flow without overbanking. Therefore, the reach downstream of Highway 101 must be able to convey the flow delivered by any future upstream improvements. Based on the alternatives examined for the reaches upstream of Highway 101, the 1 percent flow could be 4,000 cfs, 6,000 cfs, or 9,300 cfs. All these flows currently exceed the existing channel capacity.

For the reach downstream of Highway 101, two alternatives were examined, a channel modification alternative and a No Project alternative. The channel modification alternative would raise the levees to convey 4,000 cfs, 6,000 cfs, or 9,300 cfs, the three flows that could be delivered by the upstream alternatives described in this report.

Any improvements implemented in the future would have to meet current FEMA standards of providing 3 feet of freeboard. Meeting these standards, however, would not eliminate FEMA flood insurance requirements. This is because flooding downstream of Highway 101 can also result from very high tides. To eliminate FEMA flood insurance requirements downstream of Highway 101, additional improvements would also have to occur along the bayshore. Therefore, none of the alternatives discussed for the area downstream of Highway 101 would eliminate FEMA flood insurance requirements.

The alternative solutions are summarized for comparison in a table at the end of this section.

No Project

The No Project alternative describes the current practices along San Francisquito Creek downstream of Highway 101. With the No Project alternative, no action would be taken to reduce the existing flood hazard. Residences and businesses would continue to face potential hardships due to flooding. Flooding would occur because of creek flow overbanking the channel and very high tides.

This reach was improved in 1958 by a joint project between the SCVWD and SMCFCD. As part of the project, an agreement was made delegating responsibility for maintenance of the southeasterly levee to the SCVWD and maintenance of the northwesterly levee to the SMCFCD. No provisions were included for maintenance of the channel bottom or inside bank slopes. Maintenance practices,

therefore, occur based on each agency's programs and are not coordinated.

Maintenance along the channel by both agencies consists of removing debris from the channel and stabilizing the levees during high flows. On the southeasterly side of the creek, the levee road is graded and maintained in safe condition by the SCVWD. Vegetation control work does occur, but only on the southeasterly side of the creek on top of the levee and outboard levee side slope, again by the SCVWD. The SCVWD has also removed sediment immediately downstream of Highway 101 in the vicinity of the 96-inch storm drain outfall located on the southeasterly bank. With the No Project alternative, these maintenance practices would continue.

To do maintenance work in the channel, Corps, Regional Water Quality Control Board, California Department of Fish and Game, and California Environmental Quality Act requirements must be met. Without permits from these regulatory agencies, neither the SCVWD nor SMCFCD can perform sediment or vegetation removal in the channel. The SCVWD is currently trying to obtain permits for vegetation and sediment removal. Without these permits or a coordinated maintenance program, sediment buildup will continue to diminish channel capacity, pose problems for storm drain outfalls, and allow vegetation to become further established.

For the No Project alternative, some flooding could be expected to occur on average once every 3 to 4 years downstream of Highway 101. This corresponds to the approximate top of channel capacity of 2,900 cfs.

The total first cost of the No Project alternative is estimated to be $207,000 in 1996 dollars. The average annual cost of the No Project alternative is estimated to be $15,000. A detailed breakdown of the estimated costs is included in Appendix A.

Raise Levees

This alternative would involve increasing the levee height above the existing levee elevations downstream of Highway 101 to convey the 1 percent flow. An 18 foot levee top width would be maintained, which would require existing levee base widths also be increased. The base width would be increased on the outboard side of the levee. The required levee height includes 3 feet of freeboard to meet FEMA requirements. Figure 30 shows a typical cross section for this alternative.

Sedimentation in this reach is primarily a result of tidal deposition. Tidal deposition is a recurring process usually continuing until a tidal equilibrium elevation is obtained, which typically corresponds to mean high tide. Although periodic dredging of the channel can keep sediment buildup to a minimum, it is expensive and requires regulatory permits and mitigation for environmental impacts. Impacts to endangered species may also be an issue. Thus, maintaining the sediment below the equilibrium elevation, would require continual and costly maintenance. To limit or eliminate regular maintenance dredging requirements, levee heights would be designed to accommodate tidal sediments to the level of mean high tide. In addition, levee heights would be designed to accommodate existing vegetation conditions. This would also minimize vegetation removal requirements.

Several alternatives discussed for the reaches upstream of Highway 101 would reduce the 1 percent flow downstream of El Camino Real to either 4,000 cfs or 6,000 cfs. To ensure compatibility with these alternatives, the channel downstream of Highway 101 would require additional carrying capacity. An estimated 4 feet of additional levee height would be required on both sides of the channel to provide adequate carrying capacity for a flow of 4,000 cfs. To provide capacity for a flow of 6,000 cfs, an estimated 5 feet of additional height would be required on both sides of the channel. These additional levee heights include 3 feet of freeboard to meet FEMA requirements.

To increase the capacity of the channel downstream of Highway 101 to carry the full 1 percent flow of 9,300 cfs with 3 feet of freeboard, an additional 6 feet of levee height would be required on both sides of the channel.

The majority of creekside land downstream of Highway 101 is owned by either the SCVWD or the City of Palo Alto. There are, however, three residential parcels in San Mateo County that abut the creek. This alternative would require acquiring additional right-of-way from these parcels to accommodate the increased levee base width.

This alternative would have environmental impacts associated with the permanent loss of bayshore habitat under the increased levee base width near the bay on the outboard levee sides. This may include jurisdictional wetlands (saltmarsh) and special status species habitat, which may require compensatory mitigation. This alternative would not impact creek habitat since the existing sediment and vegetation would be left within the channel. Temporary impacts would also be associated with construction on both sides of the creek on the outboard levee sides.

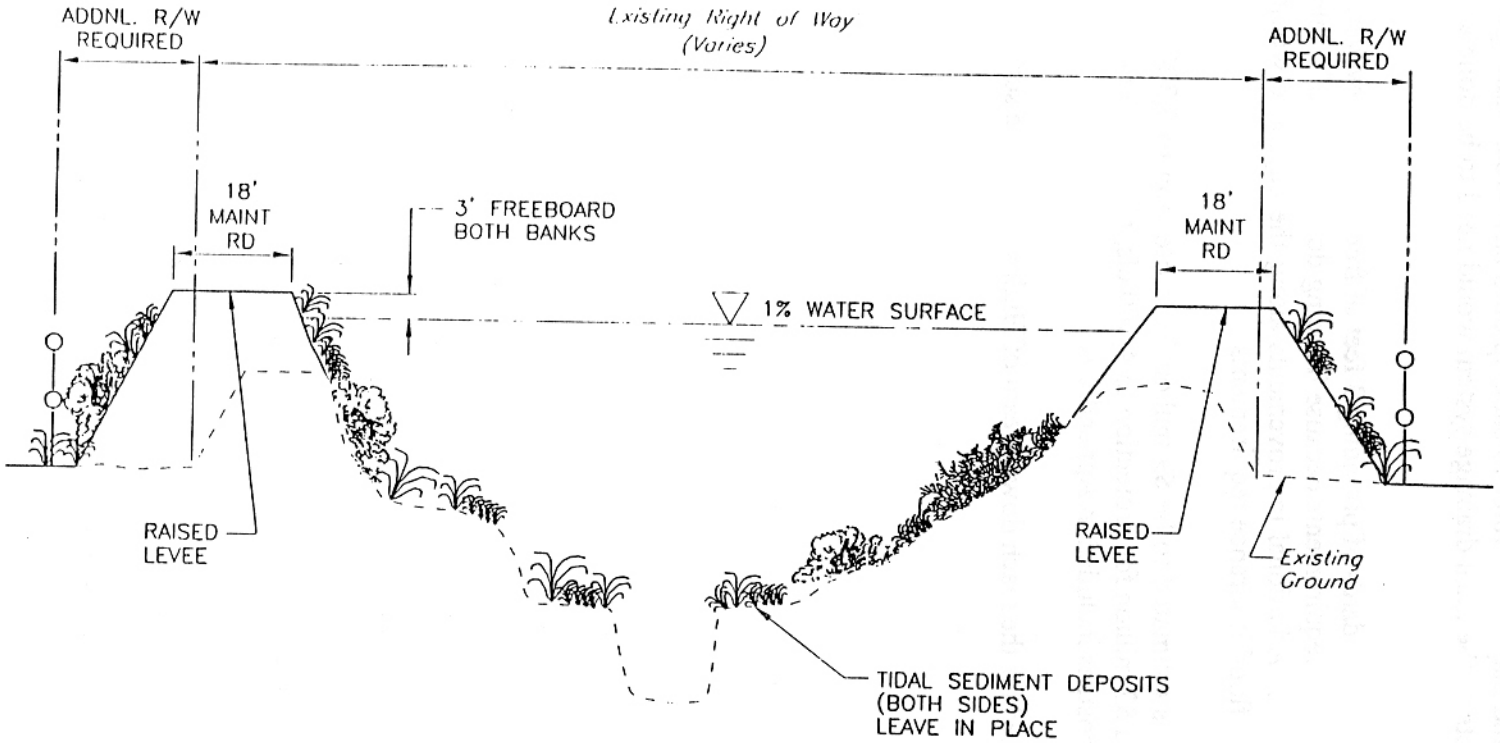
Increased levee height would result in increased water surface elevations during high flow events,

which would adversely impact local drainage. In addition, sediment would be allowed to accumulate which may hinder the proper functioning of the outfalls. These conditions may interfere with local storm drains emptying into the creek, and may cause water to back up onto city streets during storm events. A detailed analysis of the impacts to the local drainage system would need to be done as part of a comprehensive study.

This alternative would meet current FEMA standards of providing 3 feet of freeboard. However, this would not eliminate FEMA flood insurance requirements because flooding downstream of Highway 101 can also result from very high tides. Additional improvements along the bayshore would be required to eliminate tidal flooding and flood insurance requirements.

The total first cost of this alternative is estimated to be $9 million for protection to 9,300 cfs, $8 million for protection to 6,000 cfs, and $7 million for protection to 4,000 cfs, all in 1996 dollars. A detailed breakdown of the estimated costs is included in Appendix A.

Both of the alternative solutions discussed for the reach downstream of Highway 101 are summarized for comparison in Table 8.



TYPICAL SECTION
Downstream of Highway 101
not to scale

Figure 30
San Francisquito Creek
Raise Levees

Table 8
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Downstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
No Project	No measures taken to reduce current risk of flooding. Maintenance would continue at current levels.	Flooding problems and mandatory flood insurance would continue.	Sedimentation would continue to occur.	Maintenance would continue at current levels.	Areas downstream of Highway 101 are subject to flooding.	Does not solve problems of flooding or sedimentation. FEMA flood insurance program requirements cotninue.	**First Cost:** **(Present Worth of Annual Costs)** **TOTAL** **$0.2** **Annual Cost:** Annual Maintenance 0.015 **TOTAL** **$0.015**
Raise Levees	Would raise levees on both sides of the channel to accommodate 1% peak flow. Existing levee height and base width would increase. Levee base width would increase on the outboard levee side. To convey 4,000 cfs, 4 feet of additional levee height would be required.	Would provide 1% protection from creek overbanking when the appropriate levee height is used to convey the flow resulting from the selected alternative upstream of Hwy 101.	Levees would be designed to accommodate sediment accumulation up to mean high tide. Sediment elevation exceeding mean high tide would require dredging.	Maintenance requirements would be minimized by providing adequate capacity to accommodate existing vegetation and sediment accumulation up to mean high tide.	Would have environmental impacts associated with loss of bayshore habitat under widened levees near the bay on the outboard levee sides and possible impacts to local drainage systems due to sediment accumulation.	Would require additional right-of-way from 3 parcels. FEMA flood insurance program requirements would continue until additional improvements occur along the bayshore to eliminate tidal flooding.	<u>To Convey 4,000 cfs:</u> **First Cost:** R/W 0.03 Construction 3.7 Mitigation 2.4 Design, Geotech., Insp. 0.9 **TOTAL** **$7.0** **Annual Cost:** Annualized First Cost 0.5 Annual Maintenance 0.01 **TOTAL** **$0.51**
Raise Levees (cont.)	To convey 6,000 cfs, 5 feet of additional levee height is required.						<u>To Convey 6,000 cfs:</u> **First Cost:**

Table 8
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Downstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
	To convey 9,300 cfs, 6 feet of additional levee height is required.						R/W 0.04 Construction 4.3 Mitigation 2.9 Design, Geotech., Insp. 1.1 **TOTAL $8.3** **Annual Cost:** Annualized First Cost 0.6 Annual Maintenance 0.01 **TOTAL $0.61** <u>To Convey 9,300 cfs:</u> **First Cost:** R/W 0.04 Construction 5.1 Mitigation 3.4 Design, Geotech., Insp. 1.3 **TOTAL $9.8** **Annual Cost:** Annualized First Cost 0.7 Annual Maintenance 0.01

Table 8
San Francisquito Creek
Summary of Previously Considered Flood Control Alternatives
Downstream of Highway 101

Alternative	Description	1% Flooding[1]	Erosion/Sediment	Maintenance Program Issues	Adverse Impacts	Remarks	Estimated Costs First and Annual ($ Millions)
							TOTAL $0.71

NOTES:
1. The 1% flood event is defined as the flow of water that has a 1 percent chance of occurring in any given year. Sometimes, the 1 percent flood is called the hundred year flood, because it is the flood flow that would be equaled or exceeded about a hundred times in ten thousand years - or an average of one time in a hundred years.

This summary of conceptual flood control alternatives represents a review of plans which have been examined in the past for San Francisquito Creek. Many more alternatives and combinations thereof are possible. However, examination of additional alternatives and combinations is beyond the scope of this reconnaissance level study and will not be performed at this time. This information serves only as a general guide to the features and costs of previously examined plans.

FEASIBILITY STUDY

Before any flood control alternative can be selected and constructed, a comprehensive and detailed study must be completed showing that such a plan satisfies the public and meets the California Environmental Quality Act and National Environmental Policy Act requirements. This study would examine closely the "feasibility" of potential alternatives concluding in a full environmental impact assessment of a proposed project.

The Feasibility Study process begins by identifying the problems to be managed and then evaluating potential alternatives for addressing them. The range of potential alternatives is narrowed and refined with public participation. The final selection of the proposed project emerges from this process along with an environmental impact assessment of the project. Appropriate regulatory permits are acquired and then, final plans and specifications are prepared for construction.

FEASIBILITY STUDY ELEMENTS

The major elements of a Feasibility Study are listed as items 1 through 12 below. These elements may vary, depending on the lead agency that undertakes the Feasibility Study. A conceptual list of tasks associated with each of the major study elements is also included, as well as an approximate time for completion of each major element. The approximate time to complete each element is discussed in further detail in the next section.

1. Organize Study (30 weeks)
    a. Collect background information
    b. Collect as-builts from previous projects
    c. Request and perform field surveys
    d. Prepare maps
    e. Request utility information

2. Problem Definition (45 weeks)
    a. Prepare hydraulic model for existing conditions
    b. Prepare sediment transport/geomorphic model
    c. Analyze flood map and potential damages
    d. Research flood and erosion history
    e. Perform site reconnaissance
    f. Identify and map erosion sites
    g. Identify and map sediment deposition sites
    h. Research maintenance history
    i. Prepare written report of findings

3. Preliminary Alternatives Matrix (30 weeks)
    a. Identify conceptual alternatives

b. Revise hydraulic model to reflect alternatives
c. Determine capacities by reach
d. Prepare figures
e. Prepare cost estimates
f. Prepare alternatives screening matrix

4. Preliminary Project Selection (22 weeks)
   a. Determine feasible alternatives
   b. Prepare preliminary designs
   c. Prepare preliminary plan and profile figures

5. Public Participation (31 weeks)
   a. Meet with local jurisdictions
   c. Prepare photos/display figures
   d. Hold public meeting
   e. Revise plans
   f. Hold second public meeting
   g. Revise plans

6. Project Selection (16 weeks)
   a. Evaluate comments and revise plans
   b. Select project for detailed study

7. Prepare Engineer/Feasibility Report (75 weeks)
   a. Preform detailed study on selected plan
   b. Prepare cost estimates
   c. Prepare plan and profile figures
   d. Prepare maintenance guidelines
   e. Determine "bankfull" and 10% water surface profiles
   f. Meet with local jurisdictions
   g. Finalize Engineer/Feasibility Report

8. Assess Environmental Impacts (125 weeks)
   a. Select consultant
   b. Initiate startup and collect background information
   c. Perform site reconnaissance
   d. Perform biological resources survey
   e. Perform cultural resources survey
   f. Perform social impact survey
   g. Identify preliminary alternatives impacts
   h. Prepare Section 404 delineation (wetland delineation)
   i. Identify impacts and mitigation of selected plan
   j. Prepare Draft Environmental Impact Statement/Report (EIS/R)
   k. Review/Comments on EIS/R

l. Prepare Mitigation and Monitoring Plan
m. Prepare Revised Draft EIS/R
n. Draft Corps public notices
o. Apply for Corps Permit
p. Receive Corps permit
q. Finalize EIS/R

9. Hazardous Materials Investigation (91 weeks)
   a. Select Consultant
   b. Perform Level I records search
   c. Prepare Level I Report
   d. Perform Level II hazardous materials investigation
   e. Prepare Level II Report
   f. Design hazardous materials mitigation (if necessary)

10. Combine Engineer/Feasibility/EIS/Reports (22 weeks)
   a. Incorporate final review comments
   b. Revise final EIS/R cost estimate and plans

11. Circulate Engineer/Feasibility/EIS/Reports (15 weeks)
   a. Circulate ER and Draft EIS/R
   b. Hold Public Hearing on EIS/R

12. Final Planning Study (71 weeks)
   a. Respond to comments on EIS/R
   b. Finalize EIS/R
   c. Finalize permits
   d. Hold Public Hearing on Engineer/Feasibility Report
   e. Prepare Notice of Determination
   f. Receive Notice of Determination
   g. Transmit proposed project plans to design engineers

FEASIBILITY STUDY SCHEDULE AND COST

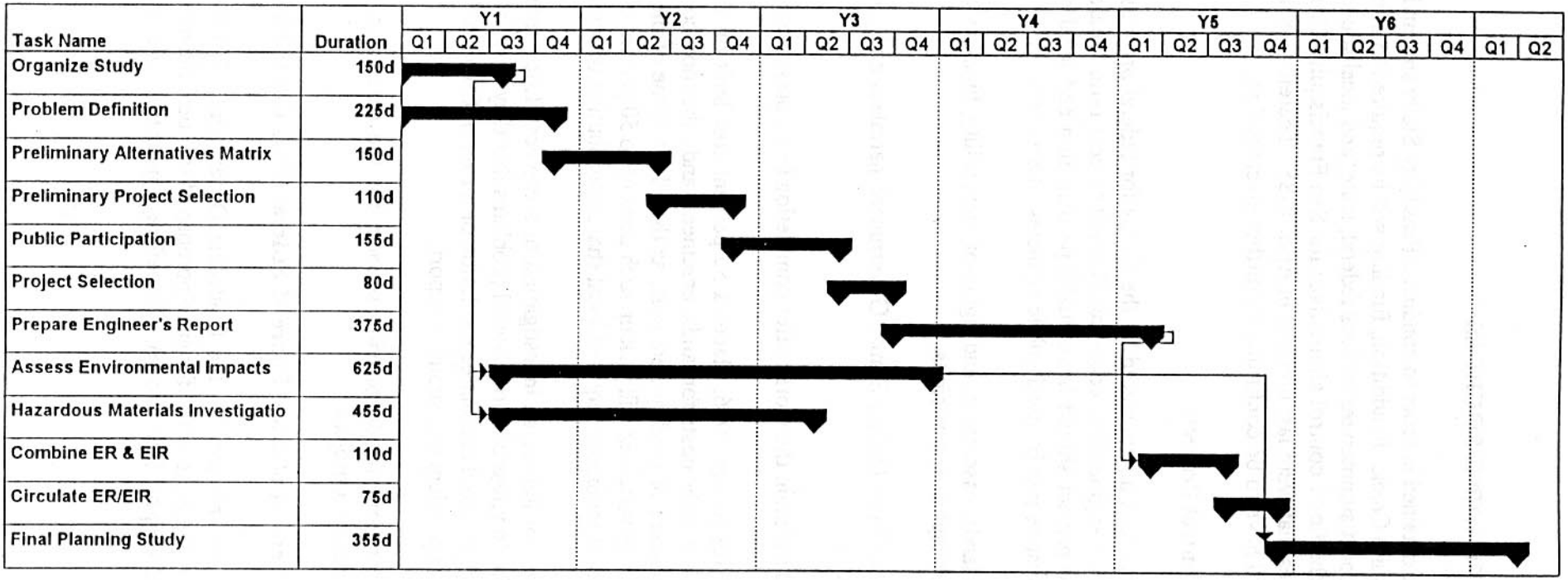
A reasonable timespan for completion of a Feasibility Study of this magnitude would be approximately six to seven years. The estimated completion time for each of the major elements listed above is relevant to that task only. Some elements can be done simultaneously, while some of them are dependent on the completion of other tasks. For instance, the biological and cultural resources survey may be initiated anytime after the study begins. However, the final EIS/R cannot be completed until the recommended alternative has been selected. The estimated time for completion assumes that tasks will be completed concurrently, as appropriate. Figure 31 illustrates an estimated schedule for a Feasibility Study of this magnitude.

Based on costs for similar projects, a Feasibility Study for San Francisquito Creek could cost approximately $5-6 million. Table 9 shows estimated costs to complete a Feasibility Study and EIS/R.

Table 9
Estimated Feasibility Study Cost Summary

Study Management	$150,000
Plan Formulation/Evaluation/Review	$50,000
Surveying and Mapping	$350,000
Civil Design	$200,000
Hydrology Study	$100,000
Hydraulics	$600,000
Sediment Study	$250,000
Geotechnical Investigation	$400,000
Environmental Studies (EIS/R)	$2-2.5 million
Cultural Resources Studies	$75,000
Social Environment Study	$50,000
Fish and Wildlife Studies	$75,000
Hazardous Materials Study Level I	$150,000
Hazardous Materials Study Level II	$400,000
Cost Estimates	$75,000
Drafting/Plan Preparation	$500,000
Report Preparation and Printing	$75,000
Study Team Meetings	$70,000
Public Meetings	$45,000
Total	**$5-6 million**

Figure 31
Estimated Feasibility Study Schedule



POTENTIAL FUNDING SOURCES

Funding must be obtained in order to conduct a Feasibility Study and environmental impact assessment for San Francisquito Creek. In addition, funding will be required to construct the project itself. This section of the report summarizes various federal, state, and local sources of funding which are most appropriate to the flood control alternatives for San Francisquito Creek. This information is from SCVWD sources that were last updated in April 1985. Therefore, some of the programs may have changed and will have to be confirmed by further investigation.

Large Flood Control Projects

This funding source is administered by the Corps for federal projects larger than $4 million. The project must have engineering, economic (benefit to cost ratio greater than 1), and environmental feasibility. The project should have public participation and local support. The federal "ABC" requirements must be met by local public agencies. These are:

A. Provide all lands, easements, and rights-of-way; utility, highway and structural relocations and alterations; water rights; and permits.

B. Agree to hold the United States Government harmless and free from damages due to the construction work.

C. Operate and maintain the works after completion (e.g., preserve certain channel capacities).

The Flood Control Act of 1936, places a 50 percent cost limit on the state/local share of federal projects. Therefore, if the costs for lands, easements and other non-construction elements constitute more than 50 percent of total project cost, as they do in some of the alternatives presented in this report, the federal government will pick up such costs up to 50 percent of the total project cost. There is also a 25 percent minimum required local share contribution of total project costs.

The Corps does not initiate an investigation or a project. Local interests inform their Senator or Representative in Congress of flood control problems that they have, and request that a federal study be made. A Congressional committee resolution or an act of Congress may then authorize the Corps to investigate the problem and submit a report.

This funding program would provide support for the study and design phase as well as the construction phase of a project.

State Reimbursement of Local Share of Federal Flood Control Projects

This program, administered by the California Department of Water Resources (DWR), allows reimbursement by the State of California of portions of the local financial burden of projects that have received federal support (see above). Therefore, application to this program would be

warranted together with application for federal flood control project support.

This program will reimburse portions of the local share of costs associated with rights-of-way, relocation, recreation, and fish and wildlife enhancement features. These costs are a significant portion of all of the alternatives considered for San Francisquito Creek.

As this is a reimbursement program, the local agency must have adequate funds to expend on qualifying project costs before reimbursement by the State. Therefore, the DWR expects the local agency to establish a revenue base for the project. Reimbursement by the State may be delayed significantly, as dispersements occur on a first-come, first-serve basis each year until funds are dispersed, then recipients are forwarded to the next fiscal year. Meanwhile, the local agency is responsible for incurring and paying project costs.

This program is the basic source of State assistance for local costs of federal flood control projects. The funding is available for the construction phase of a project, not the design or study phase.

Capital Improvement Programs

A capital improvement program is a city's or county's comprehensive listing and description of planned capital facilities together with their estimated costs, projected over a period of years. Capital facilities are public buildings, streets, storm drains, parks and playgrounds, water and sewer systems and other assets of more or less a permanent nature. Flood control facilities have sometimes been included in city or county programs when financing is available and when they are of direct benefit to the city's or county's service area.

Funds to implement capital improvement measures are obtained from a variety of sources: gas tax funds, bonds, building permit fees, developer contributions, state and federal grants, municipal improvement assessment districts, taxes and existing reserves.

A disadvantage of relying on capital improvement funds is that it is unlikely that there would be substantial money available for flood control work, as would be needed for a San Francisquito Creek project. However, funds for portions of the project, such as bridge replacement work or land acquisition, could be eligible for capital improvement funds. Additionally, recreational facilities, which may be located within the flood control project, such as bike paths or creekside parks, could be funded by a city's capital improvement funds.

Capital improvement projects are most appropriately funded by cities if they fall within incorporated areas or provide flood control benefits to part of the incorporated area. They are most appropriately funded by a county when the project or benefit falls within the unincorporated area.

Because the potential damage from flooding of San Francisquito Creek is highest for the cities of Palo Alto and Menlo Park, it is possible that joint funding of at least part of the project could come from their capital improvement funds.

Federal Aid Highway Program

This program assists CALTRANS in providing for the building or improvement of primary, secondary and urban systems roads and streets. Funds may be used for bridges, bikeways, pedestrian walkways, and other transportation related facilities. Primarily, funding is determined by traffic or structural inadequacy, not hydraulic capacity. However, a hydraulically inadequate bridge may also qualify for funding based on traffic or structural criteria. Local interests may request that the County Transportation Agency inspect and evaluate the bridges that require replacement as part of the proposed project, to determine if they qualify for funding.

Bridges are evaluated based on a standard set of factors, and given a "sufficiency rating." A rating of less than 50 may qualify a given bridge for improvement or replacement funds.

Urban Streams Restoration Grant

Authorized by the California Department of Water Resources, this fund issues small grants for the protection, restoration and enhancement of urban creek channels. The intent of the program is to combine low cost flood protection measures with preservation and enhancement of the natural environment. The small grant size and small overall budget for this program limit its usefulness for a flood control project. However, certain aspects of the proposed work may be eligible for funding based on enhancement or preservation of the natural environment of San Francisquito Creek.

Land and Water Conservation Funds Program

This program, administered by the State Department of Parks and Recreation and the National Park Service, should be considered when recreational facilities are to be implemented along with flood control work. Possible alternatives for San Francisquito Creek, which may include recreation elements, include the Webb Ranch Flood Basin and Natural Channel Widening. In addition, parkways or paths, which may be included in any levee sections, may be eligible for funding.

This is a reimbursement program. The applicant is expected to fund the entire project and be refunded 50 percent of actual expenditures up to the support ceiling of the grant when the project is complete. Operation and maintenance are the responsibility of the local agencies.

Because of the high cost of land in Santa Clara County, acquisition of significant acreage, such as required by the Webb Ranch Flood Basin alternative, is not likely through this fund.

Benefit Assessment

A possible source of revenue to local governmental agencies of the State of California may be obtained by a benefit assessment program. A benefit assessment program is a way for these agencies to collect money from property owners to implement work that is of benefit to the property owners. Such a type of program has been established by the SCVWD as a source of revenue to finance flood damage reduction activities. The SCVWD's benefit assessment program was implemented in 1981,

after Proposition 13 reduced tax revenues by more than 55 percent in 1978. The current program of benefit assessment will sunset in the year 2000, and it is unknown whether the SCVWD will request voter approval in 1998 to continue this program, and if so, at what level of support.

The SCVWD's geographic boundary is the same as that of Santa Clara County. This area is divided into five flood control zones, each based on one or more watersheds. Each zone has a separate flood control program and separate revenues and expenditures. This means the benefit assessment funds collected in each zone are used only in that zone. Benefit assessments are levied on each parcel of land within these zones based upon the benefit each parcel receives from flood damage reduction measures. The benefit to each parcel is determined based upon the proportional storm water runoff for that parcel.

Money collected in each zone is shared among all the watersheds within that zone. Funding is distributed between the watersheds in a specific zone on a priority basis, rather than based on the size of a particular watershed or floodplain. Priority is established by SCVWD advisory committee recommendation and is based on potential damages, engineering feasibility, and community support.

San Francisquito Creek is located in the Northwest Flood Control Zone. Benefit assessments generated for this zone in fiscal year 1996-97 was approximately $5.2 million. This included money from approximately 58,500 residential, commercial, industrial, and undeveloped properties. Within the Northwest Zone there are 1,303 parcels in the San Francisquito Creek watershed and 2,214 parcels in the 1996 preliminary 1 percent floodplain (not including the tidal floodplain).

The SMCFCD currently has no benefit assessment program in place. All of SMCFCD's projects were originally initiated before Proposition 13 when property tax revenue could be generated to pay for the projects. Since Proposition 13, the District has not had sufficient resources to construct any flood control projects. The SMCFCD can provide a mechanism to construct projects where sufficient revenue is available to the zone or where the property owners who want the improvements are prepared to be assessed for the improvements. If funding were to become available for this zone, SMCFCD staff would make recommendations for project priorities based on hydraulic considerations.

SMCFCD's geographic boundary is the same as that of San Mateo County. This area is divided into four flood control zones. San Francisquito Creek is one of these zones and consists of two sub-zones. The boundary of the zone is the drainage basin of the creek.

APPENDIX A

ALTERNATIVE COST ESTIMATES

San Francisquito Creek
No Project Alternative, Upstream Highway 101
Cost Estimate Summary

FIRST COST	**Present Worth**
Present worth of the total average annual cost over a 50 year project life at 7% interest.	
TOTAL FIRST COST (7%, 50-year project life)	**$66,415,950**

AVERAGE ANNUAL COST	**Annual**
Flood Damages (from SCVWD Waterways Management Model, for both counties)	$3,200,000
Flood Emergency Costs ($2,500 per structure, per 1991 COE Guadalupe GDM for 4,850 structures, a one time cost of $12,125,000 amoritized over a 50 year project life at 7% interest)	$880,000
Flood Insurance Administration Costs ($115 per structure)	$557,750
General Maintenance (based on 1985 to 1996 records)	$25,000
Major Erosion Repairs (based on 1981 to 1995 records)	$150,000
TOTAL AVERAGE ANNUAL COST	**$4,812,750**

San Francisquito Creek
Expand Searsville Lake
(Reduces 1% flow to 6,600 cfs d/s of El Camino Real)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Site Preparation				
Drain Reservoir	$1,000	L.S.	1	$1,000
Dredge & Haul Reservoir Sediments near Dam	$15	C.Y.	80,000	$1,200,000
Dismantle & Remove Existing Concrete Dam	$100	C.Y.	18,000	$1,800,000
Clearing and Grubbing	$5,500	ACRE	3	$16,500
Stripping (foundation)	$15	C.Y.	50,000	$750,000
Remove Residential Structures	$7,500	EA.	27	$202,500
Temporary Flow Diversion				
Cofferdam (assume 20' deep x 100' wide)	$15	S.F.	2,000	$30,000
MAIN DAM				
Earthwork				
Fill (dam)	$15	C.Y.	141,000	$2,115,000
Sand & Gravel Filter & Drains (1' deep on upstream face & 10' core and 5' toe)	$7	C.Y.	19,100	$133,700
Hauling Sand & Gravel (assume 30-mile RT)	$7	C.Y.	19,100	$133,700
Rock Riprap (1.5' deep on upstream face)	$50	C.Y.	3,000	$150,000
Hauling Rock Riprap (assume 30-mile RT)	$7	C.Y.	3,000	$21,000
Outlet Works (length incl. through dam and down to invert)				
Flow-Through Culvert (11.5' i.d., 550' long RCP)	$500	C.Y.	550	$275,000
Landscape				
Seeding Downstream Face	$2,140	ACRE	1.3	$2,782
SPILLWAY				
Excavation	$10	C.Y.	7,000	$70,000
Rock Riprap (stilling basin)	$50	C.Y.	1,000	$50,000
Reinforced Concrete	$500	C.Y.	1,500	$750,000
Utility Relocation (assume 1 ea.)				
Water	$75,000	EA.	1	$75,000
Sanitary Sewer	$50,000	EA.	1	$50,000
Electricity	$50,000	EA.	1	$50,000
Underground Gas Line	$50,000	EA.	1	$50,000

Item	Unit Cost	Unit	Quantity	Amount
Miscellaneous				
Toe Drains (perforated corrugated metal pipe)	$12	L.F.	1800	$21,600
42" Black Vinyl CL Fence (spillway)	$10	L.F.	700	$7,000
SUBTOTAL				$7,954,782
Mobilization (10%)				$795,478
Construction Contingencies (10%)				$795,478
TOTAL CONSTRUCTION				**$9,545,738**
Design (10%)				**$954,574**
Geotechnical				**$1,000,000**
Inspection (10%)				**$954,574**
Fee to Division of Safety of Dams (10%)				**$954,574**
Property Acquisition				
Existing Lakebed	$1,000	ACRE	33	$33,000
Undeveloped Land	$6,000	ACRE	150	$900,000
Residential Land & Structures	$1,750,000	PARCEL	16	$28,000,000
Relocation Assistance	$50,000	EA.	16	$800,000
Contingencies (10%)	10%	L.S.	18	$2,973,300
Acquisition Labor Costs	$15,000	PARCEL	18	$270,000
RIGHT-OF-WAY COSTS				**$32,976,300**
Mitigation (for dam footprint)				
Revegetation (on r/w purchased, assume 3:1)	$200,000	ACRE	4.7	$940,000
MITIGATION COSTS				**$940,000**
TOTAL COSTS *				**$47,325,760**

* Costs not included for additional measures downstream of El Camino Real to eliminate FEMA flood insurance requirements upstream of Highway 101 or for constructing berms and raising existing roadbeds to preserve existing roadways.

San Francisquito Creek
Webb Ranch Flood Basin, High Dam
(Reduces 1% flow to 4,000 cfs d/s of El Camino Real)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Site Preparation				
Clearing and Grubbing	$5,500	ACRE	16	$88,000
Remove Structures	$7,500	EA.	21	$157,500
Temporary Flow Diversion				
Diversion Channel (assume trench 2' deep x 6' wide x 600' long)	$10	C.Y.	300	$3,000
Cofferdam (assume 20' deep x 60' wide shoring)	$15	S.F.	1,200	$18,000
MAIN DAM				
Earthwork				
Earth-Haul & Fill (dam)	$15	C.Y.	771,000	$11,565,000
Sand & Gravel-Haul & Fill (filter & drains 1' deep on upstream face & 10' core and 5' toe)	$15	C.Y.	169,200	$2,538,000
Rock Riprap (1.5' deep on upstream face)	$50	TON	17,000	$850,000
Outlet Works				
Flow-Through Culvert (9.5' i.d., 610' long RCP)	$500	C.Y.	450	$225,000
Trash Rack				
10" diam. pipe-15 @ 20'	$60	L.F.	300	$18,000
Reinforced Concrete Foundation	$500	C.Y.	15	$7,500
Landscape				
Seeding Downstream Face	$2,140	ACRE	8	$17,120
SPILLWAY				
Excavation	$10	C.Y.	15,000	$150,000
Rock Riprap (stilling basin)	$50	C.Y.	1,500	$75,000
Reinforced Concrete	$500	C.Y.	1,500	$750,000
Utility Abandonment (assume 1 ea. & abandon in place)				
Water	$5,000	EA.	1	$5,000
Sanitary Sewer/Septic System	$5,000	EA.	1	$5,000
Electrical	$10,000	EA.	1	$10,000
Telephone	$10,000	EA.	1	$10,000
Miscellaneous				
Toe Drains (dam, perforated corrugated metal pipe)	$12	L.F.	2000	$24,000
42" Black Vinyl CL Fence (spillway)	$10	L.F.	800	$8,000
SUBTOTAL				$16,524,120

Item	Unit Cost	Unit	Quantity	Amount
Mobilization (10%)				$1,652,412
Construction Contingencies (10%)				$1,652,412
TOTAL CONSTRUCTION				**$19,828,944**
Design (10%)				**$1,982,894**
Geotechnical (10%)				**$1,982,894**
Inspection (10%)				**$1,982,894**
Fee to Division of Safety of Dams (10%)				**$1,982,894**
Property Acquisition (per Real Estate cost estimate)				
Land	$350,000	ACRE	300	$105,000,000
Residential Land	$600,000	PARCEL	2	$1,200,000
Relocation Assistance	$50,000	EA.	6	$300,000
Acquisition Labor Costs	$15,000	EA.	5	$75,000
RIGHT-OF-WAY COSTS				**$106,575,000**
Mitigation (for dam footprint)				
Revegetation (on r/w purchased, assume 3:1)	$200,000	ACRE	6.3	$1,260,000
MITIGATION COSTS				**$1,260,000**
TOTAL COSTS				**$135,595,522**

San Francisquito Creek
Webb Ranch Flood Basin. Low Dam
(Reduces 1% flow to 6,000 cfs d/s of El Camino Real)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Site Preparation				
Clearing and Grubbing	$5,500	ACRE	13	$71,500
Remove Structures	$7,500	EA.	21	$157,500
Temporary Flow Diversion				
Diversion Channel (assume trench 2' deep x 6' wide x 600' long)	$10	C.Y.	300	$3,000
Cofferdam (assume 20' deep x 60' wide shoring)	$15	S.F.	1,200	$18,000
MAIN DAM				
Earthwork				
Earth-Haul & Fill (dam)	$15	C.Y.	526,000	$7,890,000
Sand & Gravel-Haul & Fill (filter & drains 1' deep on upstream face & 10' core and 5' toe)	$15	C.Y.	84,000	$1,260,000
Rock Riprap (1.5' deep on upstream face)	$50	TON	13,000	$650,000
Outlet Works				
Flow-Through Culvert (12' i.d., 450' long RCP)	$500	C.Y.	450	$225,000
Trash Rack				
10" diam. pipe-15 @ 20'	$60	L.F.	300	$18,000
Reinforced Concrete Foundation	$500	C.Y.	15	$7,500
Landscape				
Seeding Downstream Face	$2,140	ACRE	6	$11,984
SPILLWAY				
Excavation	$10	C.Y.	15,000	$150,000
Rock Riprap (stilling basin)	$50	C.Y.	1,500	$75,000
Reinforced Concrete	$500	C.Y.	1,500	$750,000
Utility Abandonment (assume 1 ea. & abandon in place)				
Water	$5,000	EA.	1	$5,000
Sanitary Sewer/Septic System	$5,000	EA.	1	$5,000
Electrical	$10,000	EA.	1	$10,000
Telephone	$10,000	EA.	1	$10,000
Miscellaneous				
Toe Drains (dam, perforated corrugated metal pipe)	$12	L.F.	1800	$21,600
42" Black Vinyl CL Fence (spillway)	$10	L.F.	800	$8,000
SUBTOTAL				$11,347,084

Item	Unit Cost	Unit	Quantity	Amount
Mobilization (10%)				$1,134,708
Construction Contingencies (10%)				$1,134,708
TOTAL CONSTRUCTION				**$13,616,501**
Design (10%)				**$1,361,650**
Geotechnical (10%)				**$1,361,650**
Inspection (10%)				**$1,361,650**
Fee to Division of Safety of Dams (10%)				**$1,361,650**
Property Acquisition				
Land	$350,000	ACRE	250	$87,500,000
Relocation Assistance	$50,000	EA.	4	$200,000
Acquisition Labor Costs	$15,000	EA.	3	$45,000
RIGHT-OF-WAY COSTS				**$87,745,000**
Mitigation (for dam footprint)				
Revegetation (on r/w purchased, assume 3:1)	$200,000	ACRE	3.6	$720,000
MITIGATION COSTS				**$720,000**
TOTAL COSTS *				**$107,528,101**

* Costs not included for additional measures downstream of El Camino Real to eliminate FEMA flood insurance requirements upstream of Highway 101.

San Francisquito Creek
Upstream Diversion & Offstream Storage
(Reduces 1% flow to 4,000 cfs d/s of El Camino Real)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Site Preparation				
Remove Structures	$7,500	EA.	1,260	$9,450,000
Clearing and Grubbing	$5,500	ACRE	1,260	$6,930,000
Earthwork				
Excavate & Place (levees)	$10	C.Y.	360,000	$3,600,000
Excavate & Haul	$15	C.Y.	14,160,000	$212,400,000
Inlet/ Outlet Works				
Concrete Siphon (120 @ 500 cy each)	$500	C.Y.	60,000	$30,000,000
Outlet Pipe (concrete)	$500	C.Y.	12,000	$6,000,000
Utility Relocation (assume avg. of 1 ea. per developed area pond)				
Water	$75,000	EA.	35	$2,625,000
Sanitary Sewer	$50,000	EA.	35	$1,750,000
Electrical	$75,000	EA.	35	$2,625,000
Underground Gas Line	$75,000	EA.	35	$2,625,000
Telephone	$50,000	EA.	35	$1,750,000
Miscellaneous				
42" Black Vinyl CL Fence	$10	L.F.	320000	$3,200,000
Double Gates (maintenance access)	$800	EA.	120	$96,000
SUBTOTAL				**$283,051,000**
Mobilization (10%)				$28,305,100
Construction Contingencies (10%)				$28,305,100
TOTAL CONSTRUCTION				**$339,661,200**
Design (10%)				**$33,966,120**
Geotechnical (5%)				**$16,983,060**
Inspection (10%)				**$33,966,120**
Property Acquisition				
Undeveloped	$350,000	ACRE	630	$220,500,000
Developed, Open	$700,000	ACRE	315	$220,500,000
Developed, with Structures (assume 4 per acre)	$2,000,000	ACRE	315	$630,000,000
RIGHT-OF-WAY COSTS				**$1,071,000,000**

Item	Unit Cost	Unit	Quantity	Amount
Mitigation				
Revegetation (on r/w purchased, assume 3:1)	$200,000	ACRE	270	$54,000,000
MITIGATION COSTS				**$54,000,000**
TOTAL COSTS				**$1,549,576,500**

San Francisquito Creek
Upstream Diversion & Offstream Storage
(Reduces 1% flow to 6,000 cfs d/s of El Camino Real)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Site Preparation				
Remove Structures	$7,500	EA.	630	$4,725,000
Clearing and Grubbing	$5,500	ACRE	630	$3,465,000
Earthwork				
Excavate and Place (levees)	$10	C.Y.	180,000	$1,800,000
Excavate & Haul	$15	C.Y.	3,450,000	$51,750,000
Inlet/ Outlet Works				
Concrete Siphon (60 @ 500 cy each)	$500	C.Y.	30,000	$15,000,000
Outlet Pipe (concrete)	$500	C.Y.	6,000	$3,000,000
Utility Relocation (assume avg. of 1 ea. per developed area pond)				
Water	$75,000	EA.	17	$1,275,000
Sanitary Sewer	$50,000	EA.	17	$850,000
Electrical	$75,000	EA.	17	$1,275,000
Underground Gas Line	$75,000	EA.	17	$1,275,000
Telephone	$50,000	EA.	17	$850,000
Miscellaneous				
42" Black Vinyl CL Fence	$10	L.F.	160000	$1,600,000
Double Gates (maintenance access)	$800	EA.	60	$48,000
SUBTOTAL				**$86,913,000**
Mobilization (10%)				$8,691,300
Construction Contingencies (10%)				$8,691,300
TOTAL CONSTRUCTION				**$104,295,600**
Design (10%)				**$10,429,560**
Geotechnical (5%)				**$5,214,780**
Inspection (10%)				**$10,429,560**
Property Acquisition				
Undeveloped (50% of ponds)	$350,000	ACRE	315	$110,250,000
Developed, Open (25% of ponds)	$700,000	ACRE	88	$61,600,000
Developed, with Structures (assume 4 per acre)	$2,000,000	ACRE	88	$176,000,000
RIGHT-OF-WAY COSTS				**$347,850,000**

Item	Unit Cost	Unit	Quantity	Amount
Mitigation				
Revegetation (on r/w purchased, assume 3:1)	$200,000	ACRE	135	$27,000,000
MITIGATION COSTS				**$27,000,000**
TOTAL COSTS *				**$505,219,500**

* Costs not included for additional measures downstream of El Camino Real to eliminate FEMA flood insurance requirements upstream of HIghway 101.

San Francisquito Creek
Natural Channel Widening
Reaches 2 - 5: Highway 101 to El Camino Real
(full 1% flow contained within the creek)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Site Preparation				
Removal of Structures	$7,500	EA.	104	$780,000
Clearing and Grubbing	$5,500	ACRE	40	$220,000
Earthwork				
Excavate & Place (levees)	$10	C.Y.	139,300	$1,393,000
Maintenance Road Surfacing (6" aggreg. rock)	$0.55	S.F.	240,000	$132,000
Floodwall Construction				
Structural Concrete (channel & bridges)	$500	C.Y.	1,545	$772,500
Traffic Control				
Major Intersection-Bridge Work (Middlefield Rd.)	$200,000	EA.	1	$200,000
Minor Intersection-Bridge Work (Pope/Chaucer St.)	$100,000	EA.	1	$100,000
Permanent Closures	$10,000	EA.	8	$80,000
Bridge Work (Pope/Chaucer St. & Middlefield Rd.)				
Bridge Removal	$50	C.Y.	8,500	$425,000
Bridge Construction				
Excavation	$10	C.Y.	14,750	$147,500
Shoring	$15	S.F.	7,980	$119,700
Backfill	$15	C.Y.	12,100	$181,500
Concrete (decking & piers)	$500	C.Y.	2,575	$1,287,500
Rock Lining (transition & abuts.)	$50	C.Y.	1,330	$66,500
A/C Pavement	$5	S.F.	11,200	$56,000
Curb & Gutter	$16	L.F.	630	$10,080
Sidewalk	$8	S.F.	2,515	$20,120
Barrier/Guard Rails	$50	L.F.	610	$30,500
Roadway Work (Woodland Ave.)				
Remove A/C Pavement	$2	S.F.	104,400	$208,800
Remove Sidewalk	$2	S.F.	25,800	$51,600
Remove Curb & Gutter	$2	L.F.	8,700	$17,400
Utilities				
Underground Telephone Line	$50,000	EA.	9	$450,000
Underground Gas Line	$50,000	EA.	1	$50,000
SUBTOTAL				**$6,799,700**

Item	Unit Cost	Unit	Quantity	Amount
Mobilization (10%)				$679,970
Construction Contingencies (10%)				$679,970
TOTAL CONSTRUCTION				**$8,159,640**
Design (10%)				**$815,964**
Geotechnical (5%)				**$407,982**
Inspection (10%)				**$815,964**
Property Acquisition				
Residential Parcels, Palo Alto (price 1)	$520,000	EA.	38	$19,760,000
Residential Parcels, Palo Alto (price 2)	$738,000	EA.	33	$24,354,000
Residential Parcels, Menlo Park (price 1)	$150,000	EA.	27	$4,050,000
Residential Parcels, Menlo Park (price 2)	$334,000	EA.	6	$2,004,000
Trailer Park, Partial Take	$200,000	L.S.	1	$200,000
Multi-Unit Residential	$2,000,000	EA.	2	$4,000,000
Non-Residential Parcels or Partial Take	$10,000	ACRE	5.2	$52,000
Relocation Assistance	$25,000	EA.	214	$5,350,000
Acquisition Labor Costs	$15,000	PARCEL	107	$1,605,000
RIGHT-OF-WAY COSTS				**$61,375,000**
Mitigation/Landscaping				
Landscaping for Levees & Creekside Properties	$200,000	ACRE	33	$6,540,000
Mitigation for Bridge Work	$200,000	ACRE	3	$600,000
MITIGATION COSTS				**$7,140,000**
TOTAL COSTS				**$78,714,550**

San Francisquito Creek
Willow Road Diversion Conduit
(Reduces 1% flow to 4,000 cfs d/s of Middlefield Rd.)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
DIVERSION CONDUIT (u/s Middlefield Rd. to Hwy 101)				
Channel Modification				
Gabion Lining (El Camino Real to Diversion)	$160	C.Y.	15,000	$2,400,000
Inlet				
Trash Rack				
10" diam. pipe-10 @ 30'	$60	L.F.	300	$18,000
Reinforced Concrete Foundation	$500	C.Y.	10	$5,000
Earthwork				
Excavate & Backfill (over conduit)	$10	C.Y.	86,600	$866,000
Excavate & Haul	$15	C.Y.	170,000	$2,550,000
Shoring of Excavation	$15	S.F.	150,000	$2,250,000
Tunnelling (approximately 2000' @ Hwy 101)	$500	C.Y.	75,000	$37,500,000
Conduit				
Reinforced Concrete (11' x 37' RCB)	$500	C.Y.	50,000	$25,000,000
Traffic Control				
Minor Intersections	$100,000	EA.	10	$1,000,000
Major Intersections (Middlefield Rd. & Hwy 101 on-ramp)	$200,000	EA.	2	$400,000
Roadway Work (Willow Rd.)				
Remove A/C Pavement	$2	S.F.	300,000	$600,000
Remove Curb & Gutter	$2	L.F.	6,000	$12,000
Remove Sidewalk	$2	S.F.	22,500	$45,000
A/C Pavement	$5	S.F.	300,000	$1,500,000
Curb & Gutter	$16	L.F.	6,000	$96,000
Sidewalk	$8	S.F.	22,500	$180,000
EARTH CHANNEL (d/s Hwy 101 to Ravenswood Slough)				
Site Preparation				
Remove Structures (downstream Hwy 101)	$7,500	EA.	120	$900,000
Clearing and Grubbing	$5,500	EA.	9.2	$50,600
Earthwork				
Excavate & Place (levees)	$10	C.Y.	50,000	$500,000
Import & Place (levees)	$15	C.Y.	30,000	$450,000
Maintenance Road Surfacing (6" aggreg. rock)	$0.55	S.F.	113,000	$62,150

Item	Unit Cost	Unit	Quantity	Amount
Traffic Control				
Minor Intersections	$100,000	EA.	3	$300,000
Major Intersections (SR 84 & SPRR crossing)	$200,000	EA.	2	$400,000
Bridge Work				
SPRR Crossing near SR 84	$150	S.F.	8,500	$1,275,000
SR 84	$100	S.F.	15,200	$1,520,000
Hamilton Ave.	$100	S.F.	7,200	$720,000
Ivy Dr.	$100	S.F.	12,000	$1,200,000
Newbridge St.	$100	S.F.	12,000	$1,200,000
Roadway Work (Willow Rd.)				
Remove A/C Pavement	$2	S.F.	38,400	$76,800
Remove Curb & Gutter	$2	L.F.	1,600	$3,200
Remove Sidewalk	$2	S.F.	4,800	$9,600
A/C Pavement	$5	S.F.	38,400	$192,000
Curb & Gutter	$16	L.F.	1,600	$25,600
Sidewalk	$8	S.F.	4,800	$38,400
EARTH LEVEES (along Ravenswood Slough)				
Earthwork				
Import & Place (levees)	$15	C.Y.	320,000	$4,800,000
Utility Relocation				
Water Line	$300	L.F.	15,300	$4,590,000
Sanitary Sewer	$100	L.F.	14,000	$1,400,000
Sanitary Sewer Crossing	$50,000	EA.	2	$100,000
Electrical Line	$200	L.F.	3,700	$740,000
Gas Line-2"	$200	L.F.	10,000	$2,000,000
Telephone Line	$200	L.F.	3,700	$740,000
Storm Drain	$200	L.F.	9,200	$1,840,000
Hetch-Hetchy Crossing	$1,500,000	L.S.	1	$1,500,000
Miscellaneous				
Install Temporary Fencing	$10	L.F.	24000	$240,000
Remove Temporary Fencing	$3	L.F.	24000	$72,000
Maintenance Road Surfacing (6" aggreg. rock)	$0.55	S.F.	470,000	$258,500
SUBTOTAL				**$101,625,850**
Mobilization (10%)				$10,162,585
Construction Contingencies (10%)				$10,162,585
TOTAL CONSTRUCTION				**$121,951,020**

Item	Unit Cost	Unit	Quantity	Amount
Design (10%)				**$12,195,102**
Geotechnical (5%)				**$6,097,551**
Inspection (10%)				**$12,195,102**
Property Acquisition (for leveed channel)				
Residential Properties	$13,196,000	L.S.	1	$13,196,000
Commercial Properties	$500,000	L.S.	1	$500,000
Relocation Assistance, Tennants	$15,000	EA.	284	$4,260,000
Relocation Assistance, Commercial	$20,000	EA.	13	$260,000
Undeveloped Bayfront Land	$5,000	ACRE	50	$250,000
Commercial Land	$14	SF	10,000	$140,000
Contingencies (15%)				$2,790,900
Acquisition Labor Costs	$15,000	EA.	26	$390,000
RIGHT-OF-WAY COSTS				**$21,786,900**
Mitigation (for channel lining)				
Revegetation (off-site, assume 3:1)	$200,000	ACRE	24	$4,800,000
Revegetation right-of-way (off-site)	$500,000	ACRE	24	$12,000,000
MITIGATION COSTS				**$16,800,000**
TOTAL COSTS				**$191,025,675**

San Francisquito Creek
Willow Road Diversion Conduit
(Reduces 1% flow to 6,000 cfs d/s of Middlefield Rd.)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
DIVERSION CONDUIT (u/s Middlefield Rd. to Hwy 101)				
Channel Modification				
Gabion Lining (El Camino Real to Diversion)	$160	C.Y.	15,000	$2,400,000
Inlet				
Trash Rack				
10" diam. pipe-10 @ 30'	$60	L.F.	300	$18,000
Reinforced Concrete Foundation	$500	C.Y.	10	$5,000
Earthwork				
Excavate & Backfill (over conduit)	$10	C.Y.	65,000	$650,000
Excavate & Haul	$15	C.Y.	130,000	$1,950,000
Shoring of Excavation	$15	S.F.	150,000	$2,250,000
Tunnelling (approximately 2000' @ Hwy 101)	$500	C.Y.	60,000	$30,000,000
Conduit				
Reinforced Concrete (11' x 26' RCB)	$500	C.Y.	40,000	$20,000,000
Traffic Control				
Minor Intersections	$100,000	EA.	10	$1,000,000
Major Intersections (Middlefield Rd. & Hwy 101 on-ramp)	$200,000	EA.	2	$400,000
Roadway Work (Willow Rd.)				
Remove A/C Pavement	$2	S.F.	225,000	$450,000
Remove Curb & Gutter	$2	L.F.	6,000	$12,000
Remove Sidewalk	$2	S.F.	22,500	$45,000
A/C Pavement	$5	S.F.	225,000	$1,125,000
Curb & Gutter	$16	L.F.	6,000	$96,000
Sidewalk	$8	S.F.	22,500	$180,000
EARTH CHANNEL (d/s Hwy 101 to Ravenswood Slough)				
Site Preparation				
Remove Structures (downstream Hwy 101)	$7,500	EA.	120	$900,000
Clearing and Grubbing	$5,500	ACRE	9.2	$50,600
Earthwork				
Excavate & Place (levees)	$10	C.Y.	50,000	$500,000
Import & Place (levees)	$15	C.Y.	30,000	$450,000
Maintenance Road Surfacing (6" aggreg. rock)	$0.55	S.F.	113,000	$62,150

Item	Unit Cost	Unit	Quantity	Amount
Traffic Control				
Minor Intersections	$100,000	EA.	3	$300,000
Major Intersections (SR 84 & SPRR crossing)	$200,000	EA.	2	$400,000
Bridge Work				
SPRR Crossing near SR 84	$150	S.F.	8,500	$1,275,000
SR 84	$100	S.F.	15,200	$1,520,000
Hamilton Ave.	$100	S.F.	7,200	$720,000
Ivy Dr.	$100	S.F.	12,000	$1,200,000
Newbridge St.	$100	S.F.	12,000	$1,200,000
Roadway Work (Willow Rd.)				
Remove A/C Pavement	$2	S.F.	38,400	$76,800
Remove Curb & Gutter	$2	L.F.	1,600	$3,200
Remove Sidewalk	$2	S.F.	4,800	$9,600
A/C Pavement	$5	S.F.	38,400	$192,000
Curb & Gutter	$16	L.F.	1,600	$25,600
Sidewalk	$8	S.F.	4,800	$38,400
EARTH LEVEES (along Ravenswood Slough)				
Earthwork				
Import & Place (levees)	$15	C.Y.	320,000	$4,800,000
Utility Relocation				
Water Line	$300	L.F.	15,300	$4,590,000
Sanitary Sewer	$100	L.F.	14,000	$1,400,000
Sanitary Sewer Crossing	$50,000	EA.	2	$100,000
Electrical Line	$200	L.F.	3,700	$740,000
Gas Line- 2"	$200	L.F.	10,000	$2,000,000
Telephone Line	$200	L.F.	3,700	$740,000
Storm Drain	$200	L.F.	9,200	$1,840,000
Hetch-Hetchy Crossing	$1,500,000	L.S.	1	$1,500,000
Miscellaneous				
Install Temporary Fencing	$10	L.F.	24000	$240,000
Remove Temporary Fencing	$3	L.F.	24000	$72,000
Maintenance Road Surfacing (6" aggreg. rock)	$0.55	S.F.	470,000	$258,500
SUBTOTAL				**$87,784,850**
Mobilization (10%)				$8,778,485
Construction Contingencies (10%)				$8,778,485
TOTAL CONSTRUCTION				**$105,341,820**

Item	Unit Cost	Unit	Quantity	Amount
Design (10%)				**$10,534,182**
Geotechnical (5%)				**$5,267,091**
Inspection (10%)				**$10,534,182**
Property Acquisition (for leveed channel)				
Residential Properties	$13,196,000	L.S.	1	$13,196,000
Commercial Properties	$500,000	L.S.	1	$500,000
Relocation Assistance, Tennants	$15,000	EA.	284	$4,260,000
Relocation Assistance, Commercial	$20,000	EA.	13	$260,000
Undeveloped Bayfront Land	$5,000	ACRE	50	$250,000
Commercial Land	$14	SF	10,000	$140,000
Contingencies (15%)				$2,790,900
Acquisition Labor Costs	$15,000	EA.	26	$390,000
RIGHT-OF-WAY COSTS				**$21,786,900**
Mitigation (for channel lining)				
Revegetation (off-site, assume 3:1)	$200,000	ACRE	24	$4,800,000
Revegetation right-of-way (off-site)	$500,000	ACRE	24	$12,000,000
MITIGATION COSTS				**$16,800,000**
TOTAL COST *				**$170,264,175**

* Costs not included for additional measures downstream of El Camino Real to eliminate FEMA flood insurance requirements upstream of Highway 101.

San Francisquito Creek
No Project Alternative, Downstream Highway 101
Cost Estimate Summary

FIRST COST	**Present Worth**
Present worth of the total average annual cost over a 50 year project life at 7% interest.	
TOTAL FIRST COST (7%, 50-year project life)	**$207,000**

AVERAGE ANNUAL COST	**Annual**
General Maintenance (based on 1985 to 1996 records)	$15,000
TOTAL AVERAGE ANNUAL COST	**$15,000**

San Francisquito Creek
Raise Levees
(Raise Levees 4' to Protect to 4,000 cfs)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Channel Modification (raise levees 4')				
Earth-Haul & Fill (levees)	$15	C.Y.	128,000	$1,920,000
Clearing and Grubbing (levees)	$5,500	ACRE	12	$66,000
Concrete Transition (downstream Hwy 101)	$500	C.Y.	1,680	$840,000
Bridge Work				
Modify Pedestrian/Bike Bridge (sta. 32+00)	$85	S.F.	800	$68,000
Miscellaneous				
Maintenance Road Surfacing (6" aggreg. rock)	$0.55	S.F.	288,000	$158,400
SUBTOTAL				**$3,052,400**
Mobilization (10%)				$305,240
Construction Contingencies (10%)				$305,240
TOTAL CONSTRUCTION				**$3,662,880**
Design (10%)				**$366,288**
Geotechnical (5%)				**$183,144**
Inspection (10%)				**$366,288**
Property Acquisition (for leveed channel)				
Undeveloped Bayfront Land	$5,000	ACRE	5.9	$29,500
RIGHT-OF-WAY COSTS				**$29,500**
Mitigation				
Revegetation (off-site, assume 2:1)	$200,000	ACRE	11.8	$2,360,000
Revegetation right-of-way (off-site)	$5,000	ACRE	11.8	$59,000
MITIGATION COSTS				**$2,419,000**
TOTAL COST				**$7,027,100**

San Francisquito Creek
Raise Levees
(Raise Levees 5' to Protect to 6,000 cfs)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Channel Modification (raise levees 5')				
Earth-Haul & Fill (levees)	$15	C.Y.	166,000	$2,490,000
Clearing and Grubbing (levees)	$5,500	ACRE	12	$66,000
Concrete Transition (downstream Hwy 101)	$500	C.Y.	1,680	$840,000
Bridge Work				
Modify Pedestrian/Bike Bridge (sta. 32+00)	$85	S.F.	800	$68,000
Miscellaneous				
Maintenance Road Surfacing (6" aggreg. rock)	$0.55	S.F.	288,000	$158,400
SUBTOTAL				**$3,622,400**
Mobilization (10%)				$362,240
Construction Contingencies (10%)				$362,240
TOTAL CONSTRUCTION				**$4,346,880**
Design (10%)				**$434,688**
Geotechnical (5%)				**$217,344**
Inspection (10%)				**$434,688**
Property Acquisition (for leveed channel)				
Undeveloped Bayfront Land	$5,000	ACRE	7.1	$35,500
RIGHT-OF-WAY COSTS				**$35,500**
Mitigation				
Revegetation (off-site, assume 2:1)	$200,000	ACRE	14.2	$2,840,000
Revegetation right-of-way (off-site)	$5,000	ACRE	14.2	$71,000
MITIGATION COSTS				**$2,911,000**
TOTAL COST				**$8,380,100**

San Francisquito Creek
Raise Levees
(Raise Levees 6' to Protect to 9,300 cfs)
Cost Estimate Summary

Item	Unit Cost	Unit	Quantity	Amount
Channel Modification (raise levees 6')				
Earth-Haul & Fill (levees)	$15	C.Y.	206,000	$3,090,000
Clearing and Grubbing (levees)	$5,500	ACRE	12	$66,000
Concrete Transition (downstream Hwy 101)	$500	C.Y.	1,680	$840,000
Bridge Work				
Modify Pedestrian/Bike Bridge (sta. 32+00)	$85	S.F.	800	$68,000
Miscellaneous				
Maintenance Road Surfacing (6" aggreg. rock)	$0.55	S.F.	288,000	$158,400
SUBTOTAL				**$4,222,400**
Mobilization (10%)				$422,240
Construction Contingencies (10%)				$422,240
TOTAL CONSTRUCTION				**$5,066,880**
Design (10%)				**$506,688**
Geotechnical (5%)				**$253,344**
Inspection (10%)				**$506,688**
Property Acquisition (for leveed channel)				
Undeveloped Bayfront Land	$5,000	ACRE	8.4	$42,000
RIGHT-OF-WAY COSTS				**$42,000**
Mitigation				
Revegetation (off-site, assume 2:1)	$200,000	ACRE	16.8	$3,360,000
Revegetation right-of-way (off-site)	$5,000	ACRE	16.8	$84,000
MITIGATION COSTS				**$3,444,000**
TOTAL COST				**$9,819,600**

APPENDIX B

List of Technical Terms and Acronyms

APPENDIX B

LIST OF TECHNICAL TERMS AND ACRONYMS

Acre-Foot	A quantity of water that would cover 1 acre to a depth of 1 foot, equal to about 325,000 gallons.
Alluvial	Sedimentary material deposited by flowing or receding water.
Bankfull	In this report, the condition where flowing water just reaches the top of the channel bank, but does not overtop.
Channel	A creek, stream, or river.
Corps	United States Army Corps of Engineers
Cross Section	A vertical section at right angles to a channel or structure that provides a side view of the channel or structure; a transect taken at right angles to the flow direction.
Cubic Foot Per Second (CFS)	A measurement of flow indicating the volume of water (in cubic feet) that passes a given point during 1 second (1 cfs is approximately equal to 450 gallons/minute)
Culvert	A channel or pipe that carries flow under fill or a roadway.
Design Flow	The magnitude of flow that is used to design a channel section or structure.
Detention Basin	An off-stream pond or reservoir used to detain water during a given flow event.
Discharge	The volume of water passing through a channel during a given period of time. Usually measured in cubic feet per second.
Feasibility Study	A comprehensive and detailed study of alternative plans, showing that the plan or plans satisfies the public and meets the California Environmental Quality Act and National Environmental Policy Act requirements. The study examines the "feasibility" of potential alternatives, concluding in a full environmental impact assessment of a proposed project.
FEMA	Federal Emergency Management Agency
Freeboard	Vertical distance between the top of an embankment adjoining a channel and the water level in the channel. It is a factor of safety designed into a project.

Flood Basin	In this report, a flood basin refers to an area (such as a valley) that would be temporarily flooded in order to prevent flooding at some downstream location.
Floodwall	A wall, usually concrete, constructed next to a channel to contain flood flows.
Floodwaters	Those flows of water that cannot be contained within the channel.
Gabion	A wire mesh rectangular basket filled with uniformly sized rocks.
Gaging Station	An established location in a channel where flow measurements are taken.
HEC-1	The Corps Hydraulic Engineering Center's (HEC) computer program that uses rainfall and watershed characteristics to compute flows for a channel.
Hydrograph	A graph that plots flow against time and shows how a channel responds to an input of water, resulting from a rainstorm.
Impervious	The quality of being unable to pass or absorb water.
Invert	The lowest point in the bed of a river, stream or creek.
Jurisdictional Wetland	This includes wetland areas over which the Corps has regulatory jurisdiction. See Wetland.
Levee	A earth embankment constructed next to a channel to contain flood flows.
Mitigation	To moderate, reduce, or alleviate the impacts of a proposed activity; includes, in order: (a) avoiding the impact by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; (e) compensating for the impact by replacing or providing substitute resources or environments (Council of Environmental Quality, 1978)
NFIP	National Flood Insurance Program.
One Hundred Year Flood	See One Percent Flood.
One Percent (1%) Flood	The flood that has a 1 percent chance of being equaled or exceeded in any 1 year.
Outfall	A drainage outlet. Refers to the opening of a pipe that discharges into a channel.

□

Overbank	In a channel, the area between the main channel and the limits of the floodplain.
Riparian	Vegetation and wildlife living within, and immediately adjacent to a channel. The channel environment.
Riprap	A protective layer or facing of quarrystone (large rock) placed to prevent erosion, scour, or slouching of a channel bank. Also called rock lining.
Sacked Concrete	Burlap bags filled with concrete and placed on a channel bank to protect the bank against erosion.
Sediment Bar	Sedimentation concentrated in one location. See Sedimentation.
Sedimentation	Soil or mineral material that is deposited by moving water and settles at the bottom of a channel.
Slough	A depression, marsh, pond, or bog, usually filled with mud, that is part of an inlet or backwater.
Soffit	In this report, the lowest point of on the underside of a structure or road crossing.
Watershed	The geographical region or area drained by a channel.
Weir	A wall or obstruction built across the channel bottom with a horizontal crest over which water flows. It is built to back up water or stabilize the channel bottom.
Wetland	In this report, areas that under normal circumstances have hydrophytic vegetation, hydric soils, and wetland hydrology.

APPENDIX C

Bibliography

APPENDIX C

BIBLIOGRAPHY

Federal Emergency Management Agency. *Flood Insurance Study, City of Palo Alto, California, Santa Clara County,* August 1979.

Wilsey, Ham & Blair. *Improvement Study of San Francisquito Creek, San Mateo and Santa Clara Counties, California,* March 1964.

United States Army Corps of Engineers, San Francisco District. *Report of Survey for Flood Control and Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California,* January 1961.

———. *Survey on San Francisquito Creek, Progress Report for Flood Control and Allied Purposes,* March 1958.

———. *Survey Report on San Francisquito Creek, San Mateo and Santa Clara Counties, California, for Flood Control and Allied Purposes,* June 1972.

Vincent, James Robert. *Alternative Methods of Flood Control, San Francisquito Creek, California, Project on Engineering -Economic Planning, Stanford University,* May 1968.

APPENDIX D Comments

STANFORD UNIVERSITY
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February 13, 1998

Pat Showalter, P.E.
CRMP Coordinator
San Francisquito Creek
Coordinated Resource Management Planning
c/o Peninsula Conversation Center
3921 E. Bayshore Road
Palo Alto, CA 94303

Dear Ms. Showalter:

On behalf of Stanford University, we want to express our serious concern over recent news media reports about flood control proposals which are being circulated by Coordinated Resource Management Planning (CRMP) for public discussion. We believe that several of the proposals receiving the most attention have virtually no feasibility. Far from promoting responsible public debate over flood control measures, we believe that CRMP is doing the public a disservice by giving credence to ideas that have no practical base.

The most serious concern has to do with the idea of raising the dam at Searsville Lake. That lake sits in the middle of the Jasper Ridge Biological Preserve, a vital academic resource for Stanford faculty and students and scholars elsewhere. It is also one of the richest wildlife habitats in the region and the location for important biological and ecological research that will help us understand and make better decisions about ecosystems. Raising the dam at Searsville lake would have profound adverse consequences for Jasper Ridge. It is virtually inconceivable that Stanford would participate in a project that would have such detrimental effects on the environment and on research. Furthermore, since the watershed above the dam accounts for only a fraction of the flow of the lower portion of San Francisquito creek, a higher dam at Searsville would have very little effect on flooding.

We understand the CRMP process to be based on consensus. We further understand that CRMP intends to follow a careful process of discussion and deliberation based upon the best available facts. We believe that by putting forward ideas that have neither the backing of CRMP participants nor the benefit of careful study, the entire CRMP process is put in jeopardy.

Sincerely,

Philippe Cohen
Director of Jasper Ridge

Geoffrey Cox
Vice Provost & Dean for Institutional Planning and Operations

cc: Larry Horton

Pat Showalter, P.E.
CRMP Coordinator
San Francisquito Creek
Coordinated Resource Management Planning
c/o Peninsula Conservation Center
3921 E. Bayshore Road
Palo Alto, CA 94303

February 21, 1998

Dear Ms. Showalter:

Per our agreement at the CRMP meeting of February 5, 1998, the following comments are submitted to address errors/omissions in the draft copy of the CRMP report. These errors pertain to the proposal to Expand Searsville Lake which if uncorrected would convey a false impression of the project scope and its associated impact on lands within the Town of Woodside as well as adjacent and downstream properties.

1) Inundation Perimeter: The map as shown (CRMP Report, Fig. 13) does not accurately depict the inundated area; the proposal is based on a 20 foot rise in water level from the current lake level which equates to a 363 foot elevation for the 1% flood event (current lake level during runoff events = 343 feet). Based on the attached drawing derived from a 1991 USGS map the inundated area would extend to Phillips Road and encompass a larger area than Fig. 13 suggests. This error was acknowledged by the CRMP technical writer (Sara Duckler) at the February 5th meeting. Areas at higher elevations would also be placed at risk if water rose to the dam top.

2) Properties Affected: The CRMP report economic analysis is based upon the purchase of 16 inundated properties. This number is low by a significant factor. Properties rendered unusable or inaccessible would include a much larger number of houses and numerous other buildings, horse facilities, and associated improvements. The county assessors map can be used to arrive at an accurate count.

3) Road Access: The report indicates roads would be raised or otherwise protected but neglects to estimate costs. Based on the USGS map, several thousand feet of Portola Road and the connecting link to Hwy 84 would have to be raised by as much as 15 feet to permit vehicular travel through this region which is located directly on the San Andreas Fault. This would require a highly engineered elevated roadway taller in some portions than a freeway overpass. This would create a serious visual and environmental impact and eliminate or seriously impair vehicular access to a number of properties. Use of portions of this road system by equestrians and cyclists would likely be impaired/eliminated. The suggested use of berms to protect the roadways is not viable; several major creeks would be impounded plus the berms themselves would still need to be more than 15 feet high in some sections.

4) Environmental Impact: Fluctuating inundation of the majority of the total area of the project would occur with every significant winter runoff event, not just a 1% event. While the water level may not reach 360-365 feet it would still result in the death of the majority of the oaks and other trees and vegetation in this area. Additionally, standard flood basin practice includes the removal of inundated trees and brush to prevent obstruction of water outlets and downstream areas. The flood basin would thus be a denuded area not habitable by ground-based wildlife or the existing plant species. This effected zone directly encroaches on portions of the Jasper Ridge Biological Preserve and would immediately and permanently change the Preserve's use.

5) Dam Description: The report describes a sixty foot high earthfill dam with an elevation of 365 feet and a cross-section at the base of 590 feet. Since the existing Searsville Dam has an approx. base footing elevation of 275 feet and is approx. 70 feet high (elev. = 343.4 ft at top surface) it would seem that the proposed dam must in fact have an overall height of approx. 100 feet, not the sixty feet mentioned. Also the total elevation would need to be greater than 365 ft to achieve a 20 ft water level increase plus freeboard allowance. For stability, the same side slope cross-section (4.5:1) needs to be maintained thus the dam actually needs to be approx. 1000 feet thick at the base. The required fill (and cost) increases exponentially as the dam gets higher, thus the projected dam cost may be low by a large factor. Additionally, the proposed outlet works consisting of a single 11.5 ft diameter concrete pipe 550 feet long which would be subjected to a 20 ft head of water pressure poses hazards related to debris plugging, breakouts, and lack of ability to drain the reservoir as required by law. These issues are significant as the outlet works are a costly and engineering intensive element of dam construction.

6) Seismic Risk: The potential impoundment of five to seven thousand acre feet of water behind a tall earthfill dam located less than five miles upstream from a major population center would introduce a substantial property/casualty risk factor in any environment. Locating that same dam directly adjacent to the Cana da-Hermit Fault and within 2,500 feet of a major fault zone (San Andreas) will mandate an extraordinarily thorough analysis of the dam, associated underlying geologic structures, and failure consequences. As a backdrop, failures and near-failures in earthfill dams during the Southern California earthquakes in the last 30 years have resulted in major reassessments of dam design requirements. (See references b and c)

7) Cost: The economic analysis in Appendix A p. A-2 and A-3 of the CRMP report details various cost elements totalling $47 million. Since this estimate reflects only a fraction of a major cost element (land acquisition), neglects the costs for the road elevation, and significantly underestimates the dam size, the stated numbers are misleading at best and should not be used in comparing options. Additionally, there is a liability cost element that must be assumed; underwriting costs for insurance or the economic impact and risks of self-insurance by the responsible parties in planning, design, construction, and operation will need consideration and may be a major cost element, especially from a total life-cycle costing perspective.

The following references are useful for a more detailed analysis of dam design and risk assessment:

a) Design of Gravity Dams, U.S. Dept of Interior
b) Dams and Public Safety, U.S. Dept of Interior - Water and Power Resources Service 1980
c) Rampage by Peter Briggs - David McKay Co. (Refer to "Johnstown Flood")
d) Town of Woodside Geologic Map - Dickinson, Cummings/Cotton

Attachment: Inundation Perimeter Maps (2)

Thank you for your attention and consideration.

Sincerely,

Concerned Residents of the Town of Woodside

Phyllis S. Sletten	PHYLLIS S. SLETTEN	200 Family Farm Rd.
David J. Brown	DAVID J. BROWN	280 Family Farm Rd.
Anthony C. Bonora	ANTHONY C. BONORA	270 Family Farm Rd.
Nikki Edmunds	NIKKI EDMUNDS	260 Family Farm Rd.
Paula A. Zurcher	PAULA ZURCHER	300 FAMILY FARM RD.
Victor K Zurcher	VICTOR K ZURCHER	300 Family Farm Rd
Dorothy L Pond	Dorothy L Pond	475 Family Farm Road 475 Family Farm Rd
Eleanor A. Bell	ELEANOR A. BELL	1530 PORTOLA RD., WDS.
Linda Lotts	LINDA LOTTS	1299 PORTOLA RD. WDSD.
Elvira C. McKean	Elvira C. McKEAN	381 Family Farm Rd. Wds.
Jill Gardiner	JILL GARDINER	310 Family Farm Rd. Woodside
Paul E. Heffernan	PAUL E. HEFFERNAN	1985 PORTOLA RD @ PHILIPPS
Peter A.N. Gardiner	PETER A.N. GARDINER	310 Family Farm Rd, Woodside
Kenneth J. Cooper	KENNETH J. COOPER	290 FAMILY FARM RD WOODSIDE
Sally Cooper	SALLY COOPER	290 FAMILY FARM RD "
Charles N. Huggins	CHARLES N. HUGGINS	320 FAMILY FARM RD
Joy Craft	JOY CRAFT	350 FAMILY FARM ROAD
Ken Sletten	Kenneth G. Sletten	250 Family Farm 200 " " Rd

Sincerely,

Concerned Residents of the Town of Woodside

G.V. ATKINSON 8 OLD 24 HONDA WDSD 94062

Adelaide S. Kirkbride / ADELAIDE S. KIRKBRIDE 1550 PORTOLA RD. WDSD-94062

Candace C. Kelley Candace C. Kelley 1502 Portola Rd 94062

Patrick E. Kelley / PATRICK E. KELLEY 1502 PORTOLA RD

Kerry DeBenedetti Kerry DeBenedetti 1533 Portola Rd. Woodside

Tony Tachis TONY TACHIS 1578 TACHIS LANE WOODSIDE

John J. Sullivan John J. Sullivan 220 FAMILY FARM Rd.

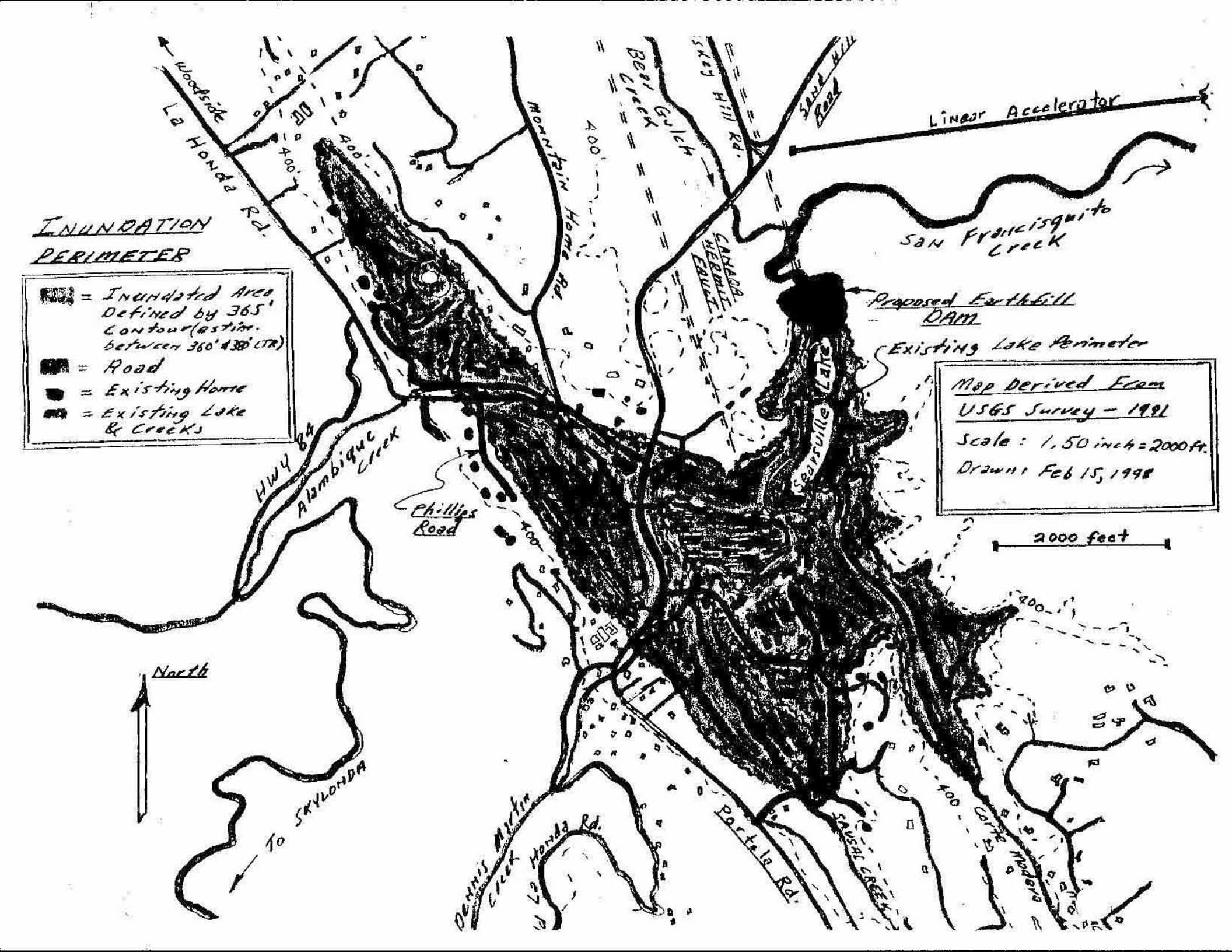
Jeanne E. Sullivan 220 Family Farm Rd Woodside

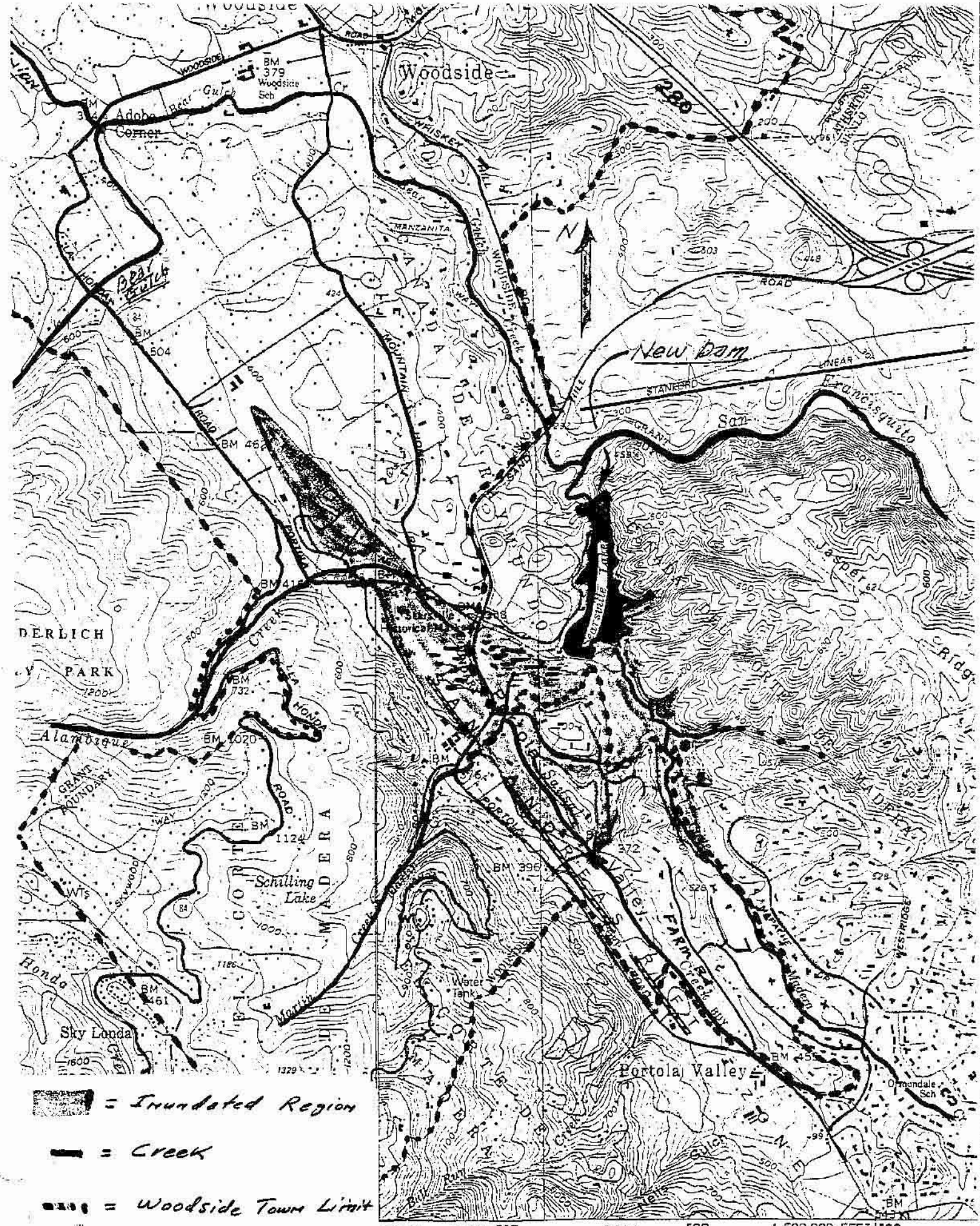
Catherine Harvey Catherine Harvey 230 Family Farm Rd Woodside

Kevin Harvey Kevin Harvey 230 Family Farm Rd Woodside

Lee R Berger 1543 PORTOLA Rd. WOODSIDE

Peter R Berger " " "


INUNDATION PERIMETER
= Inundated Area, Defined by 365' Contour (estim. between 360' & 380' CTR)
= Road
= Existing Home
= Existing Lake & Creeks
Woodside
La Honda Rd.
Mountain Home Rd.
Bear Gulch Creek
Sky Hill Rd.
Sand Hill Road
Linear Accelerator
San Francisquito Creek
Canada Hermit Court
Proposed Earthfill DAM
Existing Lake Perimeter
Searsville Lake
Map Derived From USGS Survey - 1991
Scale: 1.50 inch = 2000 ft.
Drawn: Feb 15, 1998
2000 feet
HWY 84
Alambique Creek
Phillips Road
North
To SKYLONDA
Dennis Martin Creek
La Honda Rd.
Portola Rd.
Sausal Creek
Corte Madera
400'



= Inundated Region

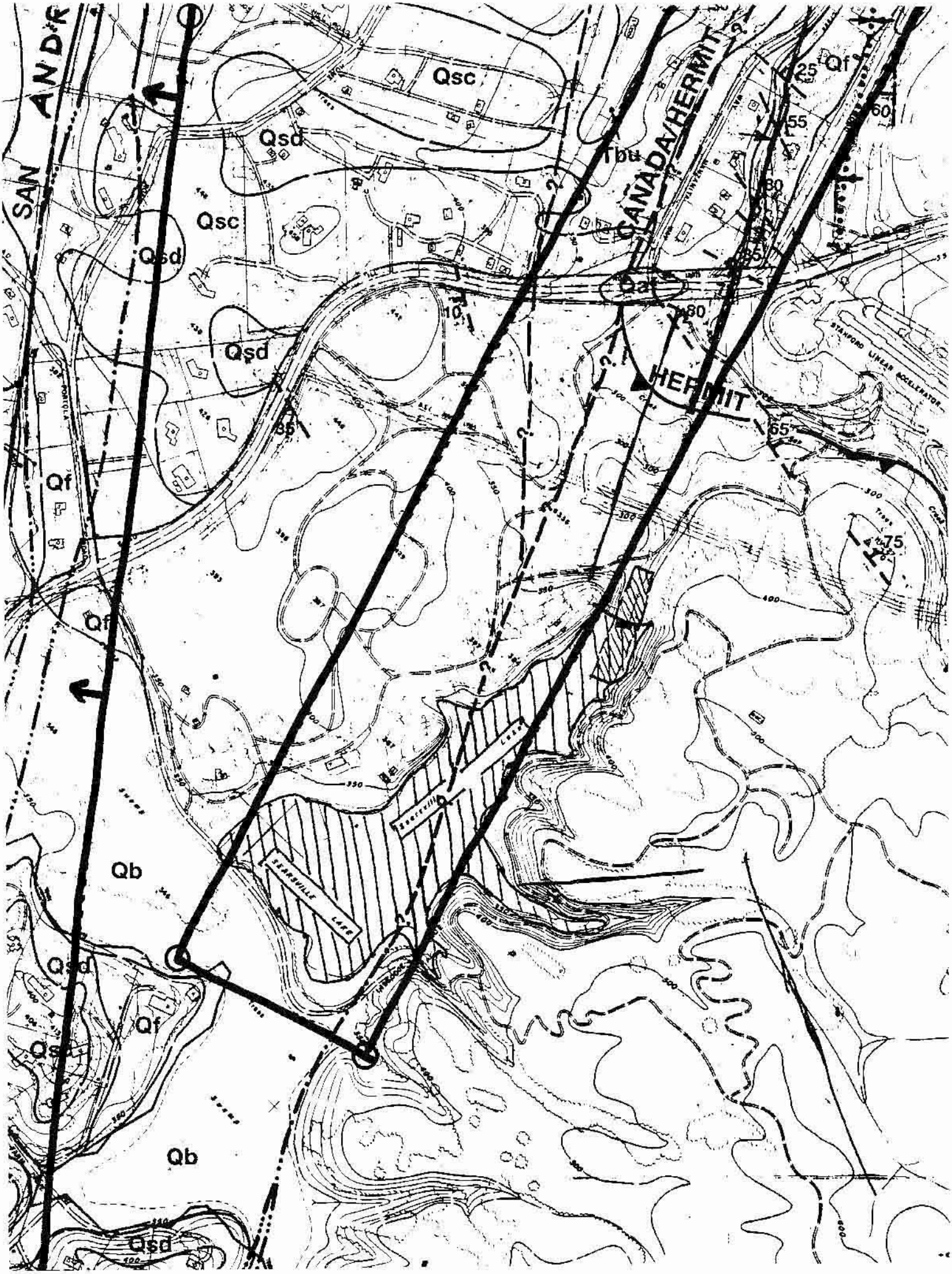
= Creek

= Woodside Town Limit

2/17/98

Produced by the United States Geological Survey

Scale: 1" = 2000 ft.


SAN ANDREAS
CANADA/HERMIT
HERMIT
Qsc
Qsd
Qf
Qb
Tbu
Qal
STANFORD LINEAR ACCELERATOR
SEARSVILLE LAKE

Nikki Edmunds
260 Family Farm Road
Woodside, CA 94062

February 24, 1998

Pat Showalter, P.E.
CRMP Coordinator
San Francisquito Creek
Coordinated Resource Management Planning
c/o Peninsula Conservation Center
3921 E. Bayshore Road
Palo Alto, CA 94303

Dear Ms. Showalter:

- I have been a long-time participating member of CRMP.
- I find myself shocked and deeply disappointed at what I see as an orchestrated attempt to mislead and misinform the public regarding the flood control option that involves raising Searsville Lake dam by 20 feet. I wish here and now to formally state **my strongest objection** to proceeding with the present plan advocating release of the Reconnaissance Report with an executive summary that reiterates the inaccuracy therein.
- The Task Force members seem to all agree that the report significantly understates: size of the area of inundation; number of properties to be acquired; and particularly the estimated cost of the project. The misstated cost is potentially the most egregious error because it is irresponsibly offered for ready comparison with the other options suggested. If CRMP proceeds as planned, this gross miscalculation will detract from the overall positive perception of your intended effort by the community that you are trying to serve.
- I thought CRMP purported itself to be a thoughtful and judicious consensus process that sought to engage not only the present membership but the community at large. Yet the upper watershed community has been virtually ignored in terms of alerting them to the potential disaster (for them) you are proposing. What's gone wrong? Can anyone stop the runaway freight train before it's too late?

Sincerely,

Nikki Edmunds

Nikki Edmunds

cc: T. Bonora, D. Brown, C. Huggins