Attachment 7. Economic Analysis – Flood Damage Reduction Costs and Benefits

Overview

The San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project (East Bayshore Road to San Francisco Bay) would increase stream flow capacity in San Francisquito Creek from the downstream face of East Bayshore Road to San Francisco Bay. It would reduce local flood risks during storm events, as well as provide the capacity needed for upstream flood protection projects being planned by the San Francisquito Creek Joint Powers Authority (SFCJPA). Increasing the Creek's flow capacity from San Francisco Bay to Highway 101 would be achieved by widening the Creek channel within the reach to convey peak flows for 100-year storm events, removing an un-maintained levee-type structure downstream of Friendship Bridge to allow flood flows from the Creek channel into the Palo Alto Baylands Preserve north of the Creek, and configuring flood walls in the upper part of the reach for consistency with structure for Caltrans' enlargement of the Highway 101/East Bayshore Road Bridge over San Francisquito Creek. Project elements include flood walls in the upper project reach downstream of East Bayshore Road, levee setbacks and creek widening in the middle reach between East Palo Alto and the Palo Alto Municipal Golf Course, and an overflow terrace at a marsh elevation along the Baylands Preserve.

The proposed project is Phase 1 of the full, two-phased project. Phase 1 involves creating a new setback levee and excavating the levee on the Santa Clara side, breaching the northern-most levee, as well as excavation of fluvial sediments from marshplain elevation throughout the Phase 1 and Phase 2 project reaches. Phase 2, to be completed at a later date, will include implementation of a new floodwall in the upstream portion of the project reach and a tie-in to Caltrans enlargement of the Highway 101/East Bayshore Road Bridge over San Francisquito Creek.

The project costs and avoided damages estimated in this attachment are limited to those damages that would be avoided through implementation of the Phase 1 project. Potential costs and benefits associated with Phase 2 of the project have not been included. As a result, all of the estimated benefits identified herein would be realized through implementation of Phase 1 as a stand-alone project, and do not depend upon implementation of future project phases.

Project costs and benefits are summarized in Table 7-1, below. Water supply benefits are described in further detail in Attachment 8, and Water Quality and Other Benefits are summarized in Attachment 9.

Table 7-1: Benefit-Cost Analysis Overview

	Present Value
Costs – Total Capital and O&M	$16,858,498
Monetizable Benefits	
Flood Damage Reduction (Attachment 7)	$20,083,637
Water Supply Benefits (Attachment 8)	N/A
Water Quality and Other Benefits	$14,227,936
Total Monetized Benefits	$34,311,573
Qualitative Benefit or Cost	**Qualitative indicator***
Water Supply Benefits (Attachment 8)	N/A
Water Quality and Other Benefits	N/A
Improved In-Stream Water Quality	+
Surface Water Quality Protection	+
Enhanced Recreational Opportunities	+
Enhanced Public Health Protection	++
Reduced Street Maintenance Requirements	+
Improved Water Quality	+
Enhanced Recreational Opportunities	+

O&M = Operations and Maintenance

* Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Economic Costs

Total capital costs for the project amount to $16,700,000 (2009 USD), to be expended between 2009 and 2014 (Attachment 4, DWR Table 6). These costs include $700,000 in sunk costs. These costs were all incurred following September 30, 2008, and include project planning, design, and environmental documentation. Because these items have no salvage value, and are therefore considered sunk costs, they have not been included in column B of DWR Table 10 (at the end of this section). Capital costs entered in DWR Table 10 total $16,000,000, and will be expended between 2011 and 2014. Construction of flood protection project elements will be completed in 2012. Capital costs for 2013 and 2014 include prepping the site for Phase 2 of the project. Once the project is in place and operational (beginning in 2012), $100,000 per year is anticipated to be required for administration and oversight, and $150,000 per year will be required for routines inspections and periodic maintenance activities, for a total of approximately $250,000 per year in operations and maintenance costs, beginning in 2012.

Over the 50-year anticipated project lifetime, the present value costs amount to $16,858,498, as shown in DWR Table 10 at the conclusion of this section.

Estimates of Historical Flood Damages

As described in the Volume II of the *Final Report on San Francisquito Creek Hydraulic Modeling and Floodplain Mapping (Floodplain Modeling and Mapping)*, which was prepared for the U.S. Army Corps of Engineers in January of 2010, the San Francisquito Creek watershed has an area of about 47 square miles, extending from Skyline Boulevard in the Santa Cruz Mountains to San Francisco Bay. The lower watershed, which is the subject of the proposed project, includes densely populated areas in East Palo Alto, Menlo Park, Palo Alto and the towns of Portola Valley and Woodside located in relatively flat-lying areas (Northwest Hydraulic Consultants, Inc., 2010).

While San Francisquito Creek is dry in summer, it experiences periodic flooding during storm events; the Creek overflowed its banks eight times between 1910 and 1972. Four major flooding events observed within the past 60 years are described in the following table (Northwest Hydraulic Consultants, Inc., 2010). The best documented historical event occurred in February 1998, which was estimated to be a 50-year event that caused an estimated $28M in damages in Palo Alto alone. While damage in East Palo Alto was widespread, physical damages were not well documented in this disadvantaged community with limited municipal resources, nor were the economic impacts on transportation and commerce evaluated.

Table 7-2: Historic Flooding Examples

Year	Peak Flow [1]	Damages
1955	5,560 cfs	• Overtopping in multiple locations, including the bridges at Middlefield Road, Pope/Chaucer Street, Highway 101, and two locations upstream of Highway 101 • Inundated 1,200 acres of commercial and residential property and 70 acres of agricultural land, and the Palo Alto Airport
1958	4,460 cfs	• Levee failure downstream of Highway 101 • Flooding of the Palo Alto Airport, City Landfill, and Golf Course, to depths of up to 4 ft • Water backed up behind the Highway 101 Bridge, causing overbanking upstream of the highway
1982	7,260 cfs	• Creek overflowed near Alpine Road, at University Avenue, and downstream of Highway 101, causing extensive damage to private and public property
1998	7,200 cfs	• Creek overtopped its banks, affecting approximately 1,700 residential and commercial structures in Palo Alto, Menlo Park and East Palo Alto • Creek's levees were damaged

1. Peak flows recorded by USGS gage at Stanford University

Existing Without-Project Conditions

As described in the Volume II of the *Final Report on San Francisquito Creek Hydraulic Modeling and Floodplain Mapping (Floodplain Modeling and Mapping)*, overland flooding in project area has been simulated using computer model FLO-2D, which simulates channel flows and overland flows including unconfined flows over complex topography and roughness, split channel flows, and urban flooding (Northwest Hydraulic Consultants, Inc., 2010). This study projected flood damages for the without-project condition in a 25-year, 50-year, 100-year, 250-year, and 500-year event. As shown in the following figure, damages were summarized for three model domains: North 1, North 2, and South. The proposed project would prevent the flood damages otherwise experience in model domain North 2, as well as approximately 20 percent of model domain South.

Figure 7-1: Location of Proposed Project and Model Domains

Flood impacts to model domains North 2 and South associated with the simulated 25-year, 50-year, and 100-year floods are summarized below (Northwest Hydraulic Consultants, Inc., 2010). It should be noted that significant damages have been recorded even in as frequent as a 10 year flood event which coincided with a high tide. For example, in 2008, a ten year flood event caused significant disruption of traffic on Highway 101 due to overtopping. However, because information on expected inundation areas and flooding impacts for the ten year event are not readily available, the 25-year event was evaluated as the most frequent event return interval. All impacts described below are taken from pages 10-11 of Volume II of the *Final Report on San Francisquito Creek Hydraulic Modeling and Floodplain Mapping (Floodplain Modeling and Mapping)*.

25-Year Flood

A 25-year event would be expected to cause significant flooding damage in model domains North 2 and South. Flood impacts and patterns are described below.

Impacts to North 2

In a 25-year flood, outflows to the floodplain area in North 2 are projected to include the following.

- The residential area located north of Highway 101 between Pulgas Avenue and San Francisquito Creek is inundated
- Total inflow is about 219 acre-ft
- Maximum inundated area is about 133 acres
- Maximum water depths range from 1-3 ft in the residential area and up to 4-9 ft in topographic depressions located at the levee running along the Creek and the bay lands
- Maximum overland flow velocities in the residential area range from 0.5-1.5 ft/s

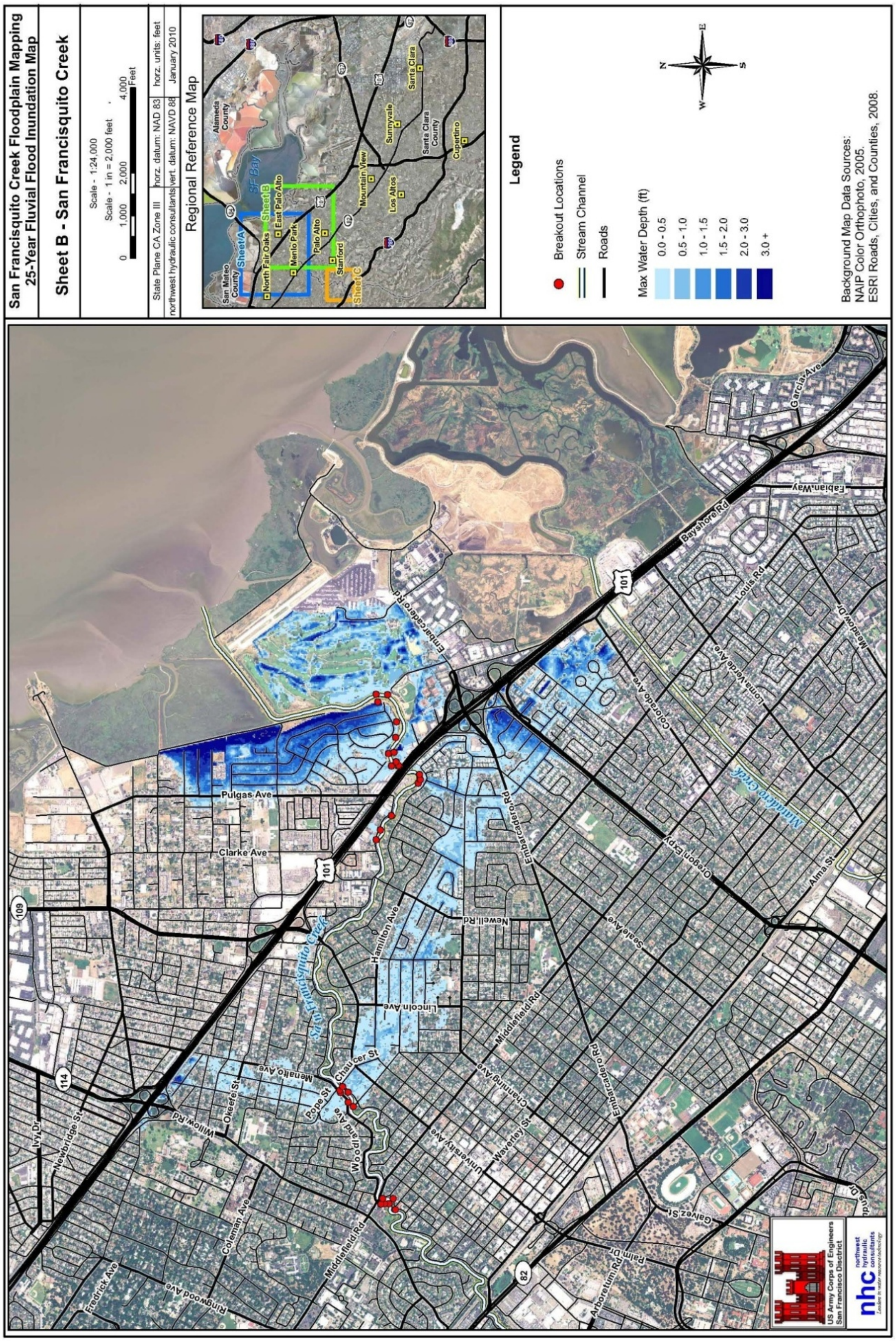
Impacts to South

In a 25-year flood, the South floodplain area would experience the following flooding impacts.

- Flows from breakouts upstream of Chaucer Street and Highway 101 flow through streets and residential areas and accumulate in local topographic depressions at Oregon Expressway and on the south side of Highway 101
- Flows from breakouts downstream of Highway 101 inundate the golf course and the airport
- Total inflow volume from the Creek to the south floodplain is 144 AF
- Maximum inundated area is approximately 350 acres
- Maximum water depths range from 0.5-1 ft in areas of sheet flow and are up to 2-4 ft in topographic depressions and ponded areas
- Maximum overland flow velocities range from 0.5-2 ft/s.

Figure 7-2 on the following page illustrates the extent of flooding anticipated in a 25-year flood.

Figure 7-2: Inundation Map – 25-Year Flood



50-Year Flood

The flooding pattern and impacts associated with the 50-year flood event are similar to that of the 500-year event, and include the following.

Impacts to North 2

In a 50-year event, outflows to North 2 are projected to include the following.

- Significant flooding occurs north of Highway 101, with minor flooding on the south side of the highway.
- Total inflow is 376 AF, all of which is contained within the floodplain
- Maximum inundated area is 173 acres
- Maximum water depths are up to 1-4 ft in built-up areas and up to 5-10 ft in depressions along the outboard levee
- Maximum flow velocities range from 0.5-2 ft/s.

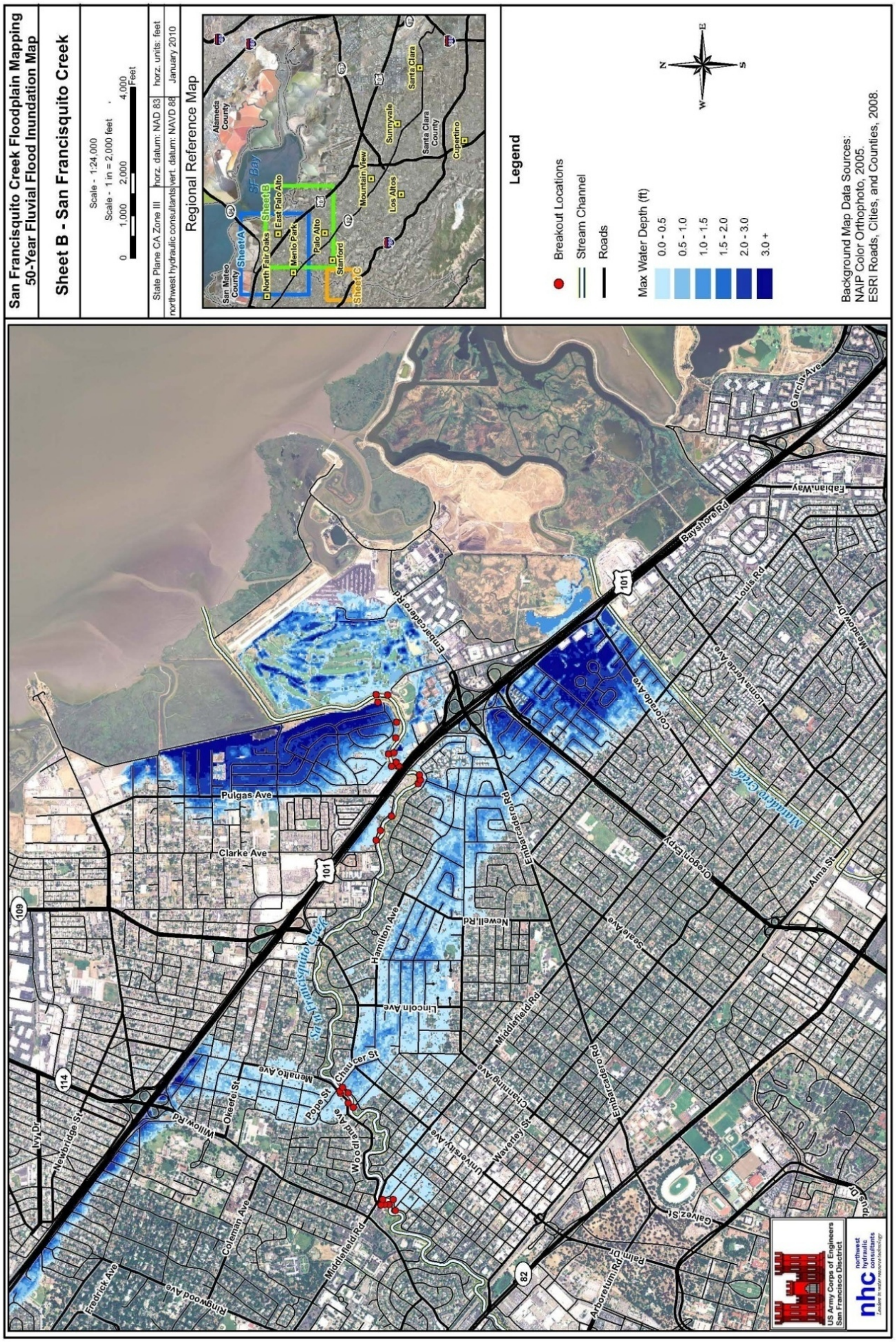
Impacts to South

In a 50-year event, the South floodplain area would experience the following flooding patterns and impacts.

- Flood waters from right bank breakouts upstream of Middlefield Road, Chaucer Street, and Highway 101 flow through residential areas and pond at Highway 101 between Embarcadero Road and Matadero Creek levee, overtop the highway, and spill into the open land area on the north side of the highway
- Flows from breakouts downstream of Highway 101 inundate the golf course and the airport
- Total volume of overbank inflow is 485 acre-ft
- Maximum inundated area is 602 acres
- Maximum water depths range from 0.5-2 ft in areas of transit sheet flow to 2-5 ft in topographic depressions and ponded areas, particularly between Embarcadero Road and Matadero Creek on the north side of Highway 101
- Maximum overland flow velocities range from 0.5-2 ft/s.

Figure 7-3 on the following page illustrates the extent of flooding anticipated in a 50-year flood.

Figure 7-3: Inundation Map – 50-Year Flood



100-Year Flood

FLO-2D model results project widespread flooding along the lower reach of San Francisquito Creek caused by a 100-year event. Impacts to model domains North 2 and South are described below.

Impacts to North 2

In a 100-year flood, outflows to the floodplain area in North 2 are projected to include the following.

- Outflows from the left bank breakouts located upstream of Highway 101 are all contained on the south side of the highway, causing minor flooding of adjacent commercial areas
- Outflows from the breakouts below Highway 101 inundate vast residential areas located north of the highway and east of Clarke Avenue
- Total volume of inflow is 562 acre-ft, all of which is contained within the floodplain boundaries
- Maximum inundated area is 208 acres
- Maximum inundation depths range from 1-5 ft in the residential areas to 5-12 ft in topographic depressions along the outboard levee
- Maximum flow velocities range from 1-3 ft/s

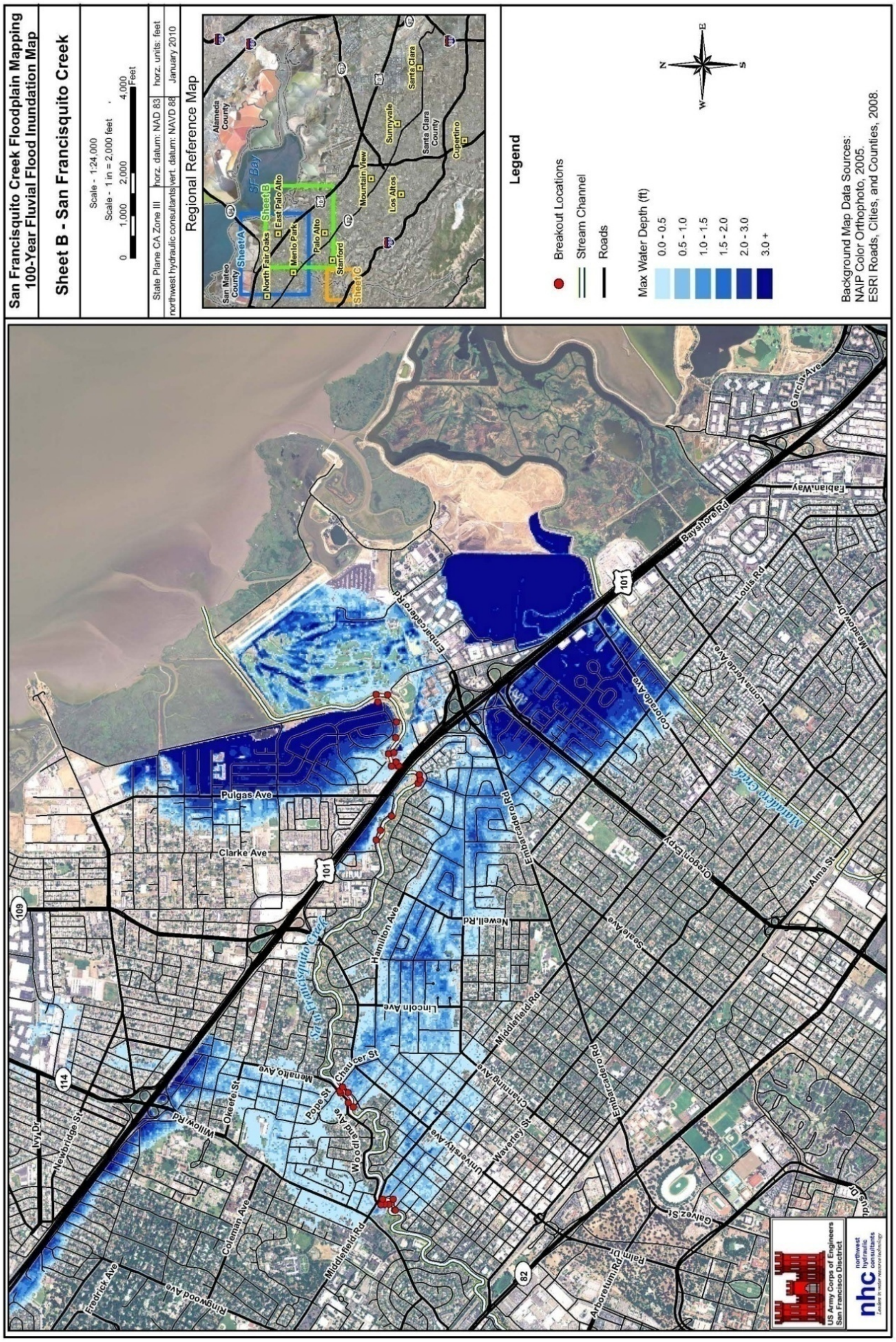
Impacts to South

In a 100-year flood, the South floodplain area would experience severe flooding impacts, including the following.

- The inundated area includes vast residential areas between San Francisquito Creek and Matadero Creek north of Highway 101, open land area on the north side of Highway 101, and the Palo Alto Airport and Golf Course area
- Total volume of inflow is 1,258 acre-ft, all of which is contained within the floodplain
- Maximum inundated area is 917 acres
- Maximum flow depths are up to about 1-3 ft in inundated residential areas between San Francisquito Creek and Embarcadero Road and in the airport/golf course area and up to 3-7 ft in the ponded areas along Matadero Creek
- Maximum flow velocities range from around 0.5-2 ft/s in areas of shallow flooding up to 2-5 ft/s in areas of deep flooding

Figure 7-4 on the following page illustrates the extent of flooding anticipated in a 100-year flood.

Figure 7-4: Inundation Map – 100-Year Flood



Expected Flood Damages Without Project

Expected flood reduction benefits with project implementation have been developed for the 100-year, 50-year, and 25-year flood events. Estimated flood damage reduction benefits have been developed based on the FLO-2D model results presented previously. These benefits are described below.

Levee Failure Assumptions without Project

As described previously, significant flood impacts are expected to occur in the 25-year, 50-year, and 100-year flood events. Under these conditions, overtopping is nearly guaranteed to occur, and the probability of overtopping in the 50-year and 100-year events was estimated as 100 percent. However, for smaller storms, tidal action could play a role in the probability of overtopping. For example, even a relatively modest ten-year event (such as that experienced in 2008) can cause overtopping and significant disruption, provided the event occurs during a period of reasonably high tides. Conversely, a 25-year event occurring during a very low tide may not cause the extent of damages described herein. As a result, the probability of overtopping due to a 25-year flood was estimated at 80 percent. Based on observations by FEMA, the Corps of Engineers and others, there is evidence of a higher coincidence of large flow events being exacerbated in fluvial-tidal interface areas than previously recognized due to elevated tide levels resulting from atmospheric conditions during large storms.

Residential Flood Damage Assumptions without Project

Estimated flood damage to residential property was monetized based on the following assumptions.

Residential Structural Damage

To estimate residential structural damages, it was first necessary to identify the approximate number of homes located in the inundation areas north and east of Highway 101 for each flood return interval. The number of homes included in the inundation area was estimated by comparing aerial imagery of residential developments in the project area with the inundation maps provided as Figures 7-2, 7-3, and 7-4. Based on this analysis, it is estimated that approximately 703 homes, 914 homes, and 1090 homes would be inundated in the 25-year, 50-year, and 100-year flood, respectively.

Recent property sale information for similar homes in the potentially inundated areas published by www.zillow.com was reviewed to determine the approximate average residential property value. A review of similar properties revealed an average value of approximately $375,000 per home. To be conservative in reflecting likely sale prices, this value was reduced by 10 percent, for an average structure value of approximately $337,500 ($375,000 * 0.9).

The Lincoln Institute of Land Policy maintains estimates of the average value of housing, land, and structures, and price indices for land and housing, for the average single-family detached owner-occupied housing unit in each of 46 large metropolitan areas in the United States. The data set is quarterly spanning the 1984:4 – 2010:3 period (http://www.lincolninst.edu/subcenters/land-values/metro-area-land-prices.asp). The percent of total value attributable to the structure alone in quarter 3 of 2010 was found to be 25.0 percent for San Jose, 23.0 percent for San Francisco, and 32.2 percent for Oakland. We have conservatively assumed a midpoint value of 27.6 percent for this analysis, which translates to an average structure replacement value of $93,150.

Assuming the replacement value of each at-risk residential structure equals approximately $93,150, we calculate the total replacement value of at-risk residential property to be $65,484,450, $85,139,100, and $101,533,500 in the 25-year, 50-year, and 100-year floods, respectively.
To estimate the percentage of structure value lost in each event, Structure Depth-Damage tables were applied, based on tables presented in the Army Corps of Engineers December 4, 2000 *Economic Guidance Memorandum (EGM) 01-03, Generic Depth-Damage Relationships*. The residential structures affected in the area were estimated to be primarily one-story structures without basements (approximately 80 percent), with some two-story structures, also without basements (approximately 20 percent). Based on the information presented previously, water depth in the inundated areas varies with return interval and location, but is generally expected to range from 1-12 ft in the residential areas inundated. For the purposes of this analysis, we have conservatively assumed an average depth of 1 foot above the first floor. The Army Corps Guidance Memorandum provides Structure Depth-Damage values of 23.3 percent and 15.2 percent for one- and two-story structures without basements, respectively. Assuming 80 percent of structures are one story and the remaining 20 percent of structures are two stories, this corresponds to an approximate value of 21.68 percent of structure value lost in a flooding event with flood waters one foot above the first floor elevation (23.3 * 0.8 + 15.2 * 0.2). Applying this percentage to our total at-risk property values, we estimate structural damages in the 25-year, 50-year, and 100-year flood events to be $14,197,029, $18,458,157, and $22,012,463, respectively ($65,484,450 * 0.2168, $85,139,100 * 0.2168, and $101,533,500 * 0.2168).

Residential Content Damage

To estimate the value of contents damaged in each event, we refer to guidance provided in the Army Corps of Engineers document entitled *Guidelines to Estimating Existing and Future Residential Content Values*, dated June, 1993. This document recommends that, in the absence of site-specific content to structure value data, a value of 55 percent should be used (refer to page X, recommendation #2). Following this guidance, we estimate the total value of residential contents at risk to be $36,016,448, $46,826,505, and $55,843,425 for the 25-year, 50-year, and 100-year flood event, respectively ($65,484,450 * 0.55, $85,139,100 * 0.55, and $101,533,500 * 0.55). We then reviewed the Content Depth-Damage curves presented in the Army Corps of Engineers *Economic Guidance Memorandum (EGM) 01-03, Generic Depth-Damage Relationships* to find generic content damage values of 13.3 percent for a one-story home with no basement and 8.7 percent for a two-story home with no basement with flood waters reaching one foot above the first floor elevation. Assuming 80 percent of homes are one-story and 20 percent of homes are two-story, this gives us a content damage value of 12.38 percent (13.3 * 0.8 + 8.7 * 0.2). Applying this percentage to the total structural value at risk, we estimate residential structure content damages to be $4,458,836, $5,797,121, and $6,913,416 for the 25-year, 50-year, and 100-year events, respectively ($36,016,448 * 0.1238, $46,826,505 * 0.1238, and $55,843,425 * 0.1238).

Summary of Estimated Residential Flood Damage

In summary, the total residential damages, including damages to structures and content, is estimated to be $18,655,865, $24,255,278, and $28,925,879 for the 25-, 50-, and 100-year flood events, respectively. Data related to cleanup and debris removal costs are not available, and have therefore been excluded from this analysis.

Commercial Flood Damage Assumptions without Project

Estimated flood damage to commercial property was monetized based on the following assumptions.

Commercial Structural Damage

Commercial damages were estimated in a similar manner to residential damages. The number of commercial facilities included in the inundation area was estimated based on aerial imagery of the affected areas. Based on this analysis, it was estimated that approximately 8 office buildings, 14 office buildings and public facilities, and 18 office buildings and public facilities would be affected in the 25-year, 50-year, and 100-year events, respectively. Property value data was not available for the at-risk commercial structures; as such, structure values have been conservatively estimated at $1 - $2 million each. The total at-risk value of commercial structures was therefore estimated to be approximately $8,000,00, $14,000,000, and $18,000,000 for the 25-year, 50-year, and 100-year flood events, respectively (8 * $1,000,000, 14 * $1,000,000, and 18 * $1,000,000).

To estimate the percentage of structure value lost in each event, Army Corps of Engineers commercial depth damage factors were applied (NRCS flood tools). Although there are multiple types of businesses located within the inundation area, the bulk of the commercial properties affected can be characterized as office buildings. As such, we applied the depth-damage factor for the category office buildings – general of 12 percent. This yielded estimated damages to commercial structures of $960,000, $1,680,000, and $2,160,000 for the 25-year, 50-year, and 100-year events, respectively ($ 8,000,000* 0.12, $14,000,000 * 0.12, and $18,000,000 * 0.12).

Commercial Content Damage

Ratios of content to structure value were not available for commercial properties. For the purposes of this analysis, we have conservatively assumed that the ratio of content value to structure value for the nonresidential properties affected is approximately 20 percent, less than half of the assumption used for residential properties. Based on this assumption, the value of at-risk contents in the inundation areas is approximately $1,600,000, $2,800,000, and $3,600,000 for the 25-year, 50-year, and 100-year flood event, respectively ($ 8,000,000* 0.2, $14,000,000 * 0.2, and $18,000,000 * 0.2). The Army Corps of Engineers commercial depth damage factor for the category office building – general is 16 percent. Applying this factor to the at-risk content values calculated previously, we estimate commercial content damages to be $256,000, $448,000, and $576,000 for the 25-year, 50-year, and 100-year flood, respectively ($1,600,000 * 0.16, $2,800,000 * 0.16, and $3,600,000 * 0.16).

Summary of Estimated Commercial Flood Damage

In summary, the total commercial damages, including damages to structures and content, is estimated to be $1,216,000, $2,128,000, and $2,736,000 for the 25-, 50-, and 100-year flood events, respectively. Data related to cleanup and debris removal costs are not available, and have therefore been excluded from this analysis.

Road Inundation Damage Assumptions without Project

Road inundation was estimated by comparing aerial imagery of roads within the project area with the inundation maps provided as Figures 7-2, 7-3, and 7-4. The following table summarizes the length of each road type expected to be inundated in the 25-, 50-, and 100-year flood events. As shown in this table, major roads, including Pulgas Avenue and O'Connor Street, would experience significant inundation in the 50- and 100-year flood events.

Table 7-3: Summary of Without-Project Road Inundation Assumptions

Road Type	Miles Inundated		
	25-Year Flood	50-Year Flood	100-Year Flood
Arterial	0	0	0
Major	1.0	1.5	2.5
Minor	5.0	6.0	7.5
Unsealed	0	0	0

Costs associated with road inundation were estimated using the default values within the Department of Water Resources' Flood Rapid Assessment Model (FRAM). These default values assume the cost per mile of highway / arterial, major, minor, and unsealed roads to be $250,000, $100,000, $30,000, and $10,000, respectively. These assumptions are based on estimates developed for the San Francisco Bay Area. The inundation areas identified in the project area are also located within the San Francisco Bay Area. As such, it was determined that these values reasonably reflect the costs associated with road inundation in the project area. In total, these costs sum to $250,000, $330,000, and $475,000 for the 25-year, 50-year, and 100-yaer floods, respectively.

Warning Time Assumptions

As discussed previously, the San Francisquito Creek Joint Powers Authority is in the process of developing an early warning system. However, this system has not yet been implemented, and flood warning is left to each individual jurisdiction to manage. For the purposes of this analysis, it was assumed that the average warning time under all three model flood events is approximately 30 minutes.

FRAM Modeling

Using these assumptions, without-project flood damages were estimated using DWR's FRAM model. Based on the assumptions above, the estimated actual annual average damages (EAD) as calculated by FRAM without the project are $1,274,192.

Expected Flood Damages With Project

Expected flood damages with project are described below.

Levee Failure Assumptions With Project

The project has been designed to prevent flooding in a 100-year fluvial event that coincides with the 100-year high tide, taking into account a potential 26-inch rise in sea level over the next 50 years. As such, there is *zero* probability of overtopping during a 25- year, 50-year, or 100-year event.

Residential Flood Damage Assumptions with Project

The value of residential property and contents at risk with project implementation was assumed to be equal to the value at risk without the project ($18,655,865, $24,255,278, and $28,925,879 for the 25-, 50-, and 100-year flood events, respectively).

Commercial Flood Damage Assumptions with Project

The value of residential property and contents at risk with project implementation was assumed to be equal to the value at risk without the project ($1,216,000, $2,128,000, and $2,736,000 for the 25-, 50-, and 100-year flood events, respectively).

Road Inundation Damage Assumptions with Project

The value of road inundation damage at risk with project implementation was assumed to be equal to the value at risk without the project ($250,000, $330,000, and $475,000 for the 25-year, 50-year, and 100-yaer floods, respectively).

Warning Time Assumptions with Project

Although the San Francisquito Creek Joint Powers Authority is in the process of developing an early warning system, that is not part of the project being proposed for funding. As such, warning time was estimated t be 30 minutes for each model flood events, consistent with the without project condition.

FRAM Modeling

Using these assumptions, flood damages with the project were estimated using DWR's FRAM model. Based on the assumptions above, the actual EAD as calculated by FRAM with the project are $0.

Expected Flood Damage Reduction Benefits with Project

As described previously, DWR's FRAM model was used to determine the EAD with and without project implementation. Based on the FRAM analysis, the annual benefit of project implementation is $1,274,192 per year. This corresponds to a present value benefit of $20,083,637.

Project Beneficiaries and Distribution of Benefits

This project will benefit stakeholders at the local and regional levels, as summarized in 7-4. This project benefits local residents by virtually eliminating the risk of levee overtopping in storm events up to and including the 100-year flood coincident with the 100-year high tide. In addition, this project will benefit regional stakeholders by eliminating the risk of flooding to Highway 101. This project will provide appreciable statewide benefits by preventing water quality impacts to the San Francisco Bay resulting from flooding.

Table 7-4: Project Beneficiaries Summary

Local	**Regional**	*Statewide*
Residents of East Palo Alto, Menlo Park, Palo Alto and the towns of Portola Valley and Woodside who currently experience flooding	Users of Highway 101 Stakeholders with an interest in San Francisco Bay supplies, fisheries, and general ecologic well-being	***Stakeholders with interest in San Francisco Bay water quality, fisheries, and general ecologic well-being***

Timing of Benefits

Project construction will be completed in 2013, and preparation for Phase 2 efforts will continue through 2014. For this analysis, a 50-year useful project life is assumed, thus benefits and costs are calculated through 2064 (50 years after the Phase 2 preparations are completed).

Uncertainty of Benefits

This analysis of costs and benefits is based on available data and some assumptions. As a result, there may be some omissions, uncertainties, and possible biases. In most cases, omissions lead to a downward bias in benefits: the project is expected to be much more beneficial than the subset of benefits that can be monetized would indicate. Several of these issues are listed in Table 7-5.

Table 7-5: Omissions, Biases, and Uncertainties, and Their Effect on the Project

Benefit or Cost Category	**Likely Impact on Net Benefits***	*Comment*
Flood damages	++	Fairly conservative assumptions were used to estimate the value of the combined assets at risk and the probability of levee overtopping over the coming 50 years. The 50-year flood event that occurred in February 1998 caused an estimated $28M in flood insurance claims in Palo Alto alone. This figure excludes physical damages in East Palo Alto and economic impacts on transportation and commerce. Our assumptions yield estimated total damages in the 50-year event of approximately $28.6 M, including damage to all locations and considering transportation and commerce. As such, it is assumed that these assumptions underestimate potential flood damages.
Debris Removal and Cleanup Costs	++	No estimates of debris removal and cleanup costs were available, and as such, these costs have been excluded from the analysis. Including these benefits could significantly increase the overall value of flood damage reduction benefits.
Project costs	U	The calculation of the present value of costs is a function of the timing of capital outlays and a number

	of other factors and conditions. Changes in these variables will change the estimate of costs.

*Direction and magnitude of effect on net benefits:
+ = Likely to increase net benefits relative to quantified estimates.
++ = Likely to increase net benefits significantly.
– = Likely to decrease benefits.
– – = Likely to decrease net benefits significantly.
U = Uncertain, could be + or –.

Potential Adverse Effects

Adverse effects associated with project implementation are expected to be limited. Non-tidal seasonal wetland habitat is present between the Palo Alto Golf Course and the outboard levee slope of San Francisquito Creek. The project will both fill a portion of these wetlands (converting them to uplands) and convert a portion of these wetlands to tidal marsh. Although there will be a loss of non-tidal season wetlands resultant from the project, the new habitat created will be of much higher value as it will not be seasonal, and will maintain year-round connectivity to other high-quality habitat either created by or opened up by the project.

Documentation Supporting Benefits

- Northwest Hydraulic Consultants Inc. *Final Report, San Francisquito Creek Hydraulic Modeling and Floodplain Mapping, Volume II: Floodplain Modeling and Mapping*. Prepared for the U.S. Army Corps of Engineers San Francisco District, January 22, 2010.
- Johnson, James. *Economic Guidance Memorandum (EGM) 01-03, Generic Depth-Damage Relationships.* Army Corps of Engineers, December 4, 2000.
- Davis, Stuart. *Guidelines to Estimating Existing and Future Residential Content Values.* Army Corps of Engineers, June, 1993
- Lincoln Institute of Land Policy Land Prices for 46 Metro Areas: http://www.lincolninst.edu/subcenters/land-values/metro-area-land-prices.asp, accessed 4/6/11.

Economic Benefit Tables

Capital costs for the project amount to $16,858,498 in present value terms, as shown in DWR Table 10. This includes initial spending starting in 2011 and continuing through the end of 2014. The project lifetime is expected to be 50 years, and annual administration costs of $100,000 per year and maintenance costs of $150,000 per year are anticipated once the flood protection elements of the project are completed in 2012. Following completion of the major flood protection elements, additional work will be completed to prepare the site for Phase 2 of the project.

As described above, flood damages were estimated using DWR’s FRAM; as such, DWR Table 11 is not required and has been omitted. Figure 7-5 presents the loss-probability curve developed for the project using the FRAM model. DWR Table 12 presents the results of the FRAM analysis. Based on this analysis, using a project life of 50 years and a 6% discount rate, the present value of expected benefits is estimated to be $20,083,637. DWR Table 13 presents basic seismic failure data.

DWR Table 10: Annual Costs
San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project

	Initial Costs	Operations and Maintenance Costs						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
YEAR	Grand Total Cost	Admin.	Ops.	Maint.	Replace.	Other	Total Costs (a) +…+ (f)	Discount Factor	Discounted Costs (g) x (h)
2009							$0	1.000	$0
2010							$0	0.943	$0
2011	$500,000						$500,000	0.890	$444,998
2012	$13,500,000	$100,000	$150,000				$13,750,000	0.840	$11,544,765
2013	$1,000,000	$100,000	$150,000				$1,250,000	0.792	$990,117
2014	$1,000,000	$100,000	$150,000				$1,250,000	0.747	$934,073
2015		$100,000	$150,000				$250,000	0.705	$176,240
2016		$100,000	$150,000				$250,000	0.665	$166,264
2017		$100,000	$150,000				$250,000	0.627	$156,853
2018		$100,000	$150,000				$250,000	0.592	$147,975
2019		$100,000	$150,000				$250,000	0.558	$139,599
2020		$100,000	$150,000				$250,000	0.527	$131,697
2021		$100,000	$150,000				$250,000	0.497	$124,242
2022		$100,000	$150,000				$250,000	0.469	$117,210
2023		$100,000	$150,000				$250,000	0.442	$110,575
2024		$100,000	$150,000				$250,000	0.417	$104,316
2025		$100,000	$150,000				$250,000	0.394	$98,412
2026		$100,000	$150,000				$250,000	0.371	$92,841
2027		$100,000	$150,000				$250,000	0.350	$87,586
2028		$100,000	$150,000				$250,000	0.331	$82,628
2029		$100,000	$150,000				$250,000	0.312	$77,951
2030		$100,000	$150,000				$250,000	0.294	$73,539
2031		$100,000	$150,000				$250,000	0.278	$69,376
2032		$100,000	$150,000				$250,000	0.262	$65,449
2033		$100,000	$150,000				$250,000	0.247	$61,745
2034		$100,000	$150,000				$250,000	0.233	$58,250
2035		$100,000	$150,000				$250,000	0.220	$54,953
2036		$100,000	$150,000				$250,000	0.207	$51,842
2037		$100,000	$150,000				$250,000	0.196	$48,908
2038		$100,000	$150,000				$250,000	0.185	$46,139
2039		$100,000	$150,000				$250,000	0.174	$43,528
2040		$100,000	$150,000				$250,000	0.164	$41,064
2041		$100,000	$150,000				$250,000	0.155	$38,739

DWR Table 10: Annual Costs

San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project

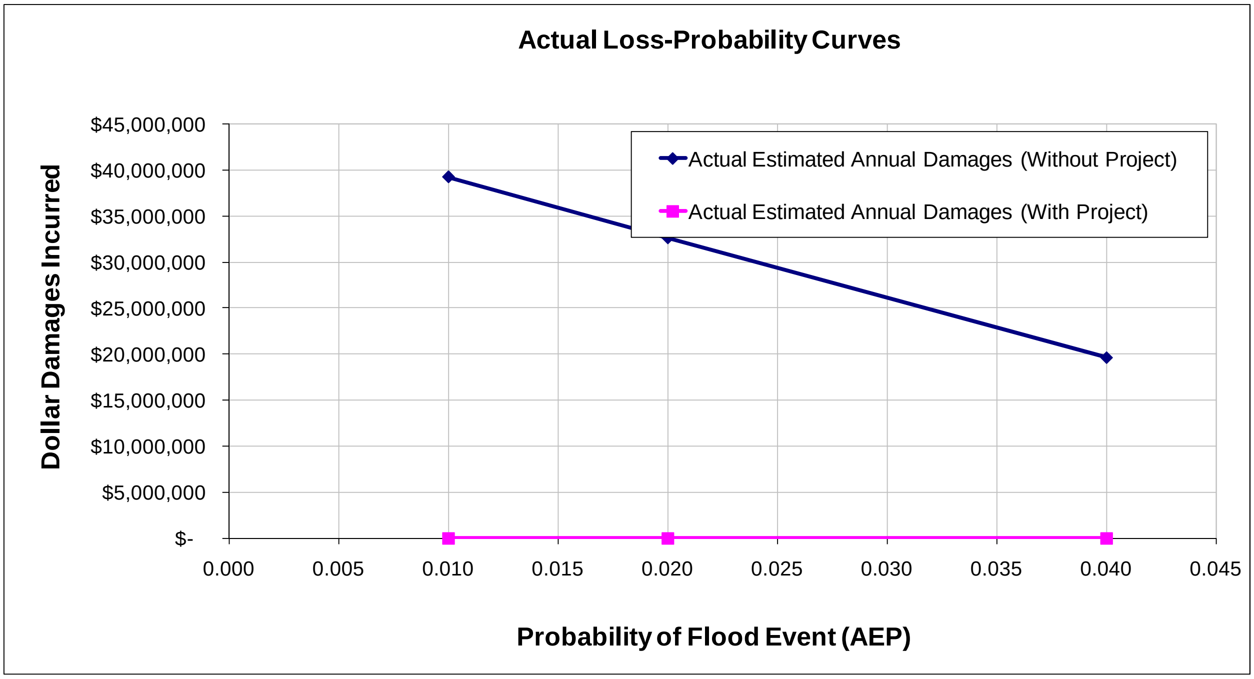
	Initial Costs	Operations and Maintenance Costs						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
YEAR	Grand Total Cost	Admin.	Ops.	Maint.	Replace.	Other	Total Costs (a) +…+ (f)	Discount Factor	Discounted Costs (g) x (h)
2042		$100,000	$150,000				$250,000	0.146	$36,547
2043		$100,000	$150,000				$250,000	0.138	$34,478
2044		$100,000	$150,000				$250,000	0.130	$32,526
2045		$100,000	$150,000				$250,000	0.123	$30,685
2046		$100,000	$150,000				$250,000	0.116	$28,948
2047		$100,000	$150,000				$250,000	0.109	$27,310
2048		$100,000	$150,000				$250,000	0.103	$25,764
2049		$100,000	$150,000				$250,000	0.097	$24,306
2050		$100,000	$150,000				$250,000	0.092	$22,930
2051		$100,000	$150,000				$250,000	0.087	$21,632
2052		$100,000	$150,000				$250,000	0.082	$20,407
2053		$100,000	$150,000				$250,000	0.077	$19,252
2054		$100,000	$150,000				$250,000	0.073	$18,163
2055		$100,000	$150,000				$250,000	0.069	$17,134
2056		$100,000	$150,000				$250,000	0.065	$16,165
2057		$100,000	$150,000				$250,000	0.061	$15,250
2058		$100,000	$150,000				$250,000	0.058	$14,386
2059		$100,000	$150,000				$250,000	0.054	$13,572
2060		$100,000	$150,000				$250,000	0.051	$12,804
2061		$100,000	$150,000				$250,000	0.048	$12,079
2062		$100,000	$150,000				$250,000	0.046	$11,395
2063		$100,000	$150,000				$250,000	0.043	$10,750
2064		$100,000	$150,000				$250,000	0.041	$10,142
Project Life	50 Years							…	
Total Present Value of Discounted Costs (Sum of Column (i))									$16,858,498
Transfer to DWR Table 20, column (c), Exhibit F: Proposal Costs and Benefits Summaries									

Comments:
Annual administration and maintenance costs includes routine inspections and upkeep. All costs are in 2009 dollars.

DWR Table 11: Event Damage
San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project

Not Required (FRAM Model used)

Figure 7-5: Loss Probability Curve (Generated by FRAM Model)
San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project



DWR Table 12: Present Value of Expected Annual Damage Benefits
San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project
(Values generated using FRAM Model)

(a)	Expected Annual Damage Without Project (1)		$1,274,192
(b)	Expected Annual Damage With Project (1)		$0
(c)	Expected Annual Damage Benefit	(a) – (b)	$1,274,192
(d)	Present Value Coefficient (2)		15.76
(e)	**Present Value of Future Benefits**	**(c) x (d)**	**$20,083,637**
	Transfer to column (e)Table 20: Proposal Costs and Benefits Summaries.		

(1) This program assumes no population growth thus EAD will be constant over analysis period.
(2) 6% discount rate; 50-year analysis period (could vary depending upon life cycle of project).

Seismic Retrofit Benefits

No data exists that would support an accurate assessment of the seismic stability of the existing levees. As described in Attachment 3, design standards that consider levee geometry as well as fill material, elasticity and moisture content will be adhered to so that the project elements (new levees) meet the criteria for seismic stability required for certification.

DWR Table 13: Seismic Failure
San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project

Variables	Without Project	With Project
Earthquake magnitude which causes structural failure	Unknown	8.0
Estimated probability of seismic event causing structural failure	Unknown	0.04
Potential inundation damage	$28,000,000	$28,000,000