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GLOSSARY

3-day discharge – The highest average discharge value calculated over three days during a water year

Alternative Package – A group of individual flood protection projects that were combined to provide 100-year flood protection

Attenuate - To reduce

Authority – The Pajaro River Watershed Flood Prevention Authority

Bypass – A parallel channel or pipeline that carries the additional flow that exceeds the existing channel capacity

CEQA (California Environmental Quality Act) – State law written to maintain a high quality environment

cfs (Cubic Feet per Second) – A measure of discharge where 1 cfs is approximately 450 gallons per minute

Corps – The Army Corps of Engineers

Design Storm – An assumed rainfall pattern used in modeling to represent rain events

Detention – Temporary storage of stormwater runoff

Drainage area – The area in which all surface runoff is carried away by a single stream system

DSOD (Division of Safety of Dams) - State agency that oversees dam construction and safety issues

ESA (Endangered Species Act) - The purposes of this act are to provide protections for the ecosystems upon which endangered species and threatened species depend

Exceedance probability – The chance that a given event will be equaled or surpassed in magnitude

FEMA (Federal Emergency Management Agency) – A federal organization created to prepare for, respond to, recover from, and mitigate against disasters

Flood easement – A purchase of the permission to use a land area for flooding

Flooding frequency – The number of times a flood occurs in any average interval of time

Flood plain – The area of land that has historically been covered by water during floods

Flood protection benefit – The percentage of the flood protection deficit that is accommodated or attenuated by a given flood protection project

Flood protection deficit – The difference in flow rates between the channel capacity and the peak flood flow

GIS (Geographic Information System) – A spatial database

Groundwater recharge – The addition of water to subterranean water bodies

GUI (Graphical User Interface) – A method of interacting with a computer program

Hydraulic roughness – The resistance to flow due to channel characteristics

Hydrograph – A location specific graph showing the change in flow rate with respect to time.

Hydrologic condition – A measure of factors that impact surface runoff; used to determine the curve number

Impervious surface – A surface not allowing the absorption or seepage of water into the ground

Levee – An embankment constructed to prevent flooding outside of a confined space

Peak discharge – The greatest discharge value at a point during a water year

PRWS (Pajaro River Watershed Study) – A study authorized by the Authority to determine the causes of flooding and identify methods of flood protection

Retention – Storage of collected storm water with no release to surface water

Return period – The average amount of time between occurrences of an event of a given size

Riparian – Related to or situated on the bank of a river or other body of water

SCVWD (Santa Clara Valley Water District) – One of the water districts included in the PRWS

Subwatershed – a portion of a watershed

TM (Technical Memorandum) – Documents cataloging technical decisions, methods, and results in support of the PRWS

USGS (United States Geological Survey) – A federal agency that collects information about and analyzes natural resources

Watershed – The area upstream of a point through which all surface water within that area flows

Water year – The period from October 1 through September 30

CHAPTER 1

INTRODUCTION

1.1 Purpose of Report

This report summarizes and explains the work done as part of Phase 2 of the Pajaro River Watershed Study. This phase included preliminary identification of all project alternatives that provided 100-year flood protection, and the selection of the most feasible alternatives for more detailed study in future phases.

Flood protection measures that include both upstream and downstream alternatives were identified and defined. In this report, the alternative projects were conceptually defined by identifying a possible project location and size, the advantages and disadvantages, a planning level cost estimate, and the approximate level of flood protection.

Once the alternatives and their flood protection capabilities were outlined, the alternatives were packaged into groups of projects that provided 100-year flood protection. Package elimination and comparison criteria were established to differentiate between the packages. Further evaluation of the alternative packages led to the conclusion that some of the alternatives were not feasible due to various factors such as lack of public support, high costs, environmental regulations, or prohibitive construction constraints. The overall list of alternative packages was trimmed by applying the elimination criteria for these factors. The comparison criteria were used to identify nine packages from the remaining alternative packages for detailed study.

This introduction provides background information on the project including the formation of the Pajaro River Watershed Flood Prevention Authority (Authority), the physical setting and history of the watershed, a brief summary of Phase 1 of the Pajaro River Watershed Study (PRWS), and a discussion of the purpose of this report.

1.2 Background

Legal Authority

The Pajaro River Watershed Flood Prevention Authority was established in July 2000 in order to "identify, evaluate, fund, and implement flood prevention and control strategies in the Pajaro River Watershed, on an intergovernmental basis." Since the watershed covers areas of four counties and four water districts, the board is comprised of one representative from each of the following agencies:

- County of Monterey
- County of San Benito
- County of Santa Clara
- County of Santa Cruz
- Monterey County Water Resources Agency
- San Benito County Water District
- Santa Clara Valley Water District
- Zone 7 Flood Control District

¹ Keeley, "Assembly Bill 807: Pajaro River Watershed Flood Prevention Authority Act." October 10, 1999.

The Authority acts as a governing body through which each member organization can participate and contribute to finding a method to provide flood protection in the watershed and promote general watershed interests. In addition to flood protection, some identified benefits include:

- Municipal, agricultural, and industrial water supply
- Groundwater recharge
- Support of rare, threatened, or endangered species
- Migration and spawning of aquatic organisms
- Preservation of wildlife habitat²

Although efforts by individual agencies have been made in the past to prevent flooding, the ultimate solution may require coordination of structural and non-structural projects throughout the four counties that make up the watershed. Flooding throughout the lower Pajaro River reaches is a hazard to public and private property including residences, agriculture, highways, watercourses, and environmental resources. Recent floods have caused millions of dollars in damage.

As described in the enabling legislation State Assembly Bill 807, the goal of the Authority is to implement flood prevention and control strategies within the watershed. It is a further goal of the study to identify strategies and projects that will provide multiple benefits, such as drinking water, ground water recharge, or environmental restoration and protection.

Watershed Setting

The Pajaro River is the largest coastal stream between the San Francisco Bay and the Salinas Watershed in the County of Monterey.³ The watershed is approximately 1,300 square miles.

The watershed covers portions of Santa Cruz, Santa Clara, San Benito, and Monterey Counties. The large size contributes to the number of diverse environments, physical features, and land uses within the watershed boundary. Tributaries to the Pajaro River, the largest of which is the San Benito River, originate throughout the watershed. A relief map of the watershed showing major highways, cities, dams, and rivers is shown on Figure 1-1.

Soap Lake is an intermittent feature of the watershed but has been found to be an extremely important flood protection feature. Upper Soap Lake is also known as San Felipe Lake and is a permanent body of water. Lower Soap Lake, referred to in this report as Soap Lake, will be formed in the floodplain between San Felipe Lake and the Highway 101 crossing. Soap Lake is created when flood events cause the flooding of low-lying areas and flow backup on the Pajaro River upstream of the San Benito River. The backwater effect is caused by a narrow passage known as Chittenden Pass that is located at the southern edge of the Santa Cruz Mountains. This upper reach of the Pajaro River acts as a natural control to reduce peak flows from the upper Pajaro River watershed. The lake effects disappear as the floodwaters recede and low-lying areas are drained.

Development within the watershed, both urban and rural, is clustered around the major cities. The major urban centers are Watsonville, Gilroy, Morgan Hill, Hollister, and San Juan Bautista. Agriculture and grazing are the dominant land uses in these areas but represent a small portion of the total watershed land use. Other industries outside of the urban setting include mining and timber harvesting. The majority of the land cover is grassland, shrubland, and forest. Figure 1-2 shows the spatial distribution of the land uses.

² "Draft Water Quality Management Plan for the Pajaro River Watershed." Prepared for Association of Monterey Bay Area of Governments. March 1999.

³ Ibid.

1. Introduction

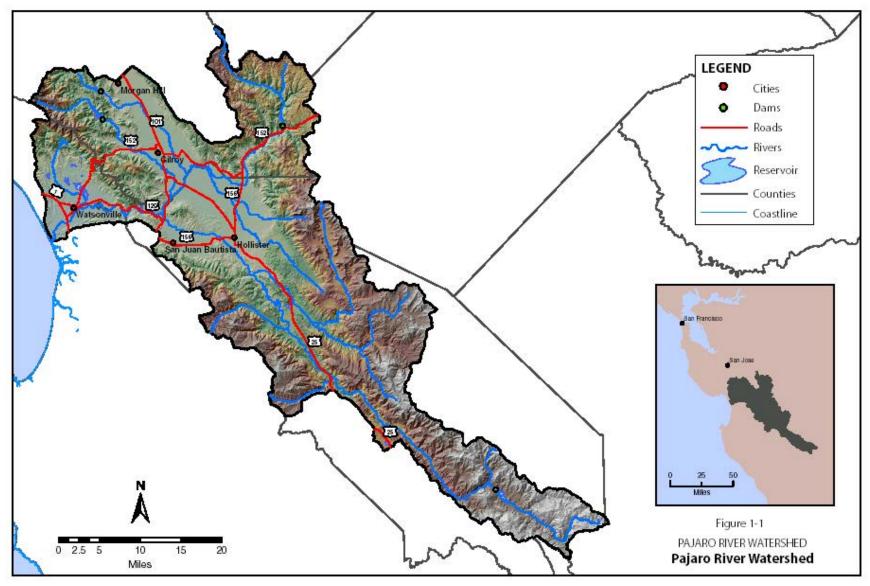


Figure 1-1: Pajaro River Watershed

1. Introduction

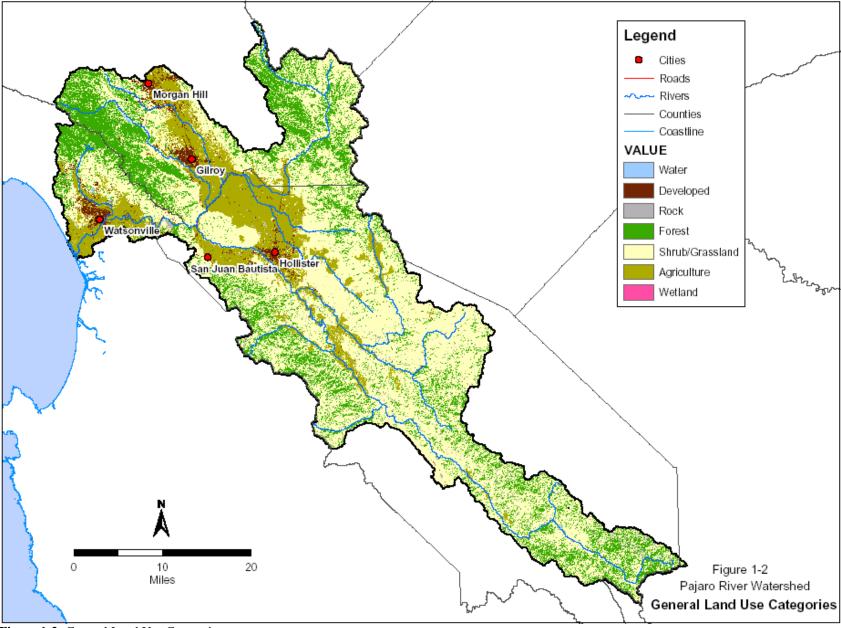


Figure 1-2: General Land Use Categories

Over the recent years, rivers within the watershed have had significant water quality issues. They have been listed on the Clean Water Act 303d list for nutrients, sediments, fecal coliform, chloride, dissolved oxygen, sodium, and total dissolved solids. These pollutants limit the uses of the water and reduce the environmental benefits.

Phase 1 Results

Phase 1 of the study established hydrology and sediment models to describe the flood impacts of watershed conditions. These models described the peak and 3-day discharge at four watershed locations in lower half of the Pajaro River watershed for six flood return periods. Table 1-1 summarizes the 25-year, 50-year, and 100-year event peak discharges at each of the four locations under buildout conditions for the current General Plan land use documents. This planning horizon occurs during the period from years 2015 to 2020.

Table 1-1: F	Ivdrologic Model	l Peak Flows Based on G	General Plan Buildout Conditions
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Watershed Location	Peak Model Flow Rate (cfs)					
	25-year Event	50-year Event	100-year Event			
San Benito River	18,800	26,200	31,600			
Soap Lake Outlet on Pajaro River	21,600	27,400	30,700			
Chittenden Gage on Pajaro River	29,300	38,400	44,400			
Pajaro River downstream of Salsipuedes Creek	32,700	43,100	49,600			

Figure 1-3 is a schematic of the four locations in the lower half of the Pajaro River watershed. As listed in Table 1-1, the San Benito River 100-yr peak flow is 31,600 cfs and the Pajaro River 100-yr peak flow at the Soap Lake outlet is 30,700 cfs. However, due to the time difference between peak flows on each river, the cumulative peak discharge of these two rivers at Chittenden and the Murphy Road Crossing is a lower flow rate, at about 44,400 cfs. The channel capacity just downstream from Chittenden is about 19,000 cfs, based on the design channel size and levee conditions. However, the channel capacity certifiable by the Corps based on current channel and levee conditions could be much lower, at 9,000 cfs. The design conditions of 19,000 cfs for channel capacity were used in this analysis. Flow from Salsipuedes Creek increases the peak discharge in the lower Pajaro River. The Pajaro River flow of 49,600 cfs just downstream from the Salsipuedes Creek confluence is the design flow for the 100-year flood event. The existing channel capacity in the lower reaches of Pajaro River is approximately 22,000 cfs, which is well below the expected 100-year flood event. Frequent flooding occurs in the region because of the lack of flood flow capacity in the river channel downstream of Chittenden.

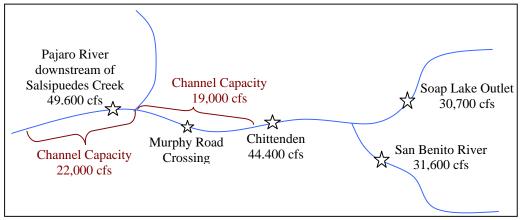


Figure 1-3: 100-Year Return Period Peak Design Flows on the Lower Pajaro River.

The following results and conclusions were based on the hydrologic modeling work:

- Since 1947, the addition of three reservoirs (Hernandez, Uvas, and Chesbro dams) reduced peak flood flows and the probability of flooding in the lower Pajaro River.
- Neither current agriculture conditions nor potential changes in agricultural conditions will cause significant changes in the design discharge or flood conditions.
- Urbanization will increase the runoff from events with frequent return periods (2-year to 25-year), but causes little change in runoff from larger storms with longer return periods (50-year to 200-year).
- Flooding in the Soap Lake area provides peak flow attenuation of Pajaro River flows upstream of the San Benito River confluence, and this situation has been assumed to continue for the Corps peak flow design conditions.

The following results and conclusions were based on the sediment modeling work:

- Sediment conditions within the Pajaro River channel should not be significantly altered by the small, predicted changes in peak design discharges.
- Significant growth of shrubby vegetation could be expected to cause an increase in sediment deposition.
- Changes in sediment load may have localized impacts at the confluence of the San Benito and Pajaro Rivers, but do not affect the Lower Pajaro system as a whole.
- The flooding along Soap Lake limits sediment discharge from the Pajaro River upstream of the San Benito River confluence.

Since the results and conclusions of the sediment studies indicated that sediment conditions would not change significantly from existing conditions, the alternatives developed during Phase 2 were focused primarily on reduction of flooding risk within the lower Pajaro River. However, sediment management impacts were considered for alternatives with incidental effects on sediment conditions, such as reservoirs and detention basins.

CHAPTER 2

IDENTIFICATION OF FLOOD PROTECTION ALTERNATIVES

Flood protection alternatives for the Pajaro River were developed by the interagency Staff Working Group at a focused project workshop. The goal of the workshop was to identify multi-objective projects that, taken in combination, would provide 100-year flood protection while enhancing opportunities for water supply, environmental restoration, groundwater protection, and intergovernmental participation. The focus of the workshop was to identify alternatives that maximize the benefits to the Valley. Many alternatives were identified at the workshop and others were developed from the initial alternatives. The alternatives were subjected to a cursory examination for feasibility, magnitude of benefits, and implementation constraints.

This chapter introduces the alternatives and provides a summary of the basic project concepts, feasibility, and benefits. Each of the projects is described in greater detail in Chapter 3. This chapter also includes a brief description of the land acquisition and/or land management alternatives that may be necessary for the various alternatives.

The general conclusions of the cursory examination of the project alternatives are as follows:

- A few single projects, reservoirs or conveyance structures, may completely protect against flooding, but most projects will provide only an incremental level of flood protection
- New dams or the raising of existing dams involve significant environmental limitations.
- Each alternative will require acquisition of land for either construction of the project alternatives or for floodplain easements.

2.1 Preliminary Identification of Alternatives

The Phase 1 models were used to identify the flood protection benefits possible through implementation of a particular alternative. Three types of alternatives were reviewed, including upstream flow retention/detention, downstream flow management flood protection, and sediment management for potential erosion/sediment control. These are described below.

Upstream Alternatives

These alternatives generally rely on flow detention or retention to improve flood protection. Flow detention attenuates the peak flow through storage of flood flows, creating a lower peak flow at a later time in the storm. Flow retention uses the capture of peak flows to prevent high flow rates from occurring in the downstream channels. Examples of these alternatives are new detention and retention in new developments, increased regional detention and retention capabilities at existing locations (i.e. expansion of Soap Lake or raising of existing dams), and construction of a new detention and retention facilities, such as new dams on the Pajaro or San Benito River.

Downstream Alternatives

These alternatives require the modification of downstream channels and floodplains to reduce risk of flood damage. The most common type of improvement is to increase downstream channel capacity. Channel improvement may be structural, as in the case of increased levee heights or floodwalls, to provide sufficient capacity to convey the expected peak flow event. Alternatives may also be non-structural, such as dedication of

specific lands as floodplains. In this case, formerly flood-prone lands are restored by removing flood flow obstacles in the floodplain.

Sediment Management Alternatives

These alternatives would generally include best management practices for managing land in the watershed, bank stabilization measures along streams, and revisions to maintenance practices regarding sediment removal. Since the Phase 1 sediment studies indicated that sediment conditions would not change significantly from existing conditions, the alternatives developed during Phase 2 were focused primarily on upstream and downstream alternatives to reduce flooding risk.

The Pajaro River Watershed stretches across four counties and multiple cities, and the river itself drains many square miles of coastal plains, providing opportunities for many distinct projects throughout the watershed. The size of the watershed and the magnitude of the peak discharge allow either single projects or combinations of projects implemented together to mitigate the flooding problems on the lower Pajaro River. However, a multiple benefit solution for the watershed would require that several projects be initiated and coordinated with each other to provide the lower Pajaro River flood protection with the maximum range of benefits.

Workshop participants reviewed the Phase 1 hydrology and sediment modeling results. Many project types and alternatives were considered including the following:

- Creating local detention basins,
- Creating regional detention basins,
- Increasing capacity of existing dams,
- Constructing new dam(s),
- Upgrading existing levees,
- Constructing new levees,
- Constructing overflow bypasses, and
- Constructing underground bypasses.

The alternatives developed during the workshop, as well as a cursory estimate of their potential benefits and constraints, are listed in Table 2-1. A more detailed description of the alternatives, their benefits, and their constraints is provided in Chapter 3.

Several upstream and downstream alternatives were estimated to have potential for significant impacts on flood protection. These alternatives were a flood channel bypass on the Lower Pajaro River, control of Soap Lake at Chittenden, and a setback levee with wetlands in the Lower Pajaro River region. Each alternative could be sized to provide 100-year flood protection to meet the flood protection benefit criteria, although there are a number of engineering, environmental, land, public, and other constraints. In addition to flood protection, other potential benefits included groundwater recharge and water quality, environmental enhancement, and reliable water supply.

Alternatives providing lower level of flood protection (up to 30% of the excess peak flow) were a regional retention basin at Tres Pinos River or San Benito River, a bypass at the San Benito River, and additional flooding of Soap Lake.

Alternatives estimated to have the least amount of additional flood protection (between 0 to 10% of the excess peak flow) were raising the existing dams at Uvas, Pacheco, Chesbro, and Hernandez, and a regional detention basin at College Lake. Raising all the dams would provide approximately 5% of the necessary flood protection, while creating a regional detention basin at College Lake is estimated to provide about 10% of the necessary flood protection.

Table 2-1: Initial Selection of Flood Protection Alternatives

Alternative	Location	Potential Flood Protection Benefit	Other Benefit(s)	Implementation Constraint(s)	Example Installation(s)
Improve channel, increase capacity	Lower Pajaro River	0 – 100%		Cost	Delta
Setback levee / habitat creation	Lower Pajaro River	0 – 100%	Environmental enhancement Recreation	enhancement Land loss	
Land Acquisition	Soap Lake Floodplain Area	Maintains planned peak flood flows	Open space Control land use Environmental enhancement	Cost	Napa
Zana requisition	General Land Acquisition for Projects	Prevents additional flood conditions	Open space Controllable	Cost	
Offstream Detention	San Justo Reservoir	Negligible	GW recharge GW quality Wastewater discharge Environmental enhancement Recreation Water supply	Permitting Land loss Cost	Lake Cunningham
Raise existing dams	Uvas, Pacheco, Chesbro, and Hernandez Dams	5%	Water supply GW recharge Recreation	Permitting	Los Vaqueros Shasta Nacimiento
Regional Detention	College Lake Expansion	0 – 10% Lower Pajaro only	Water supply GW recharge GW quality Recreation	Limited by current development	
Regional Retention	Tres Pinos / San Benito	0 – 30%	GW recharge GW quality Wastewater discharge Environmental enhancement Recreation Water supply	Permitting Land loss Cost	Warm Springs Marsh Creek
Control Soap Lake	Soap Lake Chittenden Pass	0 - 30% 0 - 100%	GW recharge Protects Santa Clara conduit Sediment harvesting	Permitting Fault line	College Lake
	Lower Pajaro	0 – 100%			
Bypass	San Benito River	0 – 30%	GW recharge	Land loss Cost	Yolo Sutter
	Other Tributary	Negligible		2001	

2.2 Land Acquisition and Management

Land acquisition or land use restrictions will be required for each of the projects. This section briefly describes the land management alternatives considered for the various projects.

Land acquisition or control can occur through two methods, the purchase of physical property or the purchase of the right to use a given property. The purchase of property would result in land ownership in fee, with control over land access. The purchase of the right to use the land for flooding is known as a flood easement. In this case, the land ownership would be retained by the existing owner, with the purchase of the easement to allow control of land use in the area. The easement purchase would allow land to be flooded temporarily and would restrict the building of structures that could be damaged by the flood or cause damage to the surrounding area. Examples of these structures include buildings, fill materials, and septic tanks. Land acquisition is one of the options available to the Pajaro River Watershed Authority to provide flood protection to the lower Pajaro River.

2.2.1 COUNTY POLICIES

Counties often have policies in place to prevent development within a floodplain or within a certain distance from the river. The following sections highlight and summarize safety and building policies associated with flood plains for each county. The information was taken from county general plans. This section includes descriptions of the existing policies effects on the study and the projects identified.

Monterey County

Monterey County considers the designated 100-yr floodplain to be the significant flood area. The following policies apply to 100-yr floodplains.

- The county will develop and participate in floodplain management plans
- The most appropriate land uses in the floodplain are agriculture, passive to low intensity recreation, and conservation
- New development within 200 ft of the riverbank or in the 100-yr floodplain is prohibited except as permitted by ordinance
- No new development is permitted in the riparian corridor
- All new development in the 100-yr floodplain must conform to the guidelines of the National Flood Insurance Program and policies of the County Board of Supervisors
- All development must be approved by the County Flood Control and Water Conservation District

San Benito County

San Benito County floodplain delineations are consistent with the FEMA 100-yr floodplain delineations. The following policies apply to the 100-yr floodplains.

- Development in potential flood hazard areas is strongly discouraged
- Floodplain zoning designation precludes development
- Parcels located completely within a flood hazard area and created before January 1994 are allowed one single-family residence
- Development of residential homes within the 100-yr floodplain requires an environmental impact report
- Lands within the 100-yr floodplain are considered to be open space and use should be limited to agriculture and open space

Santa Clara County

No mention of the floodplain delineations was found in the Santa Clara general plan. It is assumed that the policies refer to the FEMA 100-yr floodplain delineations.

- Significant natural hazard areas are designated as Resource Conservation Areas with low development densities
- The resident population in high natural hazard areas should be minimized
- It is acknowledged that some development will occur
- New development should not increase downstream risks

Santa Cruz County

No mention of the floodplain delineations was found in the Santa Cruz general plan. It is assumed that the policies refer to the FEMA 100-yr floodplain delineations.

- Development proposals that are adequately protected from hazard and do not add damage potential should be approved
- Development in the 100-yr floodplain is allowed if each proposed parcel has at least 1 development site
 which would not flood and deed restrictions indicating the limits and elevations of the 100-yr floodplain
 are recorded with the County Recorder
- Flood protection projects are allowed within the 100-yr floodplain only to protect existing development

Cities may have their own policies and should be researched before land acquisition decisions are made.

2.2.2 ACQUIRING AND USING LAND

Land acquisition and land use restrictions can be utilized in several different ways. The following sections briefly describe some of the methods considered for the PRWS project alternatives.

Purchase/Condemn

This method is used when the successive land use will be completely different from its current land use. The former owner sells his property rights to the buying authority and has no further claim to the property. For example, a parcel within the 100-yr floodplain could be bought and any structure inhibiting flood flow removed. The land could then be returned to its natural state.

Purchase/Lease

This option is a variation of the one described above. Rather than switching the land use completely, it is possible to purchase the land and lease it back to its original or a new owner. The buying authority then has control of the land use and no liability for damage claims, but allows a second party to maintain an acceptable land use. By allowing the land to be leased, some of the purchase price for the land can be recouped.

Flood Easement

A flood easement is an agreement between the landowner and purchasing authority that land within a flood zone will be allowed to flood. An easement can be bought for the use of a fraction of the land. The owner maintains the property rights and use. The easement limits building structures and other things that might impact its stated use in the easement. The original land use, such as agriculture, can be continued while that area of land is not flooded. When the land does flood though, there can be no damage claims made. Due to the productive agricultural land in the watershed, this will likely be the most attractive option for land acquisition.

Eminent Domain

All of the above options take place between a willing seller and buyer. Occasionally landowners are not willing to sell their land or right to use the land. When this happens and it has been shown that there is no other alternative, public agencies can take the land by eminent domain for the good of the public. This involves rigorous review of different options to solve the problem, study of environmental impacts, and court proceedings. The court forces the sale of the needed land at fair market value. Out of necessity, this is the last option to be considered in terms of both land acquisition and other projects.

CHAPTER 3

PRELIMINARY EVALUATION OF FLOOD PROTECTION ALTERNATIVES

This chapter includes the description and preliminary evaluation of Pajaro River flood protection alternatives identified in Chapter 2. The location, cost, and impacted facilities are subject to change as projects are evaluated further and more information becomes available. Each project alternative evaluation includes the following information:

- Alternative Description
- Flood Protection Level
- Identification of Other Benefits
- Identification of Impacted Facilities
- Implementation Issues
- Cost Estimate

A summary table of the flood protection, engineering and regulatory constraints, other benefits, and a cost estimate for each alternative is provided at the end of the chapter in Table 3-20.

3.1 Identification of Alternatives

A total of 16 alternatives were identified for further evaluation. The alternatives were divided into three categories, including:

- Army Corps of Engineers Lower Pajaro River Flood Protection Project Alternatives
 - 1. Corps Alternative 1 Floodwalls and Levee Height Increase
 - 2. Corps Alternative 3 Floodwalls and Levee Height Increase with 100 feet and 225 feet Setbacks
- Upstream Alternatives
 - 3. Land/Flood Easement at Soap Lake
 - 4. Detention Basin in San Benito Watershed
 - 5. Raise Existing Dams
 - 6. Detention Basin at College Lake
 - 7. New Pacheco Dam
 - 8. New Soap Lake Dam
 - 9. New Tres Pinos Dam
 - 10. New San Benito Dam
 - 11. New Chittenden Dam
- Downstream Alternatives
 - 12. Open Channel Bypass
 - 13. Flood Channel
 - 14. Underground Bypass
 - 15. Flood Tunnel
 - 16. Floodwalls

Concurrent with the Pajaro River Watershed Study, the Army Corps of Engineers (Corps) has been participating in a separate study focused on flow management in the Pajaro River reach downstream of Murphy Road

Crossing. The Corps has identified five alternatives consisting of a series of projects along the river. The alternatives provide different levels of flood protection, with flooding occurrences varying from a 30-year event to a 65-year event. The following Corps alternatives were evaluated as part of this report:

- 1. Corps Alternative 1 Floodwalls and Levee Height Increase
- 2. Corps Alternative 3 Floodwalls and Levee Height Increase with 100-foot and 225-foot Setbacks

The remaining three Corps alternatives have not been included in this report. Those alternatives are:

- Corps Alternative 2 100-foot Setback
- Corps Alternative 4 Floodwall In-lieu of Levees
- Corps Alternative 5 Environmental Corridor

Corps Alternatives 1 and 3 have been chosen for inclusion in this report since they were shown to be cost effective and represent the limits of flood protection provided by the Corps alternatives. Information regarding each of the five alternatives is provided in Appendix A.

3.2 Description of Evaluation Criteria

Alternatives one through sixteen were evaluated based on the following criteria:

- Level of flood protection
- Water supply benefits
- Water quality benefits
 - o Ground
 - o Surface
- Ground water recharge benefits
- Environmental benefits
 - o Enhancement
 - o Restoration
- Recreation benefits
- Regulatory compliance
- Open space preservation
- Agricultural preservation
- Public acceptance

The level of flood protection provided by each alternative was defined as a percentage of the difference between the 100-year peak flood flow and the existing channel capacity as shown on Figure 3-1. Figure 3-1 is a graph of the Phase 1 model flood flow discharges at Chittenden at general plan buildout. The general plan buildout runoff provided for land use for the planning horizon between the years 2015 and 2020. The peak discharge at Chittenden is 44,400 cubic feet per second (cfs) in the general plan buildout land use scenario. The channel capacity downstream of Chittenden, assuming Corps levee certification, is 19,000 cfs, creating a potential overflow of about 25,400 cfs in this reach. Flood protection projects in the watershed would either attenuate the 25,400 cfs flow upstream or provide sufficient capacity for conveyance. A project that would reduce this capacity deficit by 2,540 cfs has a defined flood protection benefit of 10%; a project that would reduce the entire capacity deficit would have a flood protection benefit of 100%. Preliminary hydraulic modeling for each alternative provided the estimates of reduction in peak discharge overflow for the 100-year flood event.

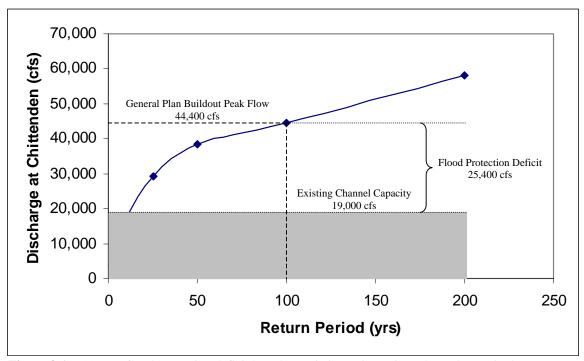


Figure 3-1: 100-year flood protection deficit based on existing Pajaro River channel capacity between Chittenden and the confluence with Salsipuedes Creek.

3.3 Description of Project Alternatives

Alternative 1: Corps Alternative 1 – Floodwalls and Levee Height Increase

Alternative Description

This alternative prevents flooding by providing increased conveyance capacity along the existing river reach. The alternative includes raising the heights of existing floodwalls and levees along the mainstem Pajaro River between Murphy Road Crossing and the river mouth at Monterey Bay. In areas upstream of the Salsipuedes Creek and Pajaro River confluence, the existing levees would be raised to an average height of eleven feet. In the reach of river through the urban area between Watsonville and Pajaro, the average levee height would be five feet and four-foot floodwalls would be constructed. For the remaining reach length downstream to Highway 1 the average height of the levees would be raised to eleven feet. Downstream of Highway 1 to Monterey Bay the average levee height would be raised to ten feet. The Corps estimates that fifty-six acres of land acquisition are required for this project.

Flood Protection

The Corps reported that the Alternative 1 project would provide flood protection during a 30-year flood event with a peak discharge of about 32,000 cfs. This alternative will provide an additional 13,000 cfs of conveyance capacity within the channel. The improvements in Alternative 1 will provide only 51 percent of the 25,400 cfs additional conveyance capacity needed for protection in a 100-year storm event.

Other Benefits

There are no additional benefits associated with this project. Habitat benefits are not available because there are no new opportunities for vegetative growth.

Impacted Facilities

In addition to the agricultural land lost for this project, there are several other impacted structures. Thurwatcher Bridge would need to be raised. Culverts would be required underneath Highway 1. Also, the railroad bridges would need to be replaced and raised four feet.

Implementation Issues

Implementation issues include:

- Endangered Species Act: Great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size, duration, and nature of the project, this would be a considerable task.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions. Any land purchased would also be no longer available for farming.
- **Road and railroad crossings**: The significant construction required at road and railroad crossings would be both expensive and a nuisance to the public.

-3. Preliminary Evaluation of Flood Protection Alternatives

Cost Estimate

The Corps estimates that the cost for lands, easements, right of ways, relocations, and disposal is \$7.4 million. Construction is \$119.4 million. Engineering, design, supervision, and administration are \$19 million. The total cost for this project is \$145.8 million, of which \$36.4 million is the non-federal share.

Further information about this project can be found in Appendix A.

Alternative 2: Corps Alternative 3 – Floodwalls and Levee Height Increase with 100 feet and 225 feet Setbacks

Alternative Description

The Corps Alternative 3 is a combination of setback levees and floodwalls. Upstream of the Salsipuedes Creek and Pajaro River confluence there would be 100-ft setback levees that are twelve feet high. Through the urban reach of river between Watsonville and Pajaro, 4-ft floodwalls would be built on the existing levees. From the railroad crossing to Highway 1 there would be 225-ft setback levees that are twelve feet high. Downstream of Highway 1 to Monterey Bay there would be 100-ft setback levees that are twelve feet high. The Corps estimates that 330 acres of land acquisition are required for this project.

Flood Protection

The Corps reported that the Alternative 3 project would provide flood protection during a 65-year flood event with a peak discharge of about 40,300 cfs. This alternative will provide an additional 21,300 cfs of conveyance capacity within the channel. The improvements in Alternative 3 will provide about 84 percent of the 25,400 cfs additional conveyance capacity needed for protection in a 100-year storm event.

Other Benefits

• **Habitat:** Depending on the level of vegetation maintenance, there is an opportunity to establish habitat for riverine species.

Impacted Facilities

In addition to the homes and agricultural land lost for this project, there are several other impacted structures. The Thurwatcher and Highway 1 bridges would be widened. Culverts would be required underneath Highway 1. Also, the railroad bridges would be replaced and raised four feet.

Implementation Issues

Implementation issues include:

- Endangered Species Act: Great care must be taken to prevent disturbance or harm to any of the species that may live in the impacted area of the project. Due to the size, duration, and nature of the project, this would be a considerable task.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions. Any land purchased would also be no longer available for farming.
- **Road and railroad crossings**: The significant construction required at road and railroad crossings would be both expensive and a nuisance to the public.

-3. Preliminary Evaluation of Flood Protection Alternatives

Cost Estimate

The Corps estimates that the cost for lands, easements, right of ways, relocations, and disposal is \$20.3 million. Construction is \$133.9 million. Engineering, design, supervision, and administration are \$23.1 million. The total cost for this project is \$177.3 million, of which \$44.3 million is the non-federal share.

Further information can be found in Appendix A.

Alternative 3: Land/Flood Easement at Soap Lake

This alternative includes either purchasing land or obtaining flood easements for the land within the Soap Lake floodplain. The alternative objective is to maintain the current flood protection benefits provided by Soap Lake by restricting development that changes the flood attenuation properties of the floodplain. The purchase of land or floodplain easements would restrict development and preserve agriculture and open space.

Alternative Description

No structural facilities would be necessary for this alternative, since the area experiences flooding during a 100-yr event. The floodplain area is considered to be about 7,900 acres. The approximate location of the floodplain boundary is shown in Figure 3-2. The northern boundary is roughly based on the limits of FEMA detailed studied of the Uvas/Carnadero and Llagas Creeks that discharge into this area. The floodplains of these creeks extend northwesterly from the Soap Lake floodplain, but are not shown on Figure 3-2.

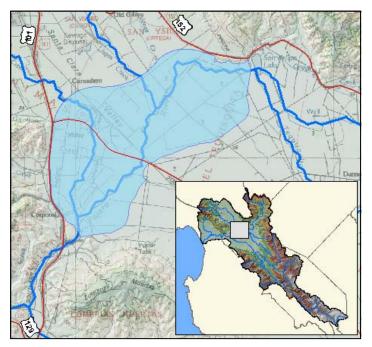


Figure 3-2: Approximate boundaries of the 100-yr floodplain in Soap Lake.

Flood Protection

No additional flood benefit is gained from this project. Instead, it maintains the flood protection that currently exists within the Soap Lake area. Therefore, the 100-yr discharge is expected to remain at 44,400 cfs between the Murphy Road Crossing and the Salsipuedes Creek confluence.

Other Benefits

There are several benefits associated with this project. They include:

- **Surface water quality**: Suspended particles will fall out of suspension as the water velocity and turbulence decreases. This minimizes the sediment deposition in the Pajaro River channel.
- **Groundwater recharge**: Flooding of the Soap Lake floodplain will provide for increasing percolation into the groundwater and recharging the aquifer.

- Regulatory compliance: Both San Benito and Santa Clara have language in their General Plans
 encouraging open space preservation and discouraging development with detrimental effects
 downstream.
- Open space preservation: Land currently held as open space would remain open space.
- Agricultural preservation: Land currently farmed would continue to be farmed.

Impacted Facilities

Due to the nature of the project, existing facilities impacts would not be changed.

Implementation Issues

San Benito and Santa Clara county policies discourage development within the floodplains but do not prohibit development. Further research is needed to determine the likelihood of development within such crucial areas such as Soap Lake or the impacts of zoning the property to prevent future development. Due to increasing pressure to provide housing in the area and employment in the area, the counties will likely experience a great deal of pressure to allow development within the floodplain. If acquisition by the PRWFPA to prevent development is to be avoided, counties will need to revise their land use policies to prohibit development and enforce them. The alternative to using policy to control the development within the floodplain and ensure the maintenance of current flood protection is purchasing the land or flood easement.

As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.

Cost Estimate

A cost estimate for the purchase of the Soap Lake floodplain area is listed on Table 3-1.

Table 3-1: Alternative 3 Cost Estimate - Purchase Soap Lake land.

	Quantity	Unit	Unit Cost	Total
Construction				
Construction Subtotal				\$0
C.O. Contingency				\$0
Total Construction				\$0
Land	7,900	acres	10,000	\$79,000,000
Implementation				
Land Acquisition		Allowance	5%	\$4,000,000
Administration		Allowance	0%	\$0
Engineering		Allowance	0%	\$0
CM		Allowance	0%	\$0
Legal		Allowance	0%	\$0
CEQA		Allowance	0%	\$0
Implementation Subtotal				\$4,000,000
Capital Cost Subtotal	-	-	-	\$83,000,000
Project Contingency	-	Allowance	25%	\$21,000,000
Total Cost	-		-	\$104,000,000

The alternative represented by this estimate provides no additional flood protection to the downstream reaches of the Pajaro River. It maintains the current level of protection provided by the natural constriction at Chittenden and floodplain area known as Soap Lake.

For information regarding the source of the unit costs for this estimate, please refer to Appendix B. Appendix B also contains assumptions and limitations of the estimate.

A cost estimate for the purchase of a flood easement for the Soap Lake floodplain area is listed on Table 3-2.

 Table 3-2:
 Alternative 3 Cost Estimate - Obtain flood easement for Soap Lake land.

	Quantity	Unit	Unit Cost	Total
Construction				
Construction Subtotal				\$0
C.O. Contingency				\$0
Total Construction				\$0
Land	7,900	acres	3,000	\$24,000,000
Implementation				
Land Acquisition		Allowance	5%	\$1,200,000
Administration		Allowance	0%	\$0
Engineering		Allowance	0%	\$0
CM		Allowance	0%	\$0
Legal		Allowance	0%	\$0
CEQA		Allowance	0%	\$0
Implementation Subtotal				\$1,200,000
Capital Cost Subtotal	-	-	-	\$25,200,000
Project Contingency	-	Allowance	25%	\$6,300,000
Total Cost	-	-	-	\$31,500,000

The alternative represented by this estimate provides no additional flood protection to the downstream reaches of the Pajaro River. It maintains the current level of protection provided by the natural constriction at Chittenden and the floodplain area known as Soap Lake.

For information regarding the source of the unit costs for this estimate, please refer to Appendix B. Appendix B also contains assumptions and limitations of the estimate.

Alternative 4: Detention Basin in San Benito Watershed

An off-stream detention basin involves temporarily flooding an area of land adjacent to the river. This flooding would reduce the downstream magnitude of the peak flow and delay the peak discharge in the lower reaches of the river. The project would involve excavation and earthen levees to limit the inundated area. A diversion facility would move the water from the river to a storage area away from the existing floodplain. The water would be discharged back into the San Benito River after the peak flows have dissipated in the Pajaro River.

Alternative Description

The modeled detention basin location is shown in Figure 3-3. The eventual shape of the detention basin would be altered to accommodate existing developments and other landscape features that cannot be submerged. Since the total storage volume required for this project is 40,000 acre-feet (AF), the basin is assumed as 20 feet deep with 2,000 acres area. The depth and inundation area would be adjusted to accommodate site conditions.

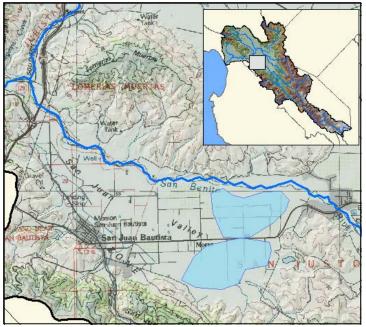


Figure 3-3: Modeled location of diversion and detention basin.

The excavation and levee construction was assumed to be represented as shown in Figure 3-4. Various depth and area combination may be used for the given storage.

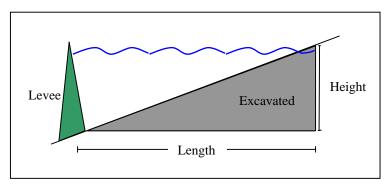


Figure 3-4: Cross-view schematic of detention basin.

The diversion would be designed to allow normal flows to pass either over a weir or through a tunnel. The Yolo Bypass⁴ is an example of a weir diversion and the Caernarvon Diversion⁵ is an example of a tunnel diversion. A weir is essentially a wall that retains low or short duration flows within the channel, but allows higher or longer duration flows to pass over it. The weir diversion would be parallel to the flow of the stream and placed at the river channel edge. High river stages would overtop the weir, discharging into a diversion channel. A tunnel diversion operates on similar principals but the tunnel is perpendicular to the flow and replaces the channel. The high sediment load during a flood could cause maintenance and capacity problems for the tunnel diversion. Figure 3-5 shows two diversion structures but only one would be necessary for the off-stream detention basin. With either method, sizable flood discharges would be partially diverted to the basin. The basin outlet would release water after the flood wave has passed.

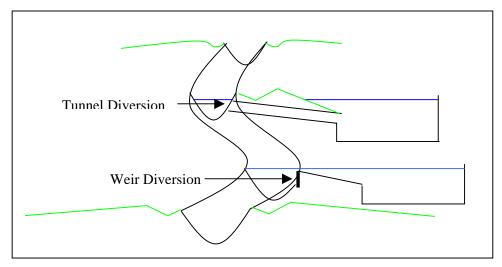


Figure 3-5: Tunnel and weir diversion structures and detention basins.

The levees associated with this alternative could be graded to allow farming on the slopes and access to the land within the basin.

Flood Protection

Flood protection benefit amounts range from 9 to 25 percent for this alternative, and are summarized in Table 3-3. Model flows at the San Benito River and at Chittenden indicate that off-stream detention can reduce the 100-yr peak discharge at Chittenden from 44,400 cfs to 38,000 cfs. The reduction of 6,400 cfs provides a 25% flood protection benefit and requires 40,000 AF of storage. To reduce the peak discharge at Chittenden by 2,400 cfs to 42,000 cfs, which is about a 9% flood protection benefit, will require 24,000 AF of storage.

 	Demico om oueur	in Determinen De		
Detention	San Benito	Chittenden	Discharge Reduction	Flood
Storage Volume	Discharge (cfs)	Discharge	at Chittenden (cfs)	Protection
(AF)		(cfs)		Benefit
None	31,600	44,400	0	0%
40,000	10,000	38,000	6,400	25%
24,000	15,000	42,000	2,400	9%

 Table 3-3:
 Summary of San Benito Off-Stream Detention Benefits.

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⁴ The Yolo Bypass is a 59,300 acre leveed floodplain that conveys up to 80% of the Sacramento River flow during high water events. (www.fisheries.org, vol 26 no 8)

⁵ The Caernarvon Diversion diverts water from the Mississippi River into the Breton Sound Basin. It was intended to restore salinity conditions in the area and will preserve more than 16,000 acres of coastal wetland within the next 50 years.

Other Benefits

There are several benefits associated with this alternative. They include:

- **Surface water quality**: Suspended particles will deposit within the detention basin as the water velocity and turbulence decreases. This minimizes potential for sediment deposition in the Pajaro River channel.
- **Groundwater recharge**: Flooding of the detention area will increase percolation into the groundwater and recharging of the aquifer.
- **Regulatory compliance**: San Benito County has language in its General Plan encouraging agriculture and open space preservation and discouraging development with detrimental effects downstream. The land acquisition associated with this project will provide this opportunity.
- Open space preservation: Land currently held as open space would remain open space.
- **Agricultural preservation**: Land currently farmed would continue to be farmed.

Impacted Facilities

The land use in this area is predominantly agriculture. The fields would be impacted during construction. The associated residences would be subject to an increased flooding risk during peak flow events. Highway 156 crosses the proposed basin area, and would either be raised in this area or protected by levees. Figures 3-6 and 3-7 are photographs of farmlands and Hwy 156 in the proposed basin area.



Figure 3-6: Current agricultural uses at proposed San Benito detention basin site.



Figure 3-7: Highway 156 in the San Juan Valley at proposed San Benito detention basin site.

Implementation Issues

Implementation issues include:

- **Endangered Species Act**: Great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size, duration, and nature of the project, this would be a considerable task.
- Major earth moving project: The amount of earth needed to be excavated, 33 million cubic yards or 20,000 AF, is equivalent to a solid tower of dirt with a footprint the size of a football field and the height of Mt. McKinley, or about 3.75 miles high. Moving and disposing of this much dirt would be extremely time consuming and costly.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.

Cost Estimate

A cost estimate for the off-stream detention basin on the San Benito River is listed on Table 3-4.

Table 3-4: Alternative 4 Cost Estimate - San Benito Detention Basin.

	Quantity	Unit	Unit Cost	Total
Construction				
Mobilization & demobilization	1	L.S.	-	\$31,510,000
Remove top 2' soil & stockpile	6,500,000	Су	\$2.77	\$18,010,000
Excavate to depth	32,300,000	Су	\$1.79	\$57,820,000
Form levees with exc. soil	4,610,000	Су	\$0.98	\$4,520,000
Transport and reform top 2' of soil	6,500,000	Су	\$5.00	\$32,500,000
Soil transport & disposal	27,690,000	Су	\$18.68	\$517,250,000
Diversion	1	L.S.	\$8,000,000	\$8,000,000
Outlet structure	1	L.S.	\$8,000,000	\$8,000,000
Construction Subtotal	-	-	-	\$677,610,000
C.O. Contingency	-	Allowance	15%	\$101,640,000
Total Construction	-	-	-	\$779,000,000
Land	2,000	Acres	\$3,000	\$6,000,000
Implementation				
Land Acquisition	-	Allowance	5%	\$300,000
Administration	-	Allowance	3%	\$23,380,000
Engineering	-	Allowance	6%	\$46,760,000
CM	-	Allowance	4%	\$31,170,000
Legal	-	Allowance	3%	\$23,380,000
CEQA	-	Allowance	1%	\$7,790,000
Implementation Subtotal	-	-	-	\$133,000,000
Capital Cost Subtotal	-	-	-	\$918,000,000
Project Contingency	-	Allowance	30%	\$275,000,000
Total Cost	-	-	<u>-</u>	\$1,200,000,000

The alternative represented by this estimate provides 25% of the necessary protection for the downstream reaches of the Pajaro River.

For information regarding the source of the unit costs for this estimate, please refer to Appendix B. Appendix B also contains assumptions and limitations of the estimate.

Alternative 5: Raise Existing Dams

During Phase 1 of the study, the existing dams were shown to be effective at reducing peak flows during flooding events. To further reduce flooding downstream, the height of the four significant existing dams could be increased. To maximize flood reduction, the dams would be sized for flood retention, with no water able to pass the dam during a 100-yr flood event.

Alternative Description

The four significant dams in this project area are the Chesbro, Uvas, Pacheco, and Hernandez dams. Figure 3-8 shows the location of the existing dams within the Pajaro River watershed. The dams are located toward the border of the watershed in hilly regions.

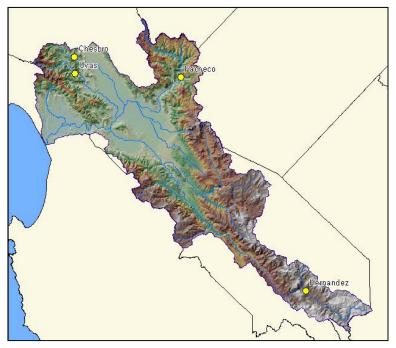


Figure 3-8: Location of the four existing dams: Chesbro, Hernandez, Pacheco, and Uvas.

Table 3-5 shows the current and project heights of the dams required to detain the 100-yr flood behind the dams.

Table 3-5: Storage, inundation area, and additional height required to store 100-yr event flows at four existing dams.

Dam	Current Storage (AF)	Additional Project Storage (AF)	Total Project Storage (AF)	Current Inundated Area (acres)	Additional Inundated Area (acres)	Project Inundated Area (acres)	Additional Project Dam Height (ft)
Chesbro	8,952	7,500	16,452	265	235	500	15
Uvas	10,000	17,400	27,400	286	294	580	30
Pacheco	6,150	12,900	19,050	205	311	516	25
Hernandez	18,700	12,900	31,600	626	664	1290	10

Each dam is assumed to be 800 ft long.

As the height of the dams is increased, the area of land that would be flooded increases as well. During a 100-yr event, about 1,500 additional acres would be flooded due to the increase in dam height.

Flood Protection

If the four dams were raised by the heights indicated in Table 3, the 100-yr peak discharge at Chittenden would be reduced by about 1,300 cfs. This reduction is equivalent to about a 5% flood protection benefit. The small decrease in discharge downstream is due to the relatively small subwatersheds draining to the four dams compared to the total watershed area.

Other Benefits

There are several benefits associated with this alternative. They include:

- Additional water supply: Raising the dams would increase the possible amount of water stored, making the reservoirs a more stable water supply. The reservoirs would need to be empty or nearly so before a flood to maximize protection from that event.
- **Surface water quality**: Suspended particles will fall out of suspension as the water velocity and turbulence decreases. This minimizes the sediment deposition in the Pajaro River channel.
- **Groundwater recharge**: Additional areas of flooding will increase percolation into the groundwater and recharging of the aquifer.
- **Recreation**: Larger reservoirs provide additional space for recreation.

Impacted Facilities:

There are several smaller roads that might be impacted by this project. These include Coalinga Road and Clear Creek Road by Hernandez Reservoir, Oak Glen Avenue by Chesbro Reservoir, and Uvas Road by the Uvas Reservoir.

Implementation Issues

Implementation issues include:

- **Permitting**: Permitting is a consideration for any project. For this project though there are many agencies with whom to coordinate. Some of these include: Department of Fish and Game, National Marine Fisheries Service, and Division of Safety of Dams (DSOD). The DSOD approval would be particularly difficult to obtain due to the additional height of the dams and the proximity to the numerous fault lines within the watershed.
- Endangered Species Act: Additional dam height and inundation area could affect certain endangered species such as the steelhead and red-legged frog. The dam height might make the stream impassible to the steelhead and the extra flooded area could impact the frog habitat.
- Local seismic activity: Due to local fault lines, seismic events and ground shaking may make a structure such as a dam unstable. Further studies are necessary to determine the vulnerability of similar projects in the area. Raising the dams might make them more susceptible to failure.

Cost Estimate

A cost estimate for the raising of four existing dams in the Pajaro River watershed is listed on Table 3-6.

Table 3-6: Alternative 5 Cost Estimate - Raise Existing Dams.

	Quantity	Unit	Unit Cost	Total
Construction				
Mobilization & demobilization	1	L.S.		\$990,000
Land clearing	1,500	Acre	\$4,200	\$6,300,000
Foundation preparation	4	Allowance	\$3,000,000	\$12,000,000
Embankment	900,000	Су	\$10	\$9,000,000
Outlet works	4	L.S.	\$1,000,000	\$4,000,000
Spillway	4	L.S.	\$1,200,000	\$4,800,000
Instrumentation	4	L.S.	\$300,000	\$1,200,000
Monitoring	4	L.S.	\$200,000	\$800,000
Construction Subtotal	-	-	ı	\$39,090,000
C.O. Contingency	-	Allowance	20%	\$7,820,000
Total Construction	-	-	-	\$47,000,000
Land	1,500	Acres	\$3,000	\$4,500,000
Implementation				
Land Acquisition	-	Allowance	5%	\$230,000
Administration	-	Allowance	3%	\$1,410,000
Engineering	-	Allowance	6%	\$2,810,000
CM	-	Allowance	4%	\$1,880,000
Legal	-	Allowance	3%	\$1,410,000
CEQA	-	Allowance	ı	\$8,000,000
Implementation Subtotal	-	-	-	\$16,000,000
Capital Cost Subtotal	-	-	-	\$68,000,000
Project Contingency	-	Allowance	30%	\$20,000,000
Total Cost	-	-	-	\$88,000,000

The alternative represented by this estimate provides 5% of the necessary protection for the downstream reaches of the Pajaro River.

Alternative 6: Detention Basin at College Lake

There are two projects included in this alternative. The first project would increase the storage capacity of College Lake. The second project would divert floodwaters from Corralitos Creek to the lake before the creek could enter Salsipuedes Creek and drain to the Pajaro River. In tandem, the two projects would decrease the amount of water flowing into the Pajaro River.

Alternative Description

To increase the capacity of College Lake, two dams would be constructed. The main dam would have an approximate footprint of 225 ft by 2200 ft. The second, a saddle dam, would have an approximate footprint of 225 ft by 600 ft. The crest of both dams would be at 79 ft with a spillway at 69 ft. The dams would be constructed using 160,000 cubic yards (cy) of borrow material from the lake bottom and local rock quarries.

The diversion from Corralitos Creek involves a pump station and a 24-inch diameter conveyance pipeline. This part of the project would have a footprint of 50 ft by 100 ft. Figure 3-9 shows the location of the two dams.

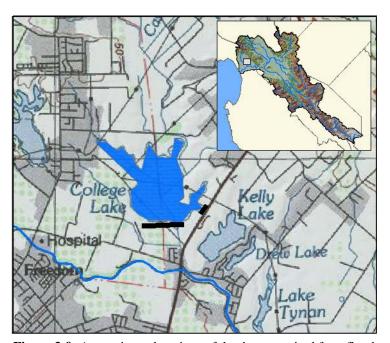


Figure 3-9: Approximate locations of the dams required for a flood detention basin in College Lake.

During a 100-yr flood event, 420 acres of land would be inundated. Figure 3-10 shows one of the strawberry fields that would be affected during the flood.



Figure 3-10: A strawberry field within the floodplain area of the College Lake dam project.

Flood Protection

The alternative described above would reduce the flow on the Pajaro River downstream of the Salsipuedes Creek confluence by less than 2,500 cfs. This is equivalent to about 10% flood protection benefit.

Other Benefits

There are several benefits associated with this alternative. They include:

- Water supply: A larger detention basin would increase the possible amount of water stored, making the reservoir a more stable water supply for either drinking or irrigation. The reservoir would need to be empty or nearly so before a flood to maximize protection from that event.
- **Surface water quality**: Suspended particles will fall out of suspension as the water velocity and turbulence decreases. This minimizes the sediment deposition in the Pajaro River channel.
- **Groundwater recharge**: The additional flooding from the dam will increase percolation into the groundwater and recharging of the aquifer.
- **Recreation**: Larger reservoirs provide additional space for recreation.

Impacted Facilities

There are few facilities that would be impacted by this project outside of the agriculture fields and their support buildings.

Implementation Issues

Implementation issues include:

• **Permitting**: Permitting is a consideration for any alternative. For this project though there are many agencies with whom to coordinate. Some of these include: Department of Fish and Game, National Marine Fisheries Service, and Division of Safety of Dams (DSOD). The DSOD approval would be

- particularly difficult to obtain due to the additional height of the dams and the proximity to the numerous fault lines within the watershed. Should the dam fail, Watsonville and Pajaro, which are directly downstream, would be at an enormous flood risk.
- Endangered Species Act: Pumping water from Corralitos Creek and building the main dam on College Lake could impact steelhead migration. Mitigation strategies would have to be implemented as a part of the project.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.
- Local seismic activity: Due to local fault lines, seismic events and ground shaking may make a structure such as a dam unstable. Further studies are necessary to determine the vulnerability of such a project in this area.
- Large amounts of new and modified infrastructure required: A great deal of work would be required to accommodate the new pump station, diversion pipeline, and dams. Roads and utilities would have to be relocated or rerouted.

A cost estimate for the development of the College Lake detention basin for flood protection is listed on Table 3-7.

Table 3-7: Alternative 6 Cost Estimate - College Lake Detention Basin.

		Quantity	Unit	Unit Cost	Total
Construc	ction				
	Mobilization & demobilization	1	L.S.	\$100,000	\$100,000
	Dewatering foundation	1	L.S.	\$30,000	\$30,000
•	Diversion of water	1	L.S.	\$50,000	\$50,000
	Reservoir clearing	25	ac	\$2,000	\$50,000
	Dam & dike	1	L.S.	\$4,366,800	\$4,366,800
	Spillway	1	L.S.	\$1,724,700	\$1,724,700
	Outlet works	1	L.S.	\$785,400	\$785,400
	Corralitos diversion	1	L.S.	\$13,500,000	\$13,500,000
	Road & utility reloc. allowance	1	L.S.	\$1,000,000	\$1,000,000
	Construction Subtotal	-	-	-	\$21,606,900
	C.O. Contingency	-	Allowance	25%	\$5,401,725
	Total Construction	-	-	-	\$27,000,000
Impleme	ntation				
	Engin., Legal and Client	-	Allowance	17.5%	\$4,700,000
Capital (Cost Subtotal	-	-	-	\$31,700,000
Land		600	acres	\$20,000	\$12,000,000
Land		000	acres	\$20,000	\$12,000,000
Total Co	st (Dec 99)	-	-	-	\$43,700,000
Present (Cost	-	-	-	\$47,000,000

The alternative represented by this estimate provides less than 10% of the necessary protection for the downstream reaches of the Pajaro River below the Salsipuedes Creek confluence.

Alternative 7: New Pacheco Dam

Building a dam on Pacheco Creek near the southern Route 156 crossing would reduce the peak discharge in the upper Pajaro River, and consequently reduce peak discharge on the lower Pajaro River.

Alternative Description

The most reasonable place for a dam on Pacheco Creek is just as the creek leaves the Ausaymas Y San Felipe Hills, as shown in Figure 3-11.

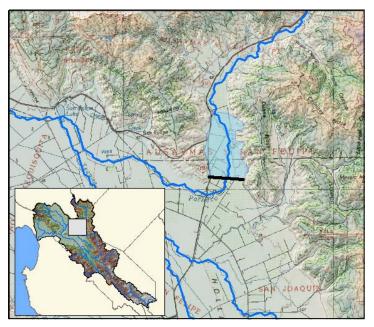


Figure 3-11: Proposed Pacheco Creek dam site.

The dam itself would be approximately 70 ft high and have a footprint of approximately 420 ft by 5,500 ft. Part of this length would likely be a high levee. The dam, along with any other construction or earthwork necessary, would store 35,000 AF of water. Approximately 1,150 acres of land would be inundated, with an average depth of about 30 ft.

Flood Protection

The Pacheco dam would reduce the peak 100-yr discharge at Chittenden by 1,800 cfs. This reduction is equivalent to a flood protection benefit of about 7%.

Other Benefits

There are several benefits associated with this alternative. They include:

- Water supply: Creating a reservoir behind the dam would store significant amounts of water, even in years without a 100-yr flood. The reservoir could be a supply for either potable or irrigation water. The reservoir would need to be empty or nearly so before a flood to maximize protection from that event.
- **Surface water quality**: Suspended particles will fall out of suspension as the water velocity and turbulence decreases. This minimizes the sediment deposition in the Pajaro River channel.
- **Groundwater recharge**: The additional flooded acreage will increase percolation into the groundwater and recharging of the aquifer.

- **Groundwater quality**: As the Pacheco sub-watershed is relatively undeveloped, the water quality should be expected to be high. The higher quality groundwater percolating into the aquifers will mix with and purge lower quality water from urban and farmed areas.
- Recreation: Reservoirs provide space and opportunity for various forms of recreation.

Impacted Facilities

The land use in this valley is predominantly agriculture. If a dam and associated reservoir were to be built, local agriculture shown in Figure 3-12 would be impacted.



Figure 3-12: Current agricultural land uses in the Pacheco Dam inundation area.

Two highways would need to be raised or relocated since they cross through the low area of the valley. They are Hwy 156 and the eastern end of Hwy 152. Hwy 156 is shown on the left side of Figure 3-13.



Figure 3-13: Infrastructure and agriculture that would be impacted by the Pacheco dam project.

Local residences would be at risk of flooding if a flood protection structure were established at the project location shown on Figure 3-11. One of the small lanes across the valley can be seen in Figure 3-14.



Figure 3-14: A residential lane that crosses Pacheco Creek.

Implementation Issues

Implementation issues include:

- **Permitting**: Permitting is a consideration for any project. For this project though there are many agencies with whom to coordinate. Some of these include: Department of Fish and Game, National Marine Fisheries Service, and Division of Safety of Dams (DSOD). The DSOD approval would be particularly difficult to obtain due to the height and length of the dam and the proximity to the numerous fault lines within the watershed. Should the dam fail, downstream residences would be subjected to an enormous flood risk.
- Endangered Species Act: Building a dam across Pacheco Creek would impact steelhead migration. Also, great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size and length and nature of the project, this would be a considerable task.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.
- Local seismic activity: Due to local fault lines, seismic events and ground shaking may make a structure such as a dam unstable. Further studies are necessary to determine the vulnerability of such a project in this area.
- Large amounts of new and modified infrastructure required: The significant roadwork would be both expensive and a nuisance to the public.

A cost estimate for a new Pacheco Dam is listed on Table 3-8.

Table 3-8: Alternative 7 Cost Estimate - New Pacheco Dam.

	Quantity	Unit	Unit Cost	Total
Construction				
Mobilization & demobilization	1	L.S.		\$2,130,000
Site preparation/clearing	55	acre	\$4,200	\$230,000
Flow control tunnel	1	L.S.	\$2,000,000	\$2,000,000
Foundation	1,250,000	су	\$10	\$12,500,000
Embankment	2,500,000	су	\$10	\$25,000,000
Outlet works	1	L.S.	\$1,000,000	\$1,000,000
Spillway	1	L.S.	\$1,200,000	\$1,200,000
Instrumentation	1	L.S.	\$500,000	\$500,000
Monitoring	1	L.S.	\$200,000	\$200,000
Construction Subtotal	-	-	-	\$44,760,000
C.O. Contingency	-	Allowance	20%	\$8,950,000
Total Construction	-	-	-	\$54,000,000
Land	1,150	acres	\$3,000	\$3,500,000
Implementation				
Land Acquisition	-	Allowance	5%	\$170,000
Administration	-	Allowance	3%	\$1,610,000
Engineering	-	Allowance	6%	\$3,220,000
CM	-	Allowance	4%	\$2,150,000
<u>Legal</u>	-	Allowance	3%	\$1,610,000
CEQA	-	Allowance	-	\$5,000,000
Implementation Subtotal	-	-	-	\$14,000,000
Capital Cost Subtotal	-	-	-	\$71,000,000
Project Contingency	-	Allowance	30%	\$21,000,000
Total Cost	-	-	-	\$92,000,000

The alternative represented by this estimate provides 7% of the necessary protection for the downstream reaches of the Pajaro River.

Alternative 8: New Soap Lake Dam

Flooding in the Soap Lake floodplain occurs regularly, and Phase 1 of this study established this flooding as a key component in attenuating the peak flows downstream in the lower Pajaro River. Constructing a dam at the outlet of Soap Lake would create flooding of additional areas and of greater depths in existing areas to further attenuate the peak flood flow from the upper Pajaro River.

Alternative Description

The dam would be located on the Pajaro River at the outlet of Soap Lake, just upstream of the Highway 101 crossing. This places it just upstream of the Santa Cruz Mountains and the Lomerias Muertas, as shown in Figure 3-15.

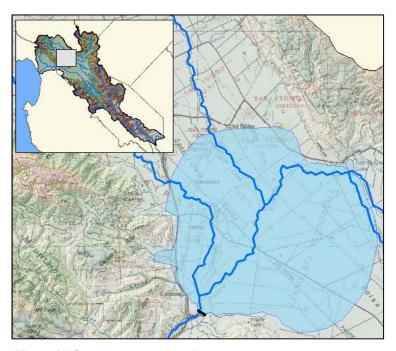


Figure 3-15: Modeled location of the new Soap Lake dam.

The dam itself would be over 30 ft. high and have a footprint of approximately 180 ft. by 900 ft. The dam, along with any other construction or earthwork necessary, would store over 122,000 AF of water. The inundated area would be approximately 15,000 acres of land and would have and average depth of about 8 ft.

Flood Protection

The dam construction would reduce the peak 100-yr discharge at Chittenden by 12,800 cfs. This reduction is equivalent to 50% of the flood protection benefit for the lower Pajaro River.

Other Benefits

There are several benefits associated with this alternative. They include:

• Water supply: Creation of a reservoir would provide storage of significant amounts of water. The reservoir could be a supply for either potable or irrigation water. The reservoir would need to be empty or nearly so before a flood to maximize protection from that event.

- **Surface water quality**: Suspended particles will fall out of suspension as the water velocity and turbulence decreases. This minimizes the sediment deposition in the lower Pajaro River channel.
- **Groundwater recharge**: The additional flooded acreage will increase percolation into the groundwater and recharging the aquifer.
- Recreation: Reservoirs provide space and opportunity for various forms of recreation.

Impacted Facilities

Most of the land that would be affected by a dam at the outlet of Soap Lake is either agricultural or open fields, as shown in Figures 3-16 and 3-17. Due to the larger and deeper flooded area, significant infrastructure would need to be modified or relocated. Figure 3-18 shows one of the two railroad branches in the affected area. Highway 101 and Highway 25 are the largest roads within the reservoir area to be modified, but there are also other roads such as Bloomfield Avenue, Frazier Lake Road., and Shore Road that would be impacted.



Figure 3-16: Agriculture in Soap Lake floodplain.



Figure 3-17: Open Space in Soap Lake.



Figure 3-18: Railroad crossing at Bloomfield Avenue.

<u>Implementation Issues</u>

Implementation issues include:

• **Permitting**: Permitting is a consideration for any alternative. For this project though there are many agencies with whom to coordinate. Some of these include: Department of Fish and Game, National Marine Fisheries Service, and Division of Safety of Dams (DSOD). The DSOD approval would be particularly difficult to obtain due to the height and length of the dam and the proximity to the numerous

- fault lines within the watershed. Should the dam fail, downstream residences would be subjected to an enormous flood risk.
- **Endangered Species Act**: Building a dam across the outlet of Soap Lake would impact steelhead migration. Also, great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size and length and nature of the project, this would be a considerable task.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.
- Local seismic activity: Due to local fault lines, seismic events and ground shaking may make a structure such as a dam unstable. Further studies are necessary to determine the vulnerability of such a project in this area.
- Large amounts of new and modified infrastructure required: The significant number of roadwork and railroad crossing relocations would be both expensive and a nuisance to the public.

A cost estimate for a new Soap Lake Dam near the outlet of the Soap Lake floodplain area is listed on Table 3-9.

Table 3-9: Alternative 8 Cost Estimate - New Soap Lake Dam.

	Quantity	Unit	Unit Cost	Total
Construction				
Mobilization & demobilization	1	L.S.		\$320,000
Site preparation/clearing	15	acre	\$4,200	\$60,000
Flow control tunnel	1	L.S.	\$2,000,000	\$2,000,000
Foundation	45,000	су	\$10	\$450,000
Embankment	90,000	су	\$10	\$900,000
Outlet works	1	L.S.	\$1,000,000	\$1,000,000
Spillway	1	L.S.	\$1,200,000	\$1,200,000
Instrumentation	1	L.S.	\$500,000	\$500,000
Monitoring	1	L.S.	\$200,000	\$200,000
Construction Subtotal	-	-	-	\$6,630,000
C.O. Contingency	-	Allowance	20%	\$1,330,000
Total Construction	-	-	-	\$8,000,000
Land	15,000	acres	\$3,000	\$45,000,000
Implementation				
Land Acquisition	-	Allowance	5%	\$2,250,000
Administration	-	Allowance	3%	\$240,000
Engineering	-	Allowance	6%	\$480,000
CM	-	Allowance	4%	\$320,000
Legal	-	Allowance	3%	\$240,000
CEQA	-	Allowance	-	\$5,000,000
Implementation Subtotal	-	-	-	\$9,000,000
Capital Cost Subtotal	-	-	-	\$62,000,000
Project Contingency	-	Allowance	30%	\$18,000,000
Total Cost	-	-	-	\$80,000,000

The alternative represented by this estimate provides 50% of the necessary protection for the downstream reaches of the Pajaro River.

Alternative 9: New Tres Pinos Dam

The Tres Pinos River has a sizeable watershed within the San Benito sub-watershed. Placing a dam on the Tres Pinos River would reduce the peak flood flow experienced on the San Benito River. This peak flow reduction would lower the peak discharge through the lower Pajaro River.

Alternative Description

To maximize the flood protection afforded by this project, the dam should be located as far downstream as possible within the Tres Pinos watershed. The dam was placed just upstream of the San Benito confluence, as shown in Figure 3-19.

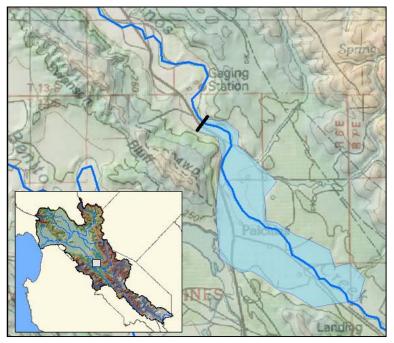


Figure 3-19: Location of the new Tres Pinos River dam.

The dam is estimated to be approximately 50 ft high, with a footprint of approximately 300 ft. by 800 ft. The dam, along with any other construction or earthwork necessary, would store 38,000 AF of water. The inundated area would be 1,000 acres of land and the average depth would be about 38 ft.

Flood Protection

The dam described above would reduce the peak 100-yr discharge at Chittenden by 8,700 cfs. This reduction is equivalent to 34% of the flood protection benefit on the lower Pajaro River.

Other Benefits

There are several benefits associated with this alternative. They include:

- Water supply: Creation of a reservoir would provide storage of significant amounts of water. The reservoir could be a supply for either potable or irrigation water. The reservoir would need to be empty or nearly so before a flood to maximize protection from that event.
- **Surface water quality**: Suspended particles will fall out of suspension as the water velocity and turbulence decreases. This minimizes the sediment deposition in the Pajaro River channel.

- **Groundwater recharge**: The additional flooded acreage will increase percolation into the groundwater and recharging the aquifer.
- Recreation: Reservoirs provide space and opportunity for various forms of recreation.

Impacted Facilities

Most of the land impacted by this alternative is open grass and shrubland as shown in Figure 3-20. There is some agriculture present, but is not very significant. Highway 25 and Panoche Road would be impacted by this project, requiring the roadways to be either relocated or raised above the possible water level. The center of the town of Paicines would also be impacted, as would the Blossom Hill Winery. Figure 3-21 shows the Paicines general store and Highway 25. Figure 3-22 is part of the Blossom Hill Winery.



Figure 3-20: Open grass and shrubland near Paicines.



Figure 3-21: Paicines general store at Highway 25.



Figure 3-22: Part of the Blossom Hill Winery.

Implementation Issues

Implementation issues include:

- **Permitting**: Permitting is a consideration for any alternative. For this project though there are many agencies with whom to coordinate. Some of these include: Department of Fish and Game, National Marine Fisheries Service, and Division of Safety of Dams (DSOD). The DSOD approval would be particularly difficult to obtain due to the height and length of the dam and the proximity to the numerous fault lines within the watershed. Should the dam fail, downstream residences would be subjected to an enormous flood risk.
- Endangered Species Act: Building a dam across Tres Pinos Creek would impact steelhead migration. Also, great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size and length and nature of the project, this would be a considerable task.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.
- Local seismic activity: Due to local fault lines, seismic events and ground shaking may make a structure such as a dam unstable. Further studies are necessary to determine the vulnerability of such a project in this area.
- Large amounts of new and modified infrastructure required: The significant number of roadwork and railroad crossing relocations would be both expensive and a nuisance to the public.

A cost estimate for a new Tres Pinos Dam is listed on Table 3-10.

Table 3-10: Alternative 9 Cost Estimate - New Tres Pinos Dam.

		Quantity	Unit	Unit Cost	Total
Constru	ıction				
	Mobilization & demobilization	1	L.S.		\$420,000
	Site preparation/clearing	25	acre	\$4,200	\$110,000
	Flow control tunnel	1	L.S.	\$2,000,000	\$2,000,000
	Foundation	112,500	су	\$10	\$1,130,000
	Embankment	225,000	су	\$10	\$2,250,000
	Outlet works	1	L.S.	\$1,000,000	\$1,000,000
	Spillway	1	L.S.	\$1,200,000	\$1,200,000
	Instrumentation	1	L.S.	\$500,000	\$500,000
	Monitoring	1	L.S.	\$200,000	\$200,000
	Construction Subtotal	-	-	ı	\$8,810,000
	C.O. Contingency	-	Allowance	20%	\$1,760,000
	Total Construction	-	-	-	\$11,000,000
Land		1,000	acres	\$3,000	\$3,000,000
Implem	entation				
	Land Acquisition	-	Allowance	5%	\$150,000
	Administration	-	Allowance	3%	\$320,000
	Engineering	-	Allowance	6%	\$630,000
	CM	-	Allowance	4%	\$420,000
	Legal	-	Allowance	3%	\$320,000
	CEQA	-	Allowance	-	\$5,000,000
	Implementation Subtotal	-	-	-	\$7,000,000
Capital	Cost Subtotal	-	-	-	\$21,000,000
Project	Contingency	-	Allowance	30%	\$6,000,000
Total C	ost	-	-	-	\$27,000,000

The alternative represented by this estimate provides 34% of the necessary protection for the downstream reaches of the Pajaro River.

Alternative 10: New San Benito Dam

Placing a dam on the San Benito River would reduce the peak flood flow experienced on the San Benito River, and reduce the peak flow through the lower Pajaro River.

Alternative Description

A possible location of the San Benito dam would be upstream of the confluence with the Tres Pinos River as shown in Figure 3-23.

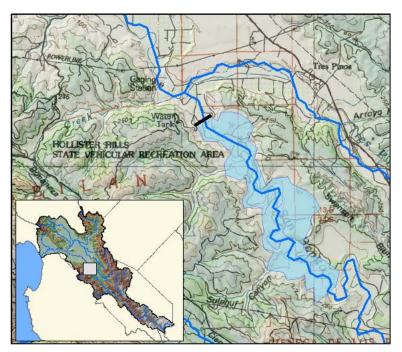


Figure 3-23: Proposed Location of the new San Benito River dam.

The dam was estimated to be approximately 120 ft high and have a footprint of approximately 720 ft by 1,600 ft. The dam, along with any other construction or earthwork necessary, would store 60,000 AF of water. The inundated area would be about 1,600 acres of land, with an average depth of about 38 ft.

Flood Protection

The dam described above would reduce the peak 100-yr discharge at Chittenden by 12,800 cfs. This reduction is equivalent to 50% of the flood protection benefit on the lower Pajaro River.

Other Benefits

There are several benefits associated with this alternative. They include:

- Water supply: Creating a reservoir would provide storage of significant amounts of water. The reservoir could be a supply for either potable or irrigation water. The reservoir would need to be empty or nearly so before a flood to maximize protection from that event.
- **Surface water quality**: Suspended particles will fall out of suspension as the water velocity and turbulence decreases. This minimizes the sediment deposition in the Pajaro River channel.

- **Groundwater recharge**: The additional flooded acreage will increase percolation into the groundwater and recharging the aquifer.
- Recreation: Reservoirs provide space and opportunity for various forms of recreation.

Impacted Facilities

The San Benito dam and reservoir would be located in a relatively remote part of San Benito. There are some residences that might be impacted. The land at the lower elevations appears to be shrubland and grazing land for horses as shown in Figure 3-24. Agricultural uses were also observed in the watershed as shown on Figure 3-25.



Figure 3-24: Open space near the San Benito River.



Figure 3-25: Agriculture near site of proposed new San Benito reservoir.

Implementation Issues

Implementation issues include:

- **Permitting**: Permitting is a consideration for any project. For this project though there are many agencies with whom to coordinate. Some of these include: Department of Fish and Game, National Marine Fisheries Service, and Division of Safety of Dams (DSOD). The DSOD approval would be particularly difficult to obtain due to the height and length of the dam and the proximity to the numerous fault lines within the watershed. Should the dam fail, downstream residences would be subjected to an enormous flood risk.
- Endangered Species Act: Building a dam across the San Benito River would impact steelhead migration. Also, great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size and length and nature of the project, this would be a considerable task.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.
- Local seismic activity: Due to local fault lines, seismic events and ground shaking may make a structure such as a dam unstable. Further studies are necessary to determine the vulnerability of such a project in this area.

A cost estimate for a new San Benito Dam at the confluence of the San Benito and Tres Pinos Rivers is listed on Table 3-11.

Table 3-11: Alternative 10 Cost Estimate - New San Benito Dam.

		Quantity	Unit	Unit Cost	Total
Constru	ıction				
	Mobilization & demobilization	1	L.S.		\$2,130,000
	Site preparation/clearing	50	acre	\$4,200	\$210,000
	Flow control tunnel	1	L.S.	\$2,000,000	\$2,000,000
	Foundation	1,250,000	су	\$10	\$12,500,000
	Embankment	2,500,000	су	\$10	\$25,000,000
	Outlet works	1	L.S.	\$1,000,000	\$1,000,000
	Spillway	1	L.S.	\$1,200,000	\$1,200,000
	Instrumentation	1	L.S.	\$500,000	\$500,000
	Monitoring	1	L.S.	\$200,000	\$200,000
	Construction Subtotal	ı	-	-	\$44,740,000
	C.O. Contingency	-	Allowance	20%	\$8,950,000
	Total Construction	-	-	-	\$54,000,000
Land		1,600	acres	\$3,000	\$5,000,000
Implem	entation				
	Land Acquisition	-	Allowance	5%	\$240,000
	Administration	-	Allowance	3%	\$1,610,000
	Engineering	-	Allowance	6%	\$3,220,000
	CM	-	Allowance	4%	\$2,150,000
	Legal	-	Allowance	3%	\$1,610,000
	CEQA	-	Allowance	-	\$5,000,000
	Implementation Subtotal	-	-	-	\$14,000,000
Capital	Cost Subtotal	-	-	-	\$73,000,000
Project	Contingency	-	Allowance	30%	\$21,000,000
Total C	ost	-	-	-	\$94,000,000

The alternative represented by this estimate provides 50% of the necessary protection for the downstream reaches of the Pajaro River.

Alternative 11: New Chittenden Dam

The confluence of the Pajaro River and San Benito River is located upstream of the town of Chittenden and Chittenden Pass, a narrow opening that restricts flow to the lower Pajaro River. This location is a good geographical location for a dam since it would be able to influence the discharge from about 90% of the watershed.

Alternative Description

Two different size dams were modeled in this location. The larger dam would be approximately 120 ft. high and have a footprint of approximately 720 ft. by 800 ft. The dam, along with any other construction or earthwork necessary, would store 120,000 AF of water. The inundated area would be more than 15,000 acres of land and the average depth would be about 8 ft due to the number of shallow flooding areas.

The smaller dam would be approximately 60 ft. high and have a footprint of approximately 360 ft. by 500 ft. The dam, along with any other construction or earthwork necessary, would store 6,000 AF of water. The inundated area would be much smaller than would occur with the large dam, with only about 380 acres of land flooded. The average depth would be about 16 ft for the smaller flooded area.

The proposed location for a dam at Chittenden is shown in Figure 3-26.

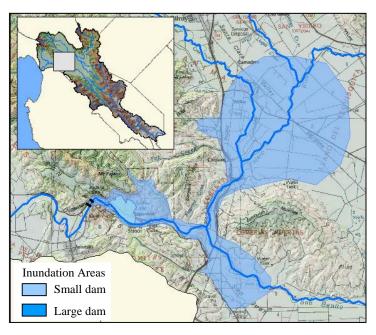


Figure 3-26: Proposed location of the new dam near Chittenden.

Flood Protection

The flood protection for the two dams is compared on Table 3-12. The larger dam would reduce the peak 100-yr discharge at Chittenden by 25,500 cfs. This reduction is equivalent to 100% of the flood protection benefit on the lower Pajaro River. The smaller dam would reduce the peak 100-yr discharge at Chittenden by 1,000 cfs. This reduction is equivalent to about 4% of the flood protection benefit on the lower Pajaro River.

Table 3-12: Chittenden Dam Discharge and Flood Protection Benefits.

Dam	Detention Storage (AF)	Discharge (cfs)	Discharge Reduction (cfs)	Flood Protection Benefit
None	0	44,400	0	0%
Small	6,000	43,400	1,000	4%
Large	120,000	18,900	25,500	100%

Other Benefits

There are several benefits associated with this alternative. They include:

- Water supply: Creating a reservoir would provide storage of significant amounts of water. The reservoir could be a supply for either potable or irrigation water. The reservoir would need to be empty or nearly so before a flood to maximize protection from that event.
- **Surface water quality**: Suspended particles will fall out of suspension as the water velocity and turbulence decreases. This minimizes the sediment deposition in the Pajaro River channel.
- **Groundwater recharge**: The additional flooded acreage will increase percolation into the groundwater and recharging the aquifer.
- **Recreation**: Reservoirs provide space and opportunity for various forms of recreation.

Impacted Facilities

The large Chittenden dam would impact nearly all of those facilities discussed in the Soap Lake dam alternative. The most significant facilities include Highway 101, Highway 25, and several railroad lines. The Chittenden dam would also require modifications to a longer section of Highway 101, the east end of Highway 129 from the dam site to Hwy 101, and additional length of railroad.

The small Chittenden dam would impact any of the low-lying structures through Soda Lake. These could include Highway 129 and a railroad.

Implementation Issues

Implementation issues include:

- **Permitting**: Permitting is a consideration for any project. For this project though there are many agencies with whom to coordinate. Some of these include: Department of Fish and Game, National Marine Fisheries Service, and Division of Safety of Dams (DSOD). The DSOD approval would be particularly difficult to obtain due to the height and length of the dam and the proximity to the numerous fault lines within the watershed. Should the dam fail, Watsonville and Pajaro would be subjected to an enormous flood risk.
- **Endangered Species Act**: Building a dam across the Pajaro River at Chittenden would impact steelhead migration. Also, great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size and length and nature of the project, this would be a considerable task.
- Public acceptance/Willing landowners: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.
- Local seismic activity: Due to local fault lines, seismic events and ground shaking may make a structure such as a dam unstable. Further studies are necessary to determine the vulnerability of such a project in this area.

	3. Preliminary Evaluation of Flood Protection Alternatives
•	Large amounts of new and modified infrastructure required : The significant road and railroad crossings would be both expensive and a nuisance to the public.

A cost estimate for a new large Chittenden Dam is listed on Table 3-13. The cost estimate for a new small Chittenden Dam is listed on Table 3-14

Table 3-13: Alternative 11 Cost Estimate - Large New Chittenden Dam.

	Quantity	Unit	Unit Cost	Total
Construction				
Mobilization & demobilization	1	L.S.		\$1,230,000
Site preparation/clearing	45	acre	\$4,200	\$190,000
Flow control tunnel	1	L.S.	\$2,000,000	\$2,000,000
Foundation	650,000	су	\$10	\$6,500,000
Embankment	1,300,000	су	\$10	\$13,000,000
Outlet works	1	L.S.	\$1,000,000	\$1,000,000
Spillway	1	L.S.	\$1,200,000	\$1,200,000
Instrumentation	1	L.S.	\$500,000	\$500,000
Monitoring	1	L.S.	\$200,000	\$200,000
Construction Subtotal	ı	-	ı	\$25,820,000
C.O. Contingency	-	Allowance	20%	\$5,160,000
Total Construction	-	-	-	\$31,000,000
Land	15,000	acres	\$3,000	\$45,000,000
Implementation				
Land Acquisition	-	Allowance	5%	\$2,250,000
Administration	-	Allowance	3%	\$930,000
Engineering	-	Allowance	6%	\$1,860,000
CM	-	Allowance	4%	\$1,240,000
Legal	-	Allowance	3%	\$930,000
CEQA	-	Allowance	=	\$5,000,000
Implementation Subtotal	-	-	-	\$12,000,000
Capital Cost Subtotal	-	-	-	\$88,000,000
Project Contingency	-	Allowance	30%	\$26,000,000
Total Cost			<u> </u>	\$114,000,000

The alternative represented by this estimate provides 100% of the necessary protection for the downstream reaches of the Pajaro River.

 Table 3-14: Alternative 11 Cost Estimate - Small New Chittenden Dam.

	Quantity	Unit	Unit Cost	Total
Construction				
Mobilization & demobilization	1	L.S.		\$400,000
Site preparation/clearing	15	acre	\$4,200	\$60,000
Flow control tunnel	1	L.S.	\$2,000,000	\$2,000,000
Foundation	100,000	су	\$10	\$1,000,000
Embankment	200,000	су	\$10	\$2,000,000
Outlet works	1	L.S.	\$1,000,000	\$1,000,000
Spillway	1	L.S.	\$1,200,000	\$1,200,000
Instrumentation	1	L.S.	\$500,000	\$500,000
Monitoring	1	L.S.	\$200,000	\$200,000
Construction Subtotal	-	-	ı	\$8,360,000
C.O. Contingency	-	Allowance	20%	\$1,670,000
Total Construction	-	-	-	\$10,000,000
Land	380	acres	\$3,000	\$1,000,000
Implementation				
Land Acquisition	-	Allowance	5%	\$60,000
Administration	-	Allowance	3%	\$300,000
Engineering	_	Allowance	6%	\$600,000
CM	-	Allowance	4%	\$400,000
Legal	-	Allowance	3%	\$300,000
CEQA	-	Allowance	-	\$5,000,000
Implementation Subtotal	-	-	-	\$7,000,000
Capital Cost Subtotal	-	-	-	\$18,000,000
Project Contingency	-	Allowance	30%	\$5,000,000
Total Cost	-	-	-	\$23,000,000

The alternative represented by this estimate provides 4% of the necessary protection for the downstream reaches of the Pajaro River.

Alternative 12: Open Channel Bypass

An open channel bypass occurs where the excess flood flow from the river is diverted into a separate channel, bypassing the areas that would normally flood. The earthen bypass channel would be designed to accommodate farming along the channel bottom and banks.

Alternative Description

The bypass would carry diverted water from the Pajaro River near the Murphy Road Crossing to just upstream of the Monterey Bay. Flood water that would normally overtop the levees would be diverted around the flood risk area. The route would follow the southern edge of the 100-yr flood plain along the hills of the Bolsa de San Cayetano. This route avoids the urbanized areas around Watsonville and Pajaro, reduces the number of road and railroad crossings, and follows a natural feature of the topography. Figure 3-27 shows a possible alignment. A diversion facility is required at the beginning of the bypass. A discharge facility must be constructed where the bypass returns the flow to the channel.

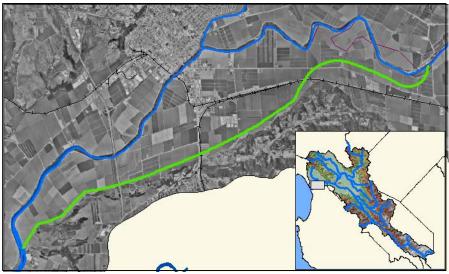


Figure 3-27: Bypass alignment.

The necessary right-of-way would be about 100 ft wide from the outside edge of the service road to the opposite channel edge, and about 45,000 ft long. The width accommodates a 20-ft service road at the top of a bank of the channel. The channel would be approximately 10 ft deep. Figure 3-27 includes a cross section of the bypass. The side slopes would be 3:1, which would allow access to the bottom of the channel and some farming on the slopes. With exception of the service road, the potentially farmable land includes the entire cross section as shown on Figure 3-28.

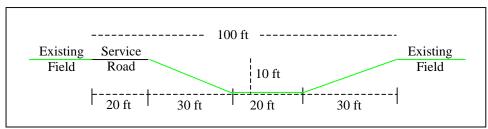


Figure 3-28: Cross section of an earthen bypass with service road.

Storm water overflow carried by the bypass would be reintroduced to the river mouth at the location shown in Figure 3-29. The hills visible on the right side of the image prevent the bypass from emptying into Monterey Bay.

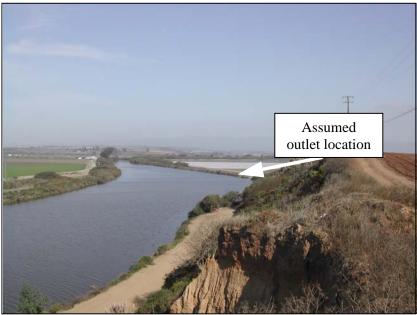


Figure 3-29: Pajaro River looking upstream at the potential location of bypass channel outlet works.

Overall, about 100 acres would be impacted by the project, assuming 20 acres would be lost to the service roads and 80 acres would be used for the bypass channel. Figure 3-30 shows the representative land use and condition for most of the route shown in Figure 3-27. Downstream of Highway 1, the bypass would parallel Trafton Road, which is shown in the photo.



Figure 3-30: Agricultural land uses along Trafton Road.

Flood Protection

An earthen bypass channel with the proposed dimensions could carry around 3,000 cfs. A diversion of this amount of water would provide around 12% of the flood protection benefit.

Other Benefits

There are two benefits associated with this alternative. They include:

- Open space preservation: Most of the land currently held as open space would remain open space.
- Agricultural preservation: Most of the land currently farmed would continue to be farmed.

Impacted Facilities

In addition to the agricultural land, several facilities would be impacted or would need to be modified. There are approximately eight significant road crossings in the route shown in Figure 3-26, including Highway 1. Two railroad crossings would also be required.

Implementation Issues

Implementation issues include:

- Endangered Species Act: Great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size, duration, and nature of the project, this would be a considerable task.
- **Public acceptance/Willing landowners**: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions.
- **Road and railroad crossings**: The significant construction required at road and railroad crossings would be both expensive and a nuisance to the public.

A cost estimate for an earth lined open channel bypass is listed on Table 3-15.

Table 3-15: Alternative 12 Cost Estimate - Open Channel Bypass.

		Quantity	Unit	Unit Cost	Total
Constru	ection				
	Mobilization & demobilization	1	L.S.		\$1,800,000
	Remove top 2' soil & stockpile	266,688	су	\$2.77	\$740,000
	Excavate channel	1,333,440	су	\$1.79	\$2,390,000
	Soil transport & disposal	1,333,440	су	\$18.68	\$24,910,000
	Access roads base	16,668	су	\$34.66	\$580,000
	Reform top 2' of soil	266,688	су	\$5.00	\$1,330,000
	Diversion	1	L.S.	\$6,000,000.00	\$6,000,000
	Outlet structure	1	L.S.	\$6,000,000.00	\$6,000,000
	Construction Subtotal	-	-	-	\$43,750,000
	C.O. Contingency	-	Allowance	15%	\$6,560,000
	Total Construction	-	-	-	\$50,000,000
Land					
	Purchase	20	acres	\$30,000.00	\$600,000
	Easement	83	acres	\$5,000.00	\$415,000
	Total				\$1,000,000
Implem	entation				
-	Land Acquisition	-	Allowance	5%	\$50,000
	Administration	-	Allowance	3%	\$1,510,000
	Engineering	-	Allowance	6%	\$3,020,000
	CM	-	Allowance	4%	\$2,010,000
	Legal	-	Allowance	3%	\$1,510,000
	CEQA	-	Allowance	1%	\$500,000
	Implementation Subtotal	-	-	-	\$9,000,000
Capital	Cost Subtotal	-	-	-	\$60,000,000
Project	Contingency	-	Allowance	30%	\$18,000,000
Total C	ost	-	-	_	\$78,000,000

The alternative represented by this estimate provides 12% of the necessary protection for the downstream reaches of the Pajaro River.

Alternative 13: Flood Channel

This alternative is similar to the Alternative 12 open channel bypass; however, the earthen channel is replaced by a concrete-lined flood channel. A flood channel diverts the excess flood flow from the river around the areas that would normally flood. The lining would prevent continued agricultural uses of the land within the footprint of the project.

Alternative Description

The bypass would carry diverted water from the Pajaro River near the Murphy Road Crossing to just upstream of the Monterey Bay. Flood water that would normally overtop the levees would be diverted around the flood risk area. The route would follow the southern edge of the 100-yr flood plain along the hills of the Bolsa de San Cayetano. This route avoids the urbanized areas around Watsonville and Pajaro, reduces the number of road and railroad crossings, and follows a natural feature in the topography. The route for the flood channel is similar to the open channel bypass shown on Figure 3-27. Similar upstream diversion and downstream outlet structures will be necessary.

The concrete lined flood channel would be 210 ft wide, 10 ft deep and about 45,000 ft long. The width accommodates two 20-ft service roads and a 150-ft base. The slope of the sides would be 1:1. The concrete lined channel would have a lower channel roughness factor and would support the use of steep side slopes. Figure 3-30 shows a cross section of the bypass. Two service roads would be required due to the width of the channel.

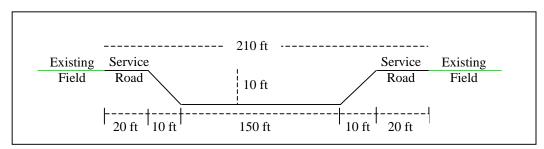


Figure 3-31: Cross section of an earthen bypass with two service roads.

Storm water overflow carried by the bypass would be reintroduced to the river mouth at the location shown in Figure 3-29. The hills visible on the right side of the image prevent the bypass from emptying into Monterey Bay.

Overall, about 220 acres would be impacted by the alternative. Figure 3-30 shows the land use and condition for most of the route shown in Figure 3-27. Downstream of Highway 1 the bypass would parallel Trafton Road, which is shown in the photo.

Flood Protection

A concrete flood channel with the above dimensions could carry around 25,500 cfs. A diversion of this amount of water would provide 100% of the flood protection benefit.

Other Benefits

Flood protection is the only benefit associated with this alternative.

Implementation Issues

Implementation issues include:

- **Endangered Species Act**: Great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size, duration, and nature of the project, this would be a considerable task.
- Public acceptance/Willing landowners: As described in Chapter 2.2, there are several issues inherent in acquiring land. The process can be expensive and time consuming. The largest difficulty however is finding willing sellers. An unwilling seller can be forced to give up the land through eminent domain but this not only eliminates many sources of funding but also creates resentment within the public. Property purchased is also taken off the tax rolls resulting in lost revenue to the local jurisdictions. Any land purchased would also be no longer available for farming.
- Road and railroad crossings: The significant road and railroad crossings would be both expensive and a nuisance to the public.

Cost Estimate

A cost estimate for a concrete lined open channel bypass is listed on Table 3-16.

Table 3-16: Alternative 13 Cost Estimate - Flood Channel.

		Quantity	Unit	Unit Cost	Total
Constru	ection				
	Mobilization & demobilization	1	L.S.		\$7,750,000
	Excavate channel	3,300,000	су	\$1.79	\$5,910,000
	Soil transport & disposal	3,300,000	су	\$18.68	\$61,640,000
	Aggregate base	125,000	су	\$34.66	\$4,330,000
	Forms in place	1,260,000	sf	\$6.33	\$7,980,000
	Concrete in place	539,000	су	\$97.82	\$52,720,000
	Finishing walls	1,260,000	sf	\$0.55	\$690,000
	Curing	80,100	csf	\$7.16	\$570,000
	Access roads	33,336	cy	\$34.66	\$1,160,000
	Diversion	1	L.S.	\$20,000,000	\$20,000,000
	Outlet structure	1	L.S.	\$20,000,000	\$20,000,000
	Construction Subtotal	-	-	-	\$182,750,000
	C.O. Contingency	-	Allowance	15%	\$27,410,000
	Total Construction	-	-	-	\$210,000,000
Land		217	acres	\$30,000	\$6,500,000
Implem	entation				
	Land Acquisition	-	Allowance	5%	\$330,000
	Administration	-	Allowance	3%	\$6,300,000
	Engineering	-	Allowance	6%	\$12,610,000
	CM	-	Allowance	4%	\$8,410,000
	Legal	-	Allowance	3%	\$6,300,000
	CEQA	-	Allowance	1%	\$2,100,000
	Implementation Subtotal	-	-	-	\$36,000,000
Capital	Capital Cost Subtotal		-	-	\$253,000,000
Project	Contingency	-	Allowance	30%	\$76,000,000
Total Co	ost	-		-	\$329,000,000

The alternative represented by this estimate provides 100% of the necessary protection for the downstream reaches of the Pajaro River.

For information regarding the source of the unit costs for this estimate, please refer to Appendix B. Appendix B also contains assumptions and limitations of the estimate.

Alternative 14: Underground Bypass

An underground bypass would consist of a tunnel constructed by cut and cover methods that diverts the excess flood flow from the river around the areas that would normally flood. An underground bypass would allow agricultural land uses above the structure after it was completed.

Alternative Description

The underground bypass would carry diverted water from the Pajaro River near the Murphy Road Crossing to just upstream of the Monterey Bay. Flood water that would normally overtop the levees would be diverted around the flood risk area. The route would follow the southern edge of the 100-yr flood plain along the hills of the Bolsa de San Cayetano. This route avoids the urbanized areas around Watsonville and Pajaro, reduces the number of road and railroad crossings, and follows a natural feature in the topography. The route for the flood channel is similar to the open channel bypass shown on Figure 3-27. Similar upstream diversion and downstream outlet structures will be necessary.

The underground bypass tunnel would be constructed from precast concrete box culverts in 20 foot wide by 12 ft height sections. The pre-cast, reinforced concrete boxes are available commercially and would reduce the construction period of the project. The boxes can be assembled within a trench and covered with the excavated material. Five box culverts would be used across each cross section, and the overall project length is about 45,000 ft. Figure 3-32, which is not to scale, shows a cross section of the tunnel. Depending on engineering constraints, the boxes might also be stackable to reduce the right of way requirements for the tunnel.

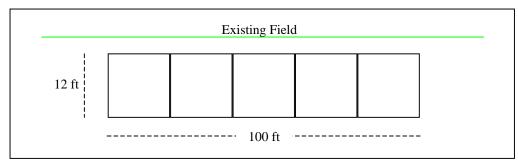


Figure 3-32: Representation of an underground flood bypass.

Storm water overflow carried by the bypass would be reintroduced to the river mouth at the location shown in Figure 3-29. The hills visible on the right side of the photo prevent the bypass from emptying into Monterey Bay.

After construction has been completed, no appreciable agricultural land area would be used or lost. Figure 3-30 shows the land use and condition for most of the route shown in Figure 3-27. Downstream of Highway 1 the bypass would parallel Trafton Road., which is shown in the photo.

Flood Protection

An underground bypass with the above dimensions could carry around 11,180 cfs. A diversion of this amount of water would provide 44% of the flood protection benefit.

Other Benefits

There are several benefits associated with this alternative. They include:

- Open space preservation: After construction, land currently held as open space would remain open space.
- Agricultural preservation: After construction, land currently farmed would continue to be farmed.
- **Aesthetically pleasing**: After construction, the project would not be visible except for the diversion at the upstream reaches and the outfall at the lower reaches of the river.

Implementation Issues

Implementation issues include:

- Endangered Species Act: Great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size and length and nature of the project, this would be a considerable task.
- **Procurement and stockpiling of concrete boxes**: The boxes, as mentioned above, are quite sizable and would need to be stored near the site. This would result in some temporary loss of land near the project site. There could also be some soil compaction at the storage site during construction, due to the weight of the boxes, which would need to be mitigated to restore the agricultural potential.
- Seasonal sequencing to minimize agriculture impacts: In order to minimize the impact on the local farmers, the project could be done in stages, working only in the non-growing seasons. This could slow down the construction and might incur additional seasonal start-up costs.
- **Road and railroad crossings**: The significant road and railroad crossings would be both expensive and a nuisance to the public.

Cost Estimate

A cost estimate for an underground bypass channel is listed on Table 3-17.

Table 3-17: Alternative 14 Cost Estimate - Underground Bypass.

		Quantity	Unit	Unit Cost	Total
Constru	ıction				
	Mobilization & demobilization	1	L.S.		\$18,030,000
	Remove top 2' soil & stockpile	500,000	су	\$2.77	\$1,390,000
	Excavate 2nd 4-ft & stockpile	1,000,000	су	\$2.77	\$2,770,000
	Excavate channel	4,000,000	су	\$1.79	\$7,160,000
	Soil transport & disposal	4,000,000	cy	\$18.68	\$74,720,000
	Pre-cast box inc. shipping	1	L.S.	\$180,000,000	\$180,000,000
	Pre-cast box installation		Allowance	40%	\$72,000,000
	Cover with excavated soil	1,000,000	cy	\$5.00	\$5,000,000
	Reform top 2' of soil	500,000	cy	\$5.00	\$2,500,000
	Diversion	1	L.S.	\$15,000,000	\$15,000,000
	Outlet structure	1	L.S.	\$15,000,000	\$15,000,000
	Construction Subtotal	-	-	-	\$393,570,000
	C.O. Contingency	-	Allowance	15%	\$59,040,000
	Total Construction	-	-	-	\$453,000,000
Land					
		155	acres	\$5,000.00	\$800,000
Implem	entation				
	Land Acquisition	-	Allowance	5%	\$39,000
	Administration	-	Allowance	3%	\$13,580,000
	Engineering	-	Allowance	6%	\$27,160,000
	CM	-	Allowance	4%	\$18,100,000
	Legal	-	Allowance	3%	\$13,580,000
	CEQA	-	Allowance	1%	\$4,530,000
	Implementation Subtotal	-	-	-	\$77,000,000
Capital	Cost Subtotal	-	-	-	\$530,000,000
Project	Contingency	-	Allowance	30%	\$160,000,000
Total C	lost	_	_	-	\$690,000,000

The alternative represented by this estimate provides 44% of the necessary protection for the downstream reaches of the Pajaro River.

For information regarding the source of the unit costs for this estimate, please refer to Appendix B. Appendix B also contains assumptions and limitations of the estimate.

Alternative 15: Flood Tunnel

This alternative is similar to the one described in Alternative 14, but would be sized much larger to convey the entire amount of flood flow. Like Alternative 14, a flood tunnel diverts the excess flood flow from the river around the areas that would normally flood, and would accommodate farming above the structure after it is completed.

Project Facilities

The channel would divert water from the Pajaro River near Murphy Road Crossing and flow back into the river just upstream of the Monterey Bay. The objective is to take the flood water that would normally overtop the levees and divert the water around the flood risk area. The route would follow the southern edge of the 100-yr flood plain along the hills of the Bolsa de San Cayetano. This avoids the urbanized areas around Watsonville and Pajaro, reduces the number of road and railroad crossings, and follows a natural low point in the landscape. Figure 3-27 shows a possible alignment. A diversion facility is necessary at the beginning of the bypass and a discharge facility at the end of the bypass.

The tunnel would be about 350 ft wide, approximately 12 ft deep, and about 45,000 ft long. Rather than dig out the tunnel, compartmentalized boxes can be assembled within a trench and recovered with the original soil. The pre-cast, reinforced concrete boxes are available commercially and may cut down on the project duration. Figure 3-33, which is not to scale, shows a cross section of the tunnel. Depending on engineering constraints, the boxes might also be stackable to reduce the width of the tunnel.

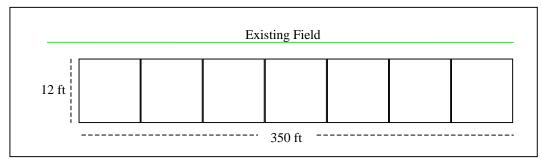


Figure 3-33: Representation of an underground bypass.

Storm water overflow carried by the bypass would be reintroduced to the river mouth at the location shown in Figure 3-29. The hills visible on the right side of the image prevent the bypass from emptying into Monterey Bay.

Once construction is complete, no appreciable land area would be used or lost. Figure 3-30 shows the land use and condition for most of the route shown in Figure 3-27. Downstream of Highway 1 the bypass would parallel Trafton Rd., which is shown in the photo.

Flood Protection

A flood tunnel with the dimensions listed above could carry around 25,500 cfs. A diversion of this amount of water would provide 100% of the flood protection benefit.

Other Benefits

There are several benefits associated with this alternative. They include:

- Open space preservation: After construction, land currently held as open space would remain open space.
- Agricultural preservation: After construction, land currently farmed would continue to be farmed.
- **Aesthetically pleasing**: After construction the project would not be visible except for the diversion at the upstream reaches and the outfall at the lower reaches of the river.

Implementation Issues

Implementation issues include:

- Endangered Species Act: Great care would need to be taken not to disturb or harm any of the species that may live in the impacted area of the project. Due to the size and length and nature of the project, this would be a considerable task.
- **Procurement and stockpiling of concrete boxes**: The boxes, as mentioned above, are quite sizable and would need to be stored near the site. This would result in some temporary loss of land near the project site. There could also be some soil compaction at the storage site during construction, due to the weight of the boxes, which would need to be mitigated to restore the agricultural potential.
- Seasonal sequencing to minimize agriculture impacts: In order to minimize the impact on the local farmers, the project could be done in stages, working only in the non-growing seasons. This could slow down the construction considerably though and might incur additional seasonal start-up costs.
- **Road and railroad crossings**: The significant road and railroad crossings would be both expensive and a nuisance to the public.

Cost Estimate

A cost estimate for a flood tunnel sized to meet 100 percent of the flood protection benefit is listed on Table 3-18.

Table 3-18: Alternative 15 Cost Estimate - Flood Tunnel.

		Quantity	Unit	Unit Cost	Total
Constru	ction				
	Mobilization & demobilization	1	L.S.		\$59,260,000
-	Remove top 2' soil & stockpile	1,700,000	су	\$2.77	\$4,710,000
-	Excavate 2nd 4-ft & stockpile	3,400,000	су	\$2.77	\$9,420,000
-	Excavate channel	15,000,000	су	\$1.79	\$26,850,000
	Soil transport & disposal	11,600,000	су	\$18.68	\$216,690,000
<u>.</u>	Pre-cast box inc. shipping	1	L.S.	\$630,000,000	\$630,000,000
	Pre-cast box installation		Allowance	40%	\$252,000,000
	Cover with excavated soil	3,400,000	су	\$5.00	\$17,000,000
<u>.</u>	Reform top 2' of soil	1,700,000	су	\$5.00	\$8,500,000
-	Diversion	1	L.S.	\$20,000,000	\$20,000,000
	Outlet structure	1	L.S.	\$20,000,000	\$20,000,000
-	Construction Subtotal	-	-	-	\$1,264,430,000
-	C.O. Contingency	-	Allowance	15%	\$189,664,500
,	Total Construction	-	-	-	\$1,450,000,000
Land		520	acres	\$5,000.00	\$2,600,000
Impleme	entation				
- -	Land Acquisition	-	Allowance	5%	\$130,000
<u>.</u>	Administration	-	Allowance	3%	\$43,620,000
<u>-</u>	Engineering	-	Allowance	6%	\$87,250,000
	CM	-	Allowance	4%	\$58,160,000
- -	Legal	-	Allowance	3%	\$43,620,000
_	CEQA	-	Allowance	1%	\$14,540,000
	Implementation Subtotal	=	-	=	\$247,000,000
Capital (Cost Subtotal	-	-	-	\$1,700,000,000
Project (Contingency	-	Allowance	30%	\$510,000,000
Total Co	ost		-		\$2,200,000,000

The alternative represented by this estimate provides 100% of the necessary protection for the downstream reaches of the Pajaro River.

For information regarding the source of the unit costs for this estimate, please refer to Appendix B. Appendix B also contains assumptions and limitations of the estimate.

Alternative 16: Floodwalls

Floodwalls could be built along the entire length of the existing levees. They would provide additional capacity to the river channel by accommodating a higher flood stage.

Alternative Description

The floodwalls would be located on top of the existing levees, as shown in Figure 3-34. Figure 3-35 shows the Monterey side of the levees at Thurwatcher Bridge and Figure 3-36 shows the Santa Cruz side of the levees around the Murphy Road Crossing.

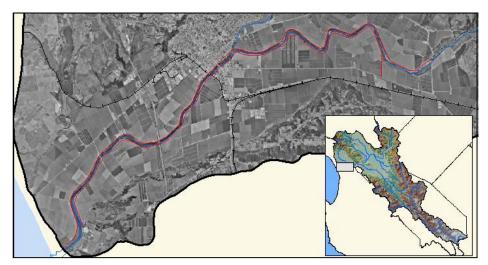


Figure 3-34: Existing levee locations with proposed floodwalls.



Figure 3-35: Monterey levees at Thurwatcher Bridge.



Figure 3-36: Santa Cruz levees at Murphy Road Crossing.

Based on findings provided by the Corps Lower Pajaro River Flood Protection Project, floodwalls could be as high as four feet in urban areas due to infrastructure constraints and local aesthetic concerns. The floodwalls could be up to five feet high in agricultural reaches. Figure 3-37 shows how floodwalls extend the channel capacity. The lighter blue indicates flow area for additional capacity that the floodwalls will create in the channel.

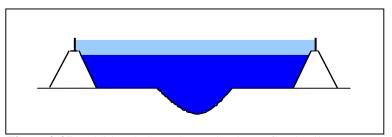


Figure 3-37: Additional channel capacity due to floodwalls.

The total length of the levee is 108,000 feet, or about 20 miles. This value includes floodwalls for the levees on both sides of the river. Since the floodwall is built on the existing levee, no additional land is used for this project.

Flood Protection

The proposed floodwall project would carry an additional 2,400 cfs, which would provide about 9% of the flood protection benefit.

Other Benefits

There are several benefits associated with this project. They include:

- Open space preservation: Land currently held as open space would remain open space.
- **Agricultural preservation**: Land currently farmed would continue to be farmed.
- **Urban preservation**: Land near the existing levees that has been urbanized would be unaffected.

Impacted Facilities

Since the floodwalls would be built upon the existing levees and within infrastructure constraints, no additional facilities would be impacted. To increase the carrying capacity of the floodwalls by raising the height, existing bridges and their surroundings, especially the Main Street Bridge, would need to be modified.

Implementation Issues

Implementation issues include:

- **Public acceptance**: The Corps Lower Pajaro River Flood Protection Project identified negative public reaction regarding several aspects of floodwalls. These included a separation of communities that occurs and the potential for the floodwalls to create barriers to species movement.
- Infrastructure constraints: There is a great deal of urbanization abutting the levees that might be inconvenienced during the construction period. Additionally, roads and bridges would have to be relocated or rebuilt to accommodate additional discharge capacity in the channel. The increased height of the water surface in the channel would have very detrimental impact on the local storm drainage facilities.

Cost Estimate

A cost estimate for use of floodwalls along the channel is listed on Table 3-19.

Table 3-19: Alternative 16 Cost Estimate - Floodwalls.

	Quantity	Unit	Unit Cost	Total
Construction				
Mobilization & demobilization	1	L.S.		\$0
Levee preparation	1	L.S.	\$1,000,000	\$1,000,000
Aggregate base	4,000	су	\$34.66	\$140,000
Forms in place	972,000	sf	\$6.33	\$6,150,000
Concrete in place	36,000	су	\$97.82	\$3,520,000
Finishing walls	972,000	sf	\$0.55	\$530,000
Curing	11,880	csf	\$7.16	\$90,000
Construction Subtotal	-	-	-	\$11,430,000
C.O. Contingency	-	Allowance	15%	\$1,710,000
Total Construction	-	-	-	\$13,300,000
Land	0	acres	\$30,000	\$0
Implementation				
Land Acquisition	-	Allowance	5%	\$0
Administration	-	Allowance	3%	\$390,000
Engineering	-	Allowance	6%	\$790,000
CM	-	Allowance	4%	\$530,000
Legal	-	Allowance	3%	\$390,000
CEQA	-	Allowance	1%	\$130,000
Implementation Subtotal	-	-	-	\$2,200,000
Capital Cost Subtotal	-	-	-	\$15,500,000
Project Contingency	-	Allowance	30%	\$4,500,000
Total Cost	-		-	\$20,000,000

The alternative represented by this estimate provides 9% of the necessary protection for the downstream reaches of the Pajaro River.

For information regarding the source of the unit costs for this estimate, please refer to Appendix B. Appendix B also contains assumptions and limitations of the estimate.

3.4 Alternative Summary

The following table summarizes the most significant characteristics of the alternatives. These include:

- Flood protection
- Engineering and regulatory constraints
- Other Benefits
- Cost

Table 3-20: Alternative Summary Table

Project	Flood Protection Benefit*	Engineering and Regulatory Constraints	Other Benefits**	Cost
Land/Flood Easement at Soap Lake	0%	-	Water quality Recharge Compliance	Purchase: \$104M Easement: \$32M
Detention Basin in San Benito watershed	25%	ESA Earth Moving Public Approval	Water quality Recharge Compliance	\$1.2B
Raise Existing Dams	5%	ESA Permitting Seismic	Add'l water supply Water quality Add'l Recharge Add'l Recreation	\$88M
Detention Basin at College Lake	10%***	ESA Permitting Seismic Infrastructure Public Approval	Water supply Water quality Recharge Recreation	\$47M
New Pacheco Dam	7%	ESA Permitting Seismic Infrastructure Public Approval	Water supply Water quality Gr.Water quality Recharge Recreation	\$92M
New Soap Lake Dam	50%	ESA Permitting Seismic Infrastructure Public Approval	Water supply Water quality Recharge Recreation	\$80M
New Tres Pinos Dam	34%	ESA Permitting Seismic Infrastructure Public Approval	Water supply Water quality Recharge Recreation	\$27M
New San Benito Dam	50%	ESA Permitting Seismic Public Approval	Water supply Water quality Recharge Recreation	\$94M

New Chittenden Dam	Large: 100% Small: 4%	ESA Permitting Seismic Infrastructure Public Approval	Water supply Water quality Recharge Recreation	Large: \$114M Small: \$23M
Open Channel Bypass	12%	ESA Road/Railroad Public Approval	-	\$78M
Flood Channel	100%	ESA Road/Railroad Public Approval	-	\$329M
Underground Bypass	44%	ESA Storing boxes Sequencing Road/Railroad	Aesthetics	\$690M
Flood Tunnel	100%	ESA Storing boxes Sequencing Road/Railroad	Aesthetics	\$2.2B
Floodwalls	9%	Infrastructure Public Approval	-	\$20M
Corps Alternative 3	Corps ESA Infrastructure		Additional habitat	\$177.3M
Corps Alternative 1	52%	ESA Infrastructure Public Approval	None	\$145.8M

^{* &}quot;Flood Protection Benefit" refers to the percentage of the discharge that is managed in addition to the existing levees. All projects except for the Corps' alternative projects assume that the existing levees can convey 19,000 cfs.

The next stage of this phase of the Pajaro River Watershed Study will determine the most favorable project alternatives for further study and evaluation. The project ranking will involve decision modeling and the input of the PRWS staff working group.

The location of each of the proposed projects is shown on Figure 3-38.

^{**} All projects except for the dams maintain a majority of the current land uses, including open space, agriculture, and urban land use.

^{***} The 10% flood protection for this project is applicable downstream of the Pajaro River and Salsipuedes Creek confluence. The project provides no flood benefit upstream of the confluence.

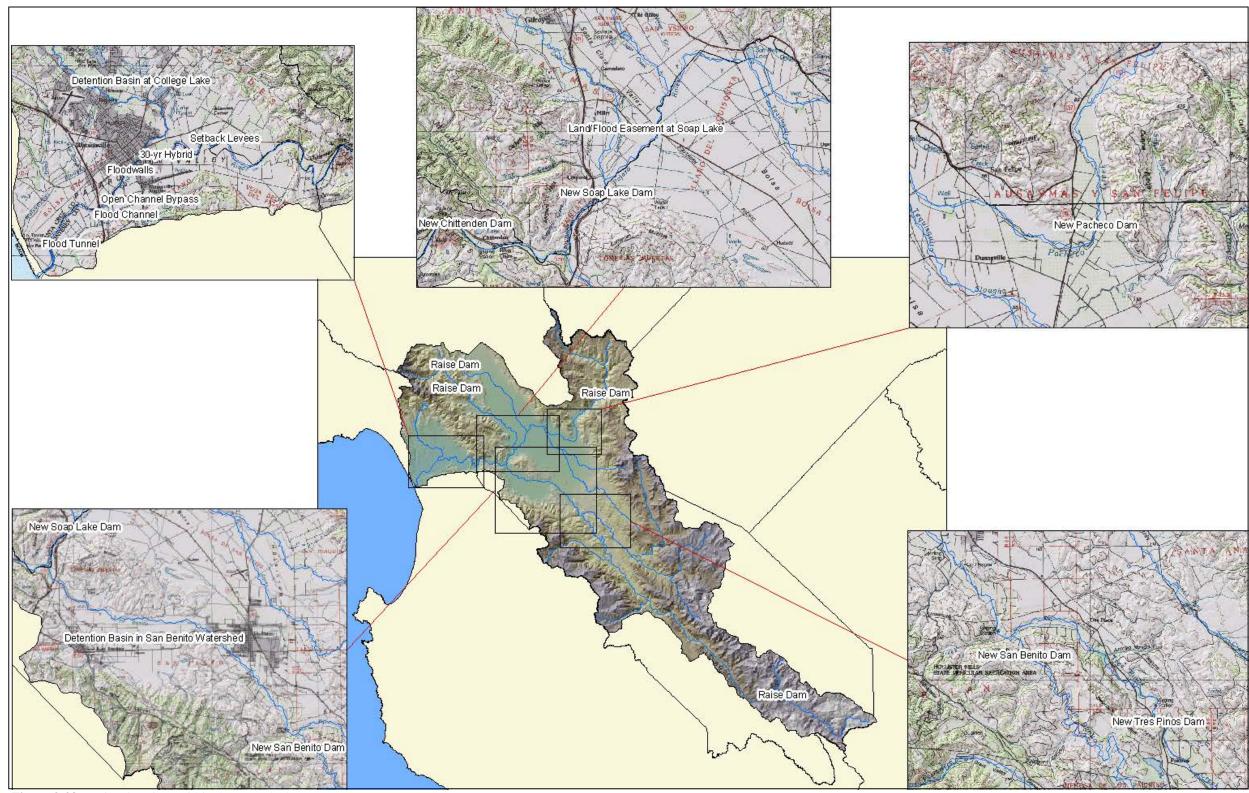


Figure 3-38: Project locations within the watershed.

CHAPTER 4

DECISION ANALYSIS

As discussed in Chapter 2, there are few single projects that can provide complete flood protection during a 100-year flood event. However, a multiple benefit solution for the watershed would require that several projects be initiated and coordinated with each other to provide the lower Pajaro River with the maximum range of benefits. Therefore, the individual projects that were evaluated in Chapter 3 were grouped into "packages" that would provide complete flood protection. To coordinate with the Corps efforts, the alternatives identified in Phase 2 were coupled with either of the two Corps projects to provide a minimum of 100-year flood protection.

After review of the packages, the Staff Working Group identified the following packages as the favored alternative packages:

- Corps Alternative 3 (65-yr) Project and New Small San Benito Dam
- Corps Alternative 3 (65-yr) Project and Open Earthen Bypass Channel
- Corps Alternative 1 (30-yr) Project and New San Benito Dam
- Corps Alternative 1 (30-yr) Project, New Pacheco Dam, and New Small San Benito Dam.

Since the Soap Lake Floodplain Preservation project was necessary to maintain the 100-year flow design value, this project was included with each of the packages.

This chapter includes a summary of the process used to develop the 100-year flood protection packages and selection process to identify several packages that could be considered viable options to provide downstream flood protection.

4.1 Development of 100-Year Flood Protection Packages

The 100-year flood protection packages were developed from combinations of the Corps projects and the alternative projects evaluated in Chapter 3. Since the two Corps projects did not provide complete 100-year flood protection, additional flood protection projects were considered necessary to supplement the Corps projects. Figure 4-1 is a graph of the modeled flood flow discharges at Chittenden at general plan buildout. The graph includes flood protection benefits for the Corps Alternative 1 with 30-year flood protection and Corps Alternative 3 with 65-year flood protection for the Lower Pajaro River. The 100-year flood event discharge and the existing level of flood protection are also shown. If the Corps Alternative 3 (65-year protection) project is constructed to provide flood protection, an additional 4,100 cfs of flow must be conveyed downstream or detained upstream by other facilities to provide flood protection, an additional 12,400 cfs must be conveyed downstream or detained upstream by other facilities to provide the same level of protection.

An incremental flood protection project was added to either of the Corps projects to provide protection against floods ranging from 43,500 cfs (98 percent of the 100-year flood flow) to 48,800 cfs (110 percent of the 100-year flood flow). The range of protection allowed is due to the preliminary nature of this phase of the study and potential routing effects that cannot be assessed at this preliminary stage.

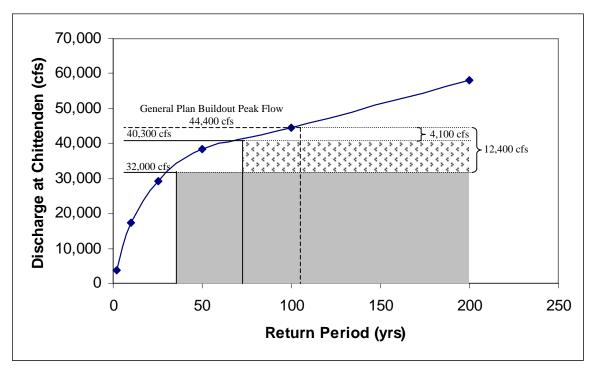


Figure 4-1: 100-year flood protection deficit of the Corps Alternatives 1 and 3.

One of the Corps alternatives and any combination of additional projects necessary to provide 100-year flood protection were considered a 100-year flood protection package. Certain guidelines were followed in developing each 100-year flood protection packages. These included:

- Each package must use either the Corps Alternative 1 (30-year protection) or 3 (65-year protection) projects as a baseline project. This guideline provides coordination with the Corps projects.
- Combinations of projects with total flood protection by detention or conveyance between 98% and 110% (43,500 cfs and 48,800 cfs) of the 100-year protection flow rate (44,400 cfs) are considered possibilities. This guideline maintains project packages of roughly similar flood protection for comparison purposes.
- Single projects, when combined with the Corps 65- or 30-year project, are considered possibilities regardless of the level of protection so long as it is at least 98%. This guideline creates packages that may exceed the 100-year flood protection level, but ensures consideration of nearly every alternative.
- Two projects identified in Chapter 3, Soap Lake Floodplain Preservation and Floodwalls, were not included in the development of 100-year flood protection packaging. The Soap Lake Floodplain Preservation project was not included since it is considered necessary to maintain the design flows used in the development of alternatives. The floodwall alternative was essentially equivalent to economically infeasible Corps Alternative 4.
- Efforts were made to develop packages with every combination of projects possible.

Sixty distinct packages were developed based on the above guidelines. The listing of packages, as well as their flood protection benefit and expected cost, is included on Table 4-1. In order to reduce the number of packages to be compared, each package was evaluated based on four criteria. If a package met a single elimination criterion, it was not considered further. The four elimination criteria are:

1) Package cost is greater than \$500 million.

- 2) 100-year flood protection is not available upstream of Salsipuedes Creek.
- 3) Extensive relocation of infrastructure, facilities, and residences is required.
- 4) Reservoirs are located nearby and upstream of population centers.

The comparison of each package against the four elimination criteria is also shown on Table 4-1 at the end of this chapter.

4.2 Recommended Packages for Comparison

Seven packages remained after application of the elimination criteria. These packages were considered viable options to provide complete flood protection during the 100-year flood event and are listed on Table 4-2 at the end of this chapter. An eighth package was added since it provided a significant amount of flood protection with a package cost of only slightly more than \$500 million. One other reference package was included in Table 4-2 to demonstrate the size and cost of an effective conveyance project that provides all of the necessary flood protection during a 100-year event without the use of one of the Corps projects.

To provide a comparison of flood protection packages and their costs at a similar level of flood protection, projects in three of the packages were made smaller to provide overall flood level protection closer to 100 percent. In package 12, the size of the San Benito Dam was reduced to provide protection only up to the 100-year flood event. In packages 3 and 24, the size of the lined flood protection channel was reduced to provide capacity for only the amount of flow that could not be conveyed through each of the Corps Lower Pajaro River Flood Protection Projects. One other package was developed to provide and earthen open bypass channel for Corps Alternative 1 (30-year protection) for comparison with Package 2. The nine packages are listed at the end of this chapter in Table 4-3. A brief description of each of the projects, their sizes, and costs that were used for the final packaging is listed in Table 4-4, also at the end of this chapter.

In Table 4-3, the listed final packages were compared using the previously identified criteria. This table allowed comparison of how additional benefits, such as additional water supply and land use maintenance, were gained by combining either of the Corps projects with projects developed in the Pajaro River Watershed Study. Flood protection packages with upstream storage generally provided additional water supply, water supply for multiple agencies, improved surface water quality, and recreational opportunities. Flood protection packages with downstream conveyance generally had less potential for damage in seismic events and less infrastructure interference.

The nine packages listed on Table 4-3 were presented to the interagency Staff Working Group. After review of the packages, the Staff Working Group identified the following packages as the favored alternative packages:

- Corps Alternative 3 (65-yr) Project and New Small San Benito Dam
- Corps Alternative 3 (65-yr) Project and Open Earthen Bypass Channel
- Corps Alternative 1 (30-yr) Project and New San Benito Dam
- Corps Alternative 1 (30-yr) Project, New Pacheco Dam, and New Small San Benito Dam.

Since the Soap Lake Floodplain Preservation project was necessary to maintain the 100-year flow design value, this project was included with each of the packages.

Each of these packages utilizes the downstream Corps project at some level of flood protection. The upstream dams will reduce the peak discharge, alter the timing of the peak, and provide benefits such as water supply, potential water quality improvements, and recreation opportunities. The open earthen bypass channel would remove the peak discharge from the main channel and transport it to the mouth of the river during flood events.

Concurrent to the selection of the four alternative packages for further analysis in Phase 3 of this study, the Corps was reassessing the 100-year peak flow expected at Chittenden. Based on additional flow monitoring during record floods in 1998, the Corps was planning to reduce the 100-year peak flow rates at Chittenden. This peak flow reduction will allow the Corps Alternative 3 to provide downstream flood protection in a 100-year flood event. This project has the least cost of the favored alternative packages and was considered to be most likely to be implemented. However, the Corps has not formally reduced the peak flood value, and has not made a final selection of the project and level of protection.

Table 4-1: Comparison of 100-Year Flood Protection Packages with Four Decision Criteria.

	Package Informa	tion		Decision Criteria			
Package No.	Package Projects	Package Flood Protection	Package Cost (Millions)	Package cost is greater than \$500M	100% Flood protection is not available upstream of Salsipuedes Creek	Extensive relocation of facilities and residences is required	Reservoirs are located nearby and upstream of population centers
1	Corps 65-Yr San Benito Detention Basin	105%	\$1,370	X		X	
2	Corps 65-Yr Earthen Open Channel	98%	\$255				
3	Corps 65-Yr Lined Flood Channel	148%	\$506	X			
4	Corps 65-Yr Underground Bypass	116%	\$866	X			
5	Corps 65-Yr Flood Tunnel	148%	\$2,392	X			
6	Corps 65-Yr Raise Existing Dams New College Lake Dam	99%	\$311		X		
7	Corps 65-Yr Raise Existing Dams New Pacheco Dam	98%	\$356				
8	Corps 65-Yr New College Lake Dam Raise Existing Dams	99%	\$311		X		X
9	Corps 65-Yr New College Lake Dam New Pacheco Dam	100%	\$316		X		
10	Corps 65-Yr New Soap Lake Dam	120%	\$257			X	
11	Corps 65-Yr New Tres Pinos Dam	110%	\$204			X	

12	Corps 65-Yr New San Benito Dam	120%	\$271				
13	Corps 65-Yr New Large Chittenden Dam	148%	\$292			X	X
14	Corps 65-Yr New Small Chittenden Dam New College Lake Dam	99%	\$247		X		X
15	Corps 65-Yr New Small Chittenden Dam Earthen Open Channel	100%	\$278				X
16	Corps 30-Yr San Benito Detention Basin Earthen Open Channel New College Lake Dam	99%	\$1,464	X	X		X
17	Corps 30-Yr San Benito Detention Basin Raise Existing Dams New College Lake Dam New Pacheco Dam	99%	\$1,565	X	X		X
18	Corps 30-Yr San Benito Detention Basin New College Lake Dam New Pacheco Dam New Small Chittenden Dam	98%	\$1,501	x	x	x	X
19	Corps 30-Yr San Benito Detention Basin New Tres Pinos Dam	106%	\$1,366	X		X	
20	Corps 30-Yr Earthen Open Channel Underground Bypass	104%	\$913	X			
21	Corps 30-Yr Earthen Open Channel Raise Existing Dams New College Lake Dam New Tres Pinos Dam	107%	\$385			X	X

							,
22	Corps 30-Yr Earthen Open Channel Raise Existing Dams New Pacheco Dam New Tres Pinos Dam	105%	\$430			X	
23	Corps 30-Yr Earthen Open Channel New Tres Pinos Dam	98%	\$251			X	
24	Corps 30-Yr Lined Flood Channel	130%	\$475				
25	Corps 30-Yr Underground Bypass Raise Existing Dams	100%	\$922	X			
26	Corps 30-Yr Underground Bypass New College Lake Dam	103%	\$882	X	X		X
27	Corps 30-Yr Underground Bypass New Pacheco Dam	101%	\$927	X			
28	Corps 30-Yr Underground Bypass New Small Chittenden Dam	100%	\$858	X			X
29	Corps 30-Yr Flood Tunnel	130%	\$2,361	X			
30	Corps 30-Yr Raise Existing Dams New San Benito Dam	104%	\$327				
31	Corps 30-Yr Raise Existing Dams New Soap Lake Dam	104%	\$313			X	
32	Corps 30-Yr Raise Existing Dams San Benito Detention Basin Earthen Open Channel New College Lake Dam	102%	\$1,551	x	X	X	X

Corps 30-Yr Raise Existing Dams Sam Benito Detention Basin 100% S1.596 X X X X Sam Benito Detention Basin 100% S1.596 X X X X X X X X X							
Raise Existing Dams 98% \$1,527 X X X X X X X X X	33	Raise Existing Dams San Benito Detention Basin Earthen Open Channel	100%	\$1,596	X	X	
Raise Existing Dams 98% \$1,527 X X X X X X X X X							
San Benito Dams 101% \$338	34	Raise Existing Dams San Benito Detention Basin Earthen Open Channel	98%	\$1,527	X	X	X
San Benito Detention Basin Raise Existing Dams 107% \$1,000 X	35	Raise Existing Dams Earthen Open Channel	101%	\$338		X	
37 New College Lake Dam 107% \$273 X X New Soap Lake Dam 107% \$287 X San Benito Detention Basin New College Lake Dam 106% \$1,643 X X Corps 30-Yr New College Lake Dam Earthen Open Channel 106% \$1,643 X X X X San Benito Detention Basin New Pacheco Dam 105% \$1,579 X X X San Benito Detention Basin New Small Chittenden Dam 105% \$1,579 X X X San Benito Detention Basin New Small Chittenden Dam 105% \$1,579 X X X San Benito Detention Basin New Small Chittenden Dam 105% \$1,579 X San Benito Detention Dam 105%	36	Raise Existing Dams Earthen Open Channel	107%	\$1,000	X		
New College Lake Dam Corps 30-Yr New College Lake Dam Earthen Open Channel San Benito Detention Basin Raise Existing Dams New Pacheco Dam Corps 30-Yr New College Lake Dam Earthen Open Channel San Benito Detention Basin New Pacheco Dam X X X X X X X X X X X X X	37	New College Lake Dam	107%	\$273		X	X
New College Lake Dam Earthen Open Channel San Benito Detention Basin Raise Existing Dams New Pacheco Dam Corps 30-Yr New College Lake Dam Earthen Open Channel San Benito Detention Basin New Small Chittenden Dam New Small Chittenden Dam	38	New College Lake Dam	107%	\$287			X
New College Lake Dam Earthen Open Channel San Benito Detention Basin New Small Chittenden Dam	39	New College Lake Dam Earthen Open Channel San Benito Detention Basin Raise Existing Dams	106%	\$1,643	x	X	X
	40	New College Lake Dam Earthen Open Channel San Benito Detention Basin New Small Chittenden Dam	105%	\$1,579	x	X	X

				Ī			
41	Corps 30-Yr New College Lake Dam Earthen Open Channel San Benito Detention Basin Raise Existing Dams New Small Chittenden Dam	104%	\$1,574	X		X	X
42	Corps 30-Yr New College Lake Dam Earthen Open Channel San Benito Detention Basin New Pacheco Dam	103%	\$1,556	X		X	X
43	Corps 30-Yr New College Lake Dam Earthen Open Channel San Benito Detention Basin New Small Chittenden Dam	101%	\$1,487	X		X	X
44	ff 30-Yr New Pacheco Dam New Soap Lake Dam	105%	\$318			X	
45	Corps 30-Yr New Pacheco Dam New San Benito Dam	105%	\$332				
46	Corps 30-Yr New Pacheco Dam San Benito Detention Basin New Small Chittenden Dam Earthen Open Channel	100%	\$1,532	x		X	X
47	Corps 30-Yr New Pacheco Dam Earthen Open Channel New Tres Pinos Dam	102%	\$343			X	
48	Corps 30-Yr New Pacheco Dam Raise Existing Dams New Tres Pinos Dam	99%	\$352			X	
49	Corps 30-Yr New Pacheco Dam New College Lake Dam New Tres Pinos Dam	101%	\$312		X	X	X

50	Corps 30-Yr New Pacheco Dam New Small Chittenden Dam New Tres Pinos Dam	98%	\$288			X	X
51	Corps 30-Yr New Soap Lake Dam	101%	\$226			X	
52	Corps 30-Yr New Tres Pinos Dam Earthen Open Channel New College Lake Dam	104%	\$298			X	Х
53	Corps 30-Yr New Tres Pinos Dam Earthen Open Channel New Small Chittenden Dam	101%	\$274			X	Х
54	Corps 30-Yr New Tres Pinos Dam Raise Existing Dams New College Lake Dam	100%	\$307		X	X	X
55	Corps 30-Yr New Tres Pinos Dam New College Lake Dam New Small Chittenden Dam	100%	\$243		X	X	X
56	Corps 30-Yr New San Benito Dam	101%	\$240				
57	Corps 30-Yr New Large Chittenden Dam	130%	\$261			X	
58	Corps 30-Yr New Small Chittenden Dam New San Benito Dam	103%	\$263				X
59	Corps 30-Yr New Small Chittenden Dam New Soap Lake Dam	103%	\$249			X	X
60	Corps 30-Yr New Small Chittenden Dam New Tres Pinos Dam San Benito Detention Basin	108%	\$1,389	X		X	X

Table 4-2: Project Packages Remaining after Application of Elimination Criteria.

Package No.	Package Projects	Package Flood Protection	Package Cost (Millions)
56	Corps Alternative 1 (30-Yr) New San Benito Dam	101%	\$240
2	Corps Alternative 3 (65-Yr) Earthen Open Channel	98%	\$260
12	Corps Alternative 3 (65-Yr) New San Benito Dam	120%	\$270
30	Corps Alternative 1 (30-Yr) Raise Existing Dams New San Benito Dam	104%	\$330
45	Corps Alternative 1 (30-Yr) New Pacheco Dam New San Benito Dam	105%	\$330
7	Corps Alternative 3 (65-Yr) Raise Existing Dams New Pacheco Dam	98%	\$360
24	Corps Alternative 1 (30-Yr) Lined Flood Channel	130%	\$480
3	Corps Alternative 3 (65-Yr) Lined Flood Channel	148%	\$506
Ref	Large Lined Flood Channel	100%	\$570

 Table 4-3: Final Flood Protection Packages.

							Comparison Criteria	on Criteria			
	Package Projects	Package Flood Protection	Package Cost (Millions)	eabivon Astervitional VVater VlqquS	101 ylqqu2 191kVV səionəgA əlqifluM	Improved Surface Water Quality	Recreation Opportunities	bneJ snietnieM esU	lsitneto9 betimiJ egsms0 bool7 rof tnev3 oimsie8 ni	Least Infrastructure eonerehetri	Dam Permitting Not Required
٧	Corps 65-Yr Small San Benito Dam	100%	\$200-240	×		×	×			×	
В	Corps 65-Yr Very Small Lined Flood Channel	100%	\$210-250						×		×
С	Corps 30-Yr New San Benito Dam	101%	\$220-260	×		×	×			×	
Q	Corps 65-Yr Earthen Open Channel	%86	\$230-290					×	×		×
E	Corps 30-Yr Small Lined Flood Channel	100%	\$270-330						×		×
F	Corps 30-Yr Raise Existing Dams New San Benito Dam	104%	\$300-360	×	×	×	×			*	
9	Corps 30-Yr New Pacheco Dam New San Benito Dam	105%	\$300-360	×	×	×	×				
Ξ	Corps 65-Yr Raise Existing Dams New Pacheco Dam	%86	\$320-400	×	*	×	×				
_	Corps 30-Yr Large Open Channel	100%	\$420-520					×	×		×

Table 4-4: Projects Included in Final Flood Protection Packages.

Corps Lower Pajaro Projects

Corps Alternative 1 (30-year protection):

This project provides flood protection by increasing the capacity of the river channel between the Murphy Road crossing and Monterey Bay. The increased capacity is realized through floodwalls, raising the existing levee height, and 100-ft setback levees. Although 65-year protection is afforded to the upstream reaches of the river length, a maximum of 30-year protection is provided downstream of the urban reaches.

Corps Alternative 3 (65-Year protection):

Project Cost: \$180 million

Project Cost: \$150 million

This project provides flood protection by increasing the capacity of the river channel between the Murphy Road crossing and Monterey Bay. The increased capacity is realized through floodwalls, raising the existing levee height, and 100- and 225-ft setback levees. 65-year protection is afforded to the entire floodplain associated with this length of river.

Upstream Detention/Retention Alternatives

New San Benito Dam

Project Cost: \$90 million

This project provides flood protection by detaining flood waters to reduce the peak flows downstream. The location of the dam would be upstream of the Tres Pinos River confluence with the San Benito River. The dam would be 120 ft high and have a footprint of 720 ft width by 1,600 ft length. Approximately 60,000 acre-feet (AF) of water would be stored over an area of 1,600 acres.

Small San Benito Dam

Project Cost: \$40 million

This project provides flood protection by detaining flood waters to reduce the peak flows downstream. The location of the dam would be upstream of the Tres Pinos River confluence with the San Benito River. The dam would be 40 ft high and have a footprint of 240 ft width by 800 ft length. Approximately 20,000 acrefeet (AF) of water would be stored over an area of 500 acres.

New Pacheco Dam

Project Cost: \$90 million

This project provides flood protection by detaining flood waters to reduce the peak flows downstream. The location of the dam would be at the foot of the Ausaymas Y San Felipe Hills, upstream of San Felipe Lake. The dam would be 70 ft high and have a footprint of 420 ft width by 5,500 ft length. Approximately 35,000 AF of water would be stored over an area of 1,150 acres.

Raise Existing Dams

Project Cost: \$90 million

This project provides flood protection by detaining flood waters to reduce the peak flows downstream. The large, existing dams in the watershed are Uvas, Chesbro, Pacheco, and Hernandez. These are all located at the periphery of the watershed. During a 100-year event, all of the upstream watershed runoff would be detained and approximately an additional 1,500 acres would be inundated.

Downstream Conveyance Alternatives

Large Earthen Open Channel

Project Cost: \$320 million

This project provides flood protection by diverting flood flows away from the existing river channel near Murphy Road crossing into a new earthen open channel. The channel would be approximately 8.5 miles long, 370 ft wide which includes two 20-ft service roads, 10 ft deep, and has sides with a 3:1 (H:V) slope. Approximately 40 acres would be converted to service road and 380 acres would maintain its current land use during dry weather periods.

Earthen Open Channel:

Project Cost: \$80 million

This project provides flood protection by diverting flood flows away from the existing river channel near Murphy Road crossing into a new earthen open channel. The channel would be approximately 8.5 miles long, 100 ft wide which includes a 20-ft service road, 10 ft deep, and has sides with a 3:1 (H:V) slope. Approximately 20 acres would be converted to service road and 80 acres would maintain its current land use during dry weather periods.

Lined Flood Channel

Project Cost: \$330 million

This project provides flood protection by diverting flood flows away from the existing river channel near Murphy Road crossing into a new lined open channel. The channel would be approximately 8.5 miles long, 210 ft wide which includes two 20-ft service roads, 10 ft deep, and is concrete lined with 1:1 (H:V) sides. A total of 220 acres would be required to build and maintain this flood protection project.

Small Lined Flood Channel

Project Cost: \$160 million

This project provides flood protection by diverting flood flows away from the existing river channel near Murphy Road crossing into a new lined open channel. The channel would be approximately 8.5 miles long, 100 ft wide which includes two 20-ft service roads, 10 ft deep, and is concrete lined with 1:1 (H:V)

sides. A total of 110 acres would be required to build and maintain this flood protection project.

Very Small Lined Flood Channel

Project Cost: \$50 million

This project provides flood protection by diverting flood flows away from the existing river channel near Murphy Road crossing into a new lined open channel. The channel would be approximately 8.5 miles long, 50 ft wide which includes a 20-ft service road, 10 ft deep, and is concrete lined with 1:1 (H:V) sides. A total of 50 acres would be required to build and maintain this flood protection project.

CHAPTER 5

CONCLUSIONS AND NEXT STEPS

The Phase 2 study included preliminary identification of all project alternatives that provided 100-year flood protection, and the selection of the most feasible alternatives for more detailed study. Of the sixty separate project packages that were developed, nine were identified as most feasible based on specific elimination criteria. The preferred packages selected by the interagency Staff Working Group included:

- Corps Alternative 3 (65-yr) Project and New Small San Benito Dam
- Corps Alternative 3 (65-yr) Project and Open Earthen Bypass Channel
- Corps Alternative 1 (30-yr) Project and New San Benito Dam
- Corps Alternative 1 (30-yr) Project, New San Benito Dam, and New Pacheco Dam.

Since the Soap Lake Floodplain Preservation project was necessary to maintain the 100-year flow design value, this project was included with each of the packages.

Based on additional flow monitoring during record floods in 1998, the Corps is considering the reduction of the 100-year peak flow rates at Chittenden from 44,400 cfs to 40,100 cfs. This peak flow reduction will allow the Corps Alternative 3 to provide downstream flood protection in a 100-year flood event. This project would cost less than the four favored alternative packages, since it would not require implementation of Phase 2 alternative projects. However, the Corps has not changed the peak flow rate at Chittenden, or made a final selection of the project and level of flood protection. If the Corps selects a project that does not protect the surrounding communities and land from flooding in the 100-year event, the packages developed in Phase 2 of the Pajaro River Watershed Study, or some variation of them, would be able to provide that protection. If the Corps Lower Pajaro River project with 100-year flood protection is selected, the increase in project cost with the addition of Phase 2 alternatives could be considered with any multiple use benefits. A decision tree based upon Corps of Engineers actions and decisions is presented on Figure 5-1.

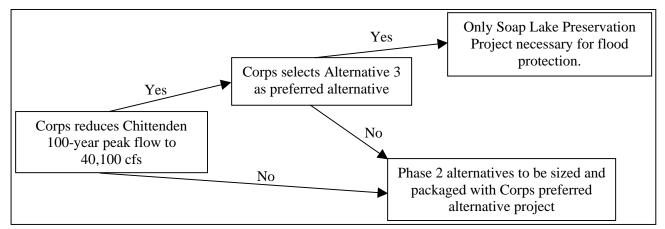


Figure 5-1: Decision Tree for Phase 3 Actions

Phase 3 will include Soap Lake Preservation Plan alternative to verify peak flow reduction characteristics. In development of flood protection alternatives, the Soap Lake Preservation Project was identified as a necessary component of the Corps project with 100-year event flood protection. This project will verify the floodplain attenuation characteristics of the Soap Lake area and identify preservation plans necessary to maintain the existing flood attenuation properties. The project will not be affected by the Corps actions regarding the adjustment of flows, or with their decision regarding the preferred Lower Pajaro River project, therefore it is recommended to be included in Phase 3. Phase 3 of the Pajaro River Watershed Study will focus on understanding the functionality of Soap Lake and the flood peak attenuation benefits it provides locally and downstream of Chittenden Pass.

Certain issues and items of concern need to be resolved or addressed in Phase 3 of the study. These include stakeholder consensus, coordination with other studies, and environmental matters. At this point in the study, a strong foundation has been laid for most of these matters. For the others, being aware of the concerns and complying with any laws or regulations is the best preparation. Below is a brief description of some of these issues, why they are important, and any work that should be done in the next phase of the study to resolve or address the issues.

Stakeholder Consensus

One of the keystones of a successful program is being sure that people agree on its value and believe that the best possible projects have been developed. Consensus within two groups is important for this study. One is consensus within the Authority and the second is consensus within the public.

Agency representatives meet at least once a month to discuss progress on the study and answer any questions that arise. With all eight agencies discussing issues of concern and working together, it is possible to arrive at a solution that is both technically feasible and politically friendly. The representatives of the eight agencies have all agreed with the recommendations of the Phase 2 study.

The other aspect of consensus is the public opinion. Through outreach efforts, it is possible to both educate the public and obtain their input for the study. It is important to learn what matters to the stakeholders since they are the ones who will be directly impacted by any projects or conclusions that come out of the study. During Phase 2, the opportunities to inform and educate the public on the progress of the study were through presentations at the Authority Board meetings and the progress reports at the Lower Pajaro River stakeholder meetings. In Phase 3 of the study, public outreach efforts will be increased to ensure stakeholder issues are identified and addressed in the Soap Lake Preservation Project.

Coordination With Other Studies

Coordination with past, current, and future projects affecting the Pajaro River watershed is crucial to the success of the study. Past projects have identified areas of concern for the local residents and collected a great deal of data for the watershed. Future studies should be able to dovetail with ongoing efforts for this study. Current relevant projects and studies include:

- Corps Lower Pajaro River Flood Protection Project
- San Luis Reservoir Low Point Improvement Project
- Various Sediment Projects with the Regional Water Quality Control Board
- Pajaro Valley Water Management Agency Water Supply Project
- Llagas Creek Flood Protection Project

It is critical that Phase 3 efforts are closely coordinated with the Lower Pajaro River Project and that progress on both projects is communicated in a unified, consistent message.

Environmental Issues

Impacts to the environment are very important considerations when planning any project or developing an area. Threatened and endangered species such as the steelhead trout, the California red-legged frog, the tidewater goby, and the western pond turtle must be protected and their habitats preserved. The Pajaro River Watershed Study will, at a minimum, be in compliance with the Endangered Species Act (ESA). However, a project like the Soap Lake Preservation Project could go beyond simply complying by providing environmental enhancement opportunities, which would then maximize funding opportunities.

In addition to the ESA and biological environmental impacts, the Clean Water Act must be adhered to as well. For example, the Pajaro River was listed on the 303(d) list as a high priority site for nutrients and Llagas Creek is listed for both nutrients at a high priority and sedimentation at a medium priority. San Benito River was listed on the 1998 list as a medium priority for sedimentation and Hernandez Reservoir was a medium priority for mercury. Again, the Soap Lake Preservation Project, with careful planning and consideration, could provide the necessary flood protection benefits as well as the needed water quality improvements.

The scope for Phase 3 of the study has been developed to ensure the Soap Lake Preservation Project is developed in a manner that maintains the flood attenuation benefits, protects and enhances the environment, and maximizes funding opportunities.

APPENDICES

Appendix A

The following pages are excerpts from the Pajaro River Flood Protection Project Planning Process Meeting on September 12, 2002. They provide details regarding the construction and costs for the five Corps alternatives proposed for the lower Pajaro River.





U.S. Army Corps of Engineers Planning Process Meeting

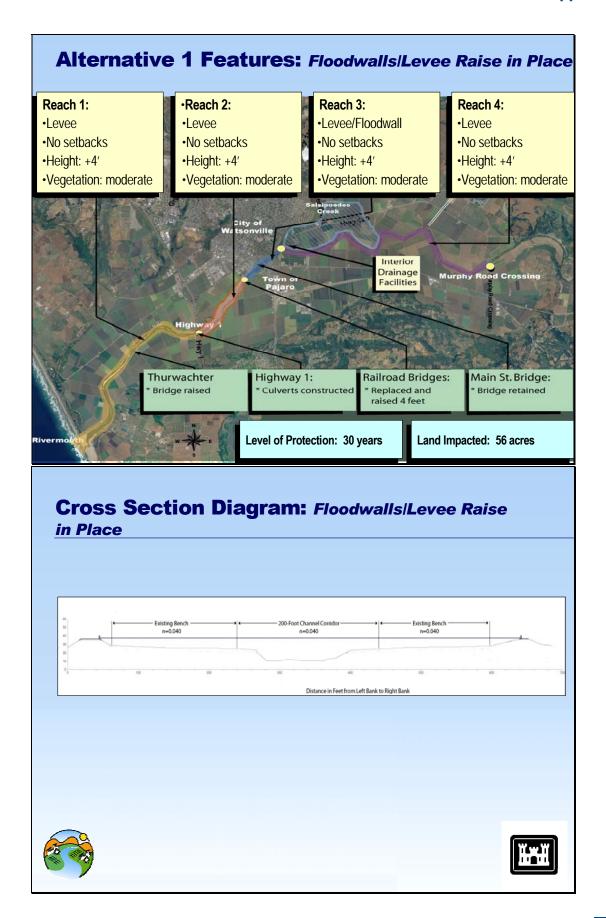
September 12, 2002







Review of Project Alternatives for Mainstem



Economic/Financial Feasibility: Floodwalls/Levee Raise in Place

Preliminary Estimates in Millions:

LERRD's	\$	7.4
Construction	1	19.4
E&D, S&A (15%)		19.0
Total Project Cost*	\$14	45.8

Annual Cost \$ 10.4 **OMRR&R** (1%) 1.2 \$11.6 **Total Annual Cost**

Benefits \$15.8

Net Benefits \$4.2

Benefit:Cost Ratio 1.36:1

Non-Federal Cost (25%) \$36.4

Alternative 2 Features: 100-foot Setback

Reach 1:

- Levee

Reach 2:

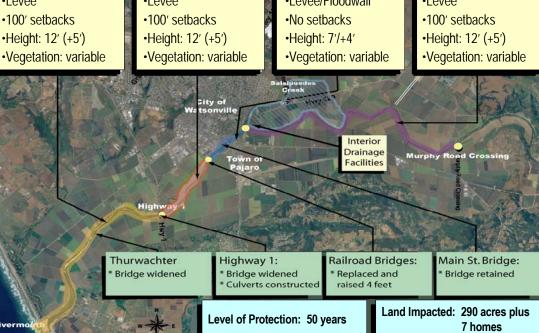
Levee

Reach 3:

·Levee/Floodwall

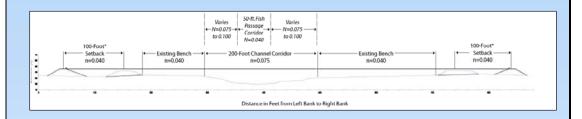
Reach 4:

•Levee



^{*} Total annual cost does not include environmental mitigation or cultural resource costs.

Cross Section Diagram: 100-foot Setback



^{*} Representative section; will actually vary by location.



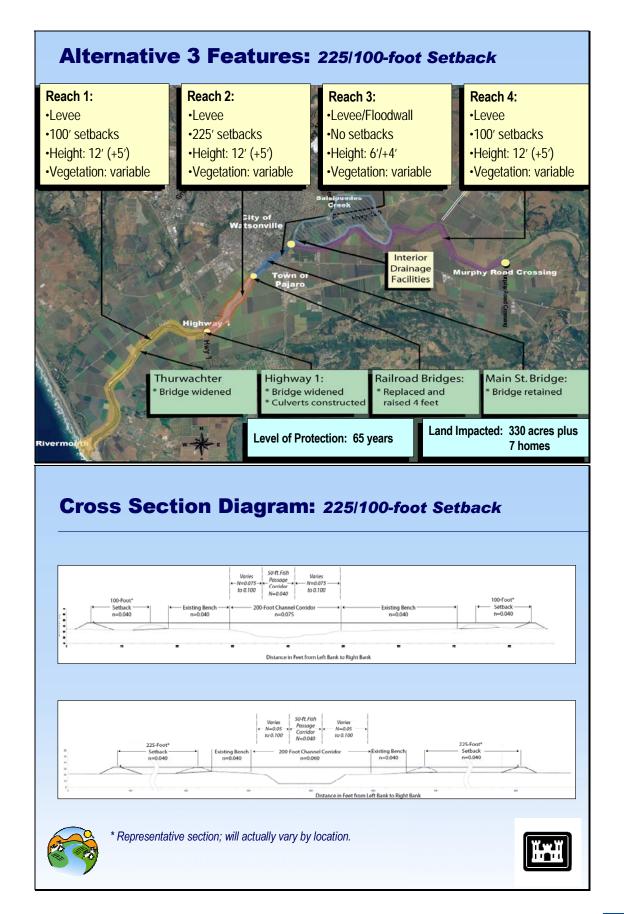


Economic/Financial Feasibility: 100-foot Setback

Preliminary Estimates in Millions:

LERRD's	\$ 18.6
Construction	133.9
E&D, S&A (15%)	22.9
Total Project Cost*	\$175.4
Annual Cost	\$ 12.7
OMRR&R (0.6%)	0.8
Total Annual Cost	\$13.5
Benefits	\$16.1
Net Benefits	\$2.6
Benefit:Cost Ratio	1.19:1
Non-Federal Cost (25%)	\$43.9

^{*} Total annual cost does not include environmental mitigation or cultural resource costs.



Economic/Financial Feasibility: 225/100-foot Setback

Preliminary Estimates in Millions:

LERRD's Construction	\$ 20.3 133.9
E&D, S&A (15%)	23.1
Total Project Cost*	\$177.3
Annual Cost	\$ 12.8
OMRR&R (0.6%)	0.8
Total Annual Cost	\$13.6

Benefits \$16.8

Net Benefits \$3.2

Benefit: Cost Ratio 1.24:1

\$44.3 Non-Federal Cost (25%)

Alternative 4 Features: Floodwall In-lieu of Levee

Reach 1:

- Floodwall

Reach 2:

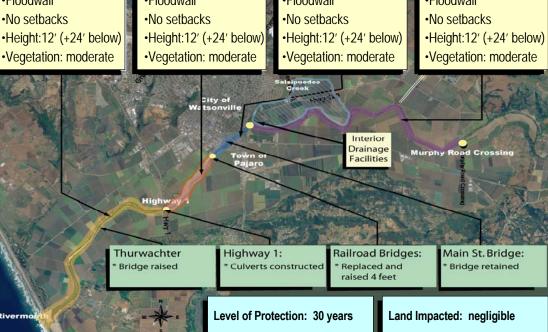
Floodwall

Reach 3:

Floodwall

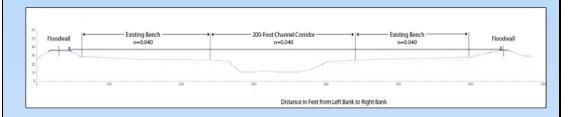
Reach 4:

Floodwall



^{*} Total annual cost does not include environmental mitigation or cultural resource costs.







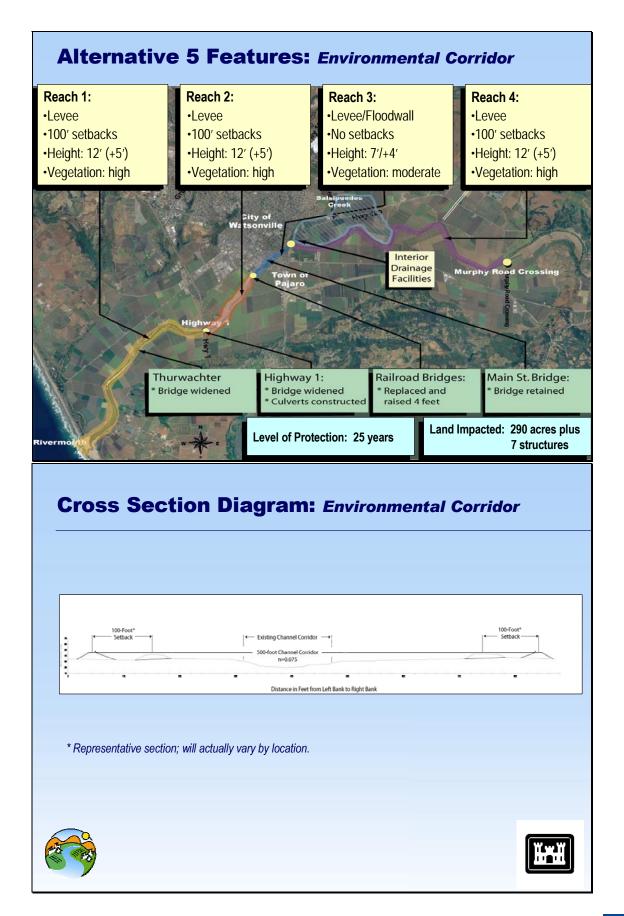


Economic/Financial Feasibility: Floodwall In-lieu of Levee

Preliminary Estimates in Millions:

LERRD's	\$ 4.4
Construction	275.8
E&D, S&A (15%)	42.0
Total Project Cost*	\$322.2
Annual Cost	\$ 23.0
OMRR&R (1%)	2.8
Total Annual Cost	\$25.8
Benefits	\$15.8
Net Benefits	-\$10.0
Benefit:Cost Ratio	0.61:1
Non-Federal Cost (25%)	\$80.5

^{*} Total annual cost does not include environmental mitigation or cultural resource costs.



Economic/Financial Feasibility: *Environmental Corridor*

Preliminary Estimates in Millions:

LERRD's	\$ 18.6
Construction	133.9
E&D, S&A (15%)	22.9
Total Project Cost*	\$175.4
Annual Cost	\$ 12.7
OMRR&R (0.4%)	0.6
Total Annual Cost	\$13.3
Benefits	\$12.0
Net Benefits	-\$1.3
Benefit:Cost Ratio	0.90:1
Non-Federal Cost (25%)	\$43.9

^{*} Total annual cost does not include environmental mitigation or cultural resource costs.

Economic/Financial Feasibility Comparison

(Preliminary Estimates in Millions): All Mainstem Alternatives

	Alt 1 Fwalls/ Levee	Alt 2 100' Setback	Alt 3 225/100' Setback	Alt 4 Floodwall	Alt 5 Env'l Corridor
Total Project Cost	\$145.8	\$175.4	\$177.3	\$322.2	\$175.4
Total Annual Cost	\$11.6	\$13.5	\$13.6	\$25.8	\$13.3
Benefits	\$15.8	\$16.1	\$16.8	\$15.8	\$12.0
Net Benefits	\$4.2	\$2.6	\$3.2	-\$10.0	-\$1.3
Benefit:Cost Ratio	1.36:1	1.19:1	1.24:1	0.61:1	0.90:1
Non-Federal Cost (25%)	\$36.4	\$43.9	\$44.3	\$80.5	\$43.9
LOP	30 yrs	50 yrs	65 yrs	30 yrs	25 yrs

Appendix B

The alternative cost estimates in Chapter 3 of this report are relative estimated construction costs intended only for comparison with each other. Several costs that could greatly affect the final estimate of costs were either approximated or neglected.

Unit Costs

The following is a table of the unit costs and sources used in the cost estimates contained within this report.

Table B-1: Unit cost and source of information for items within the project cost estimates.

Item	Unit Price	Source
Aggregate base (roads and concrete)	\$34.66/cy	Pajaro River Levee Project A1+1, U.S. Army Corps of San Francisco, 1/15/02, p.8
Concrete in place	\$97.82/cy	Pajaro River Levee Project A1+1, U.S. Army Corps of San Francisco, 1/15/02, p.11
Curing	\$7.16/csf	Pajaro River Levee Project A1+1, U.S. Army Corps of San Francisco, 1/15/02, p.11
Diversion	Varies	Based on log regression of Corps Diversion (Caernarvon and Davis Pond)
Embankment	\$10/cy	Lopez Dam Seismic Remediation Project Construction Cost Estimate & King 1/00
Excavate to depth	\$1.79/cy	Pajaro River Levee Project A2+1, U.S. Army Corps of San Francisco, 1/15/02, p.10
Finishing walls	\$0.55/sf	Pajaro River Levee Project A1+1, U.S. Army Corps of San Francisco, 1/15/02, p.11
Flow control tunnel	\$2,000,000	Estimate by John Clark, Montgomery Watson Harza
Form levees with exc. soil	\$0.98/cy	Pajaro River Levee Project A1+1, U.S. Army Corps of San Francisco, 1/15/02, p.8
Forms in place	\$6.33/sf	Pajaro River Levee Project A1+1, U.S. Army Corps of San Francisco, 1/15/02, p.11
Foundation	\$10/cy	Lopez Dam Seismic Remediation Project Construction Cost Estimate & King 1/00
Foundation preparation	\$3,000,000	Estimate by John Clark, Montgomery Watson Harza
Instrumentation	\$300,000-\$500,000	Estimate by John Clark, Montgomery Watson Harza, upgrades vs. new equipment
Land clearing	\$4,200/acre	Pajaro River Levee Project A1+1, U.S. Army Corps of San Francisco, 1/15/02, p.5
Land easement - Downstream of Chittenden	\$5,000/acre	Basin Management Plan, Pajaro Valley Water Management Agency, 2/02
Land easement - Upstream of Chittenden	\$3,000/acre	Santa Clara County Open Space Authority & San Benito County Assessors Office, 8/02
Land purchase - Downstream of Chittenden	\$30,000/acre	Basin Management Plan, Pajaro Valley Water Management Agency, 2/02

Land purchase - Upstream of Chittenden	\$10,000/acre	Santa Clara County Open Space Authority & San Benito County Assessors Office, 8/02
Mobilization & demobilization	5% of Construction items	2002 Current Construction Costs, Saylor Publications, Inc.
Monitoring	\$200,000	Lopez Dam Seismic Remediation Project Construction Cost Estimate
Outlet structure	Varies	Assumption that outlet works will be about as expensive as the diversion
Outlet works	\$1,000,000	Lopez Dam Seismic Remediation Project Construction Cost Estimate & King 1/00
Pre-cast box inc. shipping	Varies	Rough estimate, Frank Arellano, BridgeTech
Pre-cast box installation	40% of Pre-cast box inc. shipping	Rough estimate, Frank Arellano, BridgeTech
Remove top 2' soil & stockpile	\$2.77/cy	2002 Current Construction Costs, Saylor Publications, Inc.
Soil transport & disposal	\$18.68/cy	Pajaro River Levee Project A1+1, U.S. Army Corps of San Francisco, 1/15/02, p.7
Spillway	\$1,200,000	Lopez Dam Seismic Remediation Project Construction Cost Estimate & King 1/00
Transport and reform soil	\$5.00/cy	Combination and average of several items from 2002 Current Construction Costs, Saylor Publications, Inc.
College Lake Detention Estimate		Evaluation of College Lake and Bolsa de San Cayetano Projects, Kenneth King, P.E., 1/00

Omitted Items

It should be noted that several items of considerable expense were omitted from the cost estimates, including:

- Mitigation
- Replacement and/or relocation of infrastructure

Mitigation and the replacement or relocation of infrastructure can be very expensive, and in some cases, prohibitive. These items were not included though due to the variability of impacts due to the design of the project. With additional planning and identification of a more limited number of alternatives for preliminary design, the impact on the final cost of these items can be considered. A description of some of the major infrastructure that might be impacted by the alternatives has been included as additional information in each of the alternatives to provide the likely scope of the infrastructure improvements necessary.

Repair costs for the existing levees were not included in any of the alternative cost estimates.

Assumptions and Approximations

The cost estimates are based on uniform unit cost assumptions. This is considered reasonable for the level of detail required at this stage of the project planning. As with the infrastructure and mitigation, a more detailed conceptual design will allow a reduction in the percentage variation of the estimated cost from actual project costs. The following items are especially impacted by the preliminary assumptions:

Dam foundation

- Dam spillway
- Dam outlet works
- Monitoring
- Instrumentation
- Flow control tunnel
- Land acquisition

The following assumptions were made regarding the construction of and the unit costs for the dams:

- Site preparation includes all clearing, grubbing & demolition
- Flow control tunnel includes all materials and labor necessary to provide a temporary passage for water
- Foundation includes excavation, grouting & concrete
- Embankment includes soil, placement, drains & armoring
- Outlet works include concrete, chute, terminal structure, pipes & valves
- Spillway includes concrete and drain
- Raising the dams involves building on top of the existing dams
- Foundation preparation includes excavation and conditioning of existing embankment and foundation

Due to the significant excavation included in most of the alternatives, one of the major cost items is soil transport and disposal (\$18.68/cy). This value includes a 3-mile round trip to dispose of the soil and a \$12/cy landfill disposal fee. It is possible that this cost could increase or decrease, depending on the ultimate design of the project and the potential for use of the excavated soil in construction. Changes in the unit cost or amount of excavation will influence the total cost of the alternative. In most cases, the total costs accounted for less than 15 percent of the total construction costs for the alternative, which is within the expected range of the cost estimate for the conceptual stage of design.

